

Monday, 8:30-10:00

■ MA-01

Monday, 8:30-10:00

KEY Askja N-132

KEYNOTE: Advances in Portfolio Optimization

Stream: Multiple Objective Optimization

Invited session

Chair: *José Rui Figueira*, Instituto Superior Tecnico, Technical University of Lisbon, Av. Cavaco Silva, Tagus Park, 2780 - 990 Porto Salvo, 2780 - 990, Lisbon, Portugal, figueira@ist.utl.pt

Chair: *Kathrin Klamroth*, Institute of Applied Mathematics, University of Erlangen-Nuremberg, Martensstr. 3, 91058, Erlangen, Germany, klamroth@am.uni-erlangen.de

1 - KEYNOTE: Advances in Portfolio Optimization

Ralph E. Steuer, Terry College of Business, University of Georgia, Department of Banking and Finance, Brooks Hall, 30602-6253, Athens, GA, United States, rsteuer@uga.edu

This keynote discusses advances that have been made in both conventional and multiple criteria portfolio selection in finance. In the conventional case, discussions center about a new computer capability that can exactly compute mean-variance efficient frontiers of problems with up to several thousand securities in only a matter of minutes. In the multiple criteria case, discussions center about extensions to the theory of portfolio selection that allow multiple objectives (such as dividends, liquidity, social responsibility, amount invested in R&D, and so forth).

■ MA-02

Monday, 8:30-10:00

APP Askja N-131

Emergency Services Planning

Stream: OR in Health Care

Invited session

Chair: *Sally Brailsford*, University of Southampton, School of Management, SO17 1BJ, Southampton, United Kingdom, s.c.brailsford@soton.ac.uk

1 - Allocation/Reallocation of Ambulances to Casualty Clusters

Rajan Batta, Industrial and Systems Engineering, University at Buffalo (SUNY), 420 Bell Hall., 14260, Buffalo, NY, United States, batta@eng.buffalo.edu

In this talk, we consider ambulance allocation and reallocation models for a postdisaster relief operation. The initial focus is on allocating the correct number of ambulances to each cluster at the beginning of the rescue process. The second problem analyzes the ambulance reallocation problem on the basis of a discrete time policy. We consider the objective of minimizing makespan. The complication is that the distance between clusters needs to be factored in when making an ambulance reallocation decision. Results are illustrated via a case study.

2 - Analyzing the emergency medical systems on highways using a multiple dispatch and partial backup hypercube queuing model

Ana Iannoni, Dept. of Production Engineering, Federal University of São Carlos, P 676, 13565-905, São Carlos, SP, Brazil, aiannoni@dep.ufscar.br, *Reinaldo Morabito*

In this study we adapt the hypercube queuing model to analyze Emergency Medical Systems (EMS) on highways, operating within particular dispatching policies. The model considers that: the emergency calls are of different types, the servers are distinct, only certain servers in the system can service calls in a given region (partial backup), and, depending on the call type, one or more identical or distinct servers are immediately dispatched to service such call (multiple dispatch). Computational results are analyzed applying the approach to study an EMS operating on Brazilian highways.

3 - Emergency service generalized flexible simulation model

Giorgio Romanin-Jacur, Management and Engineering, University of Padova, Stradella San Nicola, 3, 36100, Vicenza, Italy, romjac@dei.unipd.it, *Paola Facchin*

We build up and implement a generalized flexible simulation model, apt to describe almost all existing emergency services, based on common characteristics, on conventions which are internationally accepted for pathology classification and on largely adopted assistance rules. It may be easily adapted to different types of supplied services, by adjustment of small portions of it, and to different arrival patterns, structures, resources and working rules, by determination of few parameters. Micro Saint implementation presents a good compromise between abstraction level and user friendliness.

■ MA-03

Monday, 8:30-10:00

APP Askja N-130

Auctions in Theory and Practice

Stream: Auctions

Invited session

Chair: *Wedad Elmaghraby*, R.H. Smith School of Business, University of Maryland, Decision and Information Technology, 20742, College Park, MD, United States, welmaghr@rhsmith.umd.edu

1 - Multiple sourcing and procurement process selection with bidding events

Tunay Tunca, Graduate School of Business, Stanford University, 518 Memorial Way, 94305, Stanford, CA, United States, tunca_tunay@gsb.stanford.edu

We examine the procurement process selection problem of a large industrial buyer who purchases an intermediate good from a group of suppliers through bidding events. We derive the optimal quantity and contract strategies for a standard single-stage reverse auction process and a two-stage process. We then derive the optimal number of suppliers to be sourced from for both processes and characterize the conditions under which each procurement mode will be optimal.

2 - Joint versus serial auctions in procurement

Dolores Romero Morales, Saïd Business School, University of Oxford, Park End Street, OX1 1HP, Oxford, United Kingdom, dolores.romero-morales@sbs.ox.ac.uk, *Reinder B. Lok*, *Richard Steinberg*

We consider a supply chain consisting of a buyer and multiple suppliers, where the buyer requires a component over a planning horizon from the suppliers. The buyer is considering running a joint auction for all periods versus a series of one-period auctions. The buyer will have the advantage of purchasing units in advance. However, suppliers will also be able to compete more efficiently against the buyer since they will incorporate more information about their costs and capacities. We derive scenarios for which the joint auction is at least as good as the series of one-period auctions.

3 - Evaluating multiattribute bids for industrial procurement

Jayant Kalagnanam, Mathematical Sciences, IBM Research, 1101 Kitchawan Rd, PO Box 218, 10598, Yorktown Hts, NY, United States, jayantkr@yahoo.com

Multiattribute RFPs/auctions are common practice today. We bring useful tools from multiattribute utility theory and social choice theory to this problem. We introduce the use of preference elicitation techniques and rank aggregation to aid decisions in single vs group decision making contexts. We will present examples to illustrate these approaches.

4 - Scheduling Agent Auction Trading

Barin Nag, Management, Towson University, 8000 York Road, 21252, Towson, Maryland, United States, bnag@towson.edu

Scheduling auction trading by intelligent agents in the supply chain is a matter of matching prices and quantities to the best advantage of buyer and seller agents. We consider split lots with discounted pricing for larger quantities. We develop a model and a heuristic solution.

■ MA-04

Monday, 8:30-10:00

APP Askja N-129

Telecommunications I

Stream: Telecommunications (c)

Invited session

Chair: *Adrian Werner*, NTNU, Norway, Adrian.Werner@iot.ntnu.no

1 - Multi-feature testing in telecommunications

Roberto Rossi, Cork Constraint Computation Centre, University College Cork, Washington Street, Cork, Ireland, rrossi@4c.ucc.ie, *Armagan Tarim*, *Brahim Hnich*, *Steven Prestwich*

We address the problem of computing pass/fail probabilities for multi-feature tests, when an initial population of good/bad items and a set of parameters for test/repair machines are given. We propose an efficient solution method based on a finite-state automaton that classifies scenarios into one of four possible main categories. We propose an algebraic method that let us compute pass/fail probability values without generating every possible scenario. The described algebraic method is linear in both space and time.

2 - Parallel algorithm and implementation for a cryptographic system

Eduard Franti, Telecommunication, IMT Bucharest, Erou Iancu Nicolae 32 B sector 2, 7000, Bucharest, Romania, edif@atlas.cpe.pub.ro, *Monica Dascalu*

This paper presents a complex project that aims the development and design of a parallel computing based cryptographic system. A special software tool was developed in order to select the cryptographic schemes that are optimal for hardware implementation. This software is necessary mainly in order to choose a large set of local rules as possible keys that should be integrated in hardware. The VLSI implementation resulted in cheap, robust, and versatile cryptographic circuits that may be adapted to different devices (like phones) in order to ensure the privacy of data communication.

3 - Development of proxy server for protecting privacy by distributing information

Shozo Naito, Web Business Technology, The Kyoto College of Graduate Studies for Informatics, 7 Monzen-cho Tanaka Sakyo-ku, 606-8225, Kyoto, Japan, s_naito@kcg.ac.jp, *Hong Seung Ko*, *Makoto Hirose*, *Takao Nakaguchi*

We propose a method for protecting privacy by way of (1) introducing a proxy server, (2) distributing information necessary for realizing a web service, and (3) encrypting information required by the individual server by the server's own private key. This method makes it possible that privacy is protected against information leak from or unauthorized access to the proxy or the individual server. Furthermore this method requests only the standard browser and does not request installation of any specific programs in the client.

4 - Telecom portals: strategic interactions and value flow analysis

Adrian Werner, National Institute for Technology Management, University College Dublin, Michael Smurfit Graduate School of Business, Blackrock, —, Co. Dublin, Ireland, adrian.werner@ucd.ie, *Amiya Chakravarty*

New technology and deregulation have created new options in telecom value chains. Portals are a user's point for access to a range of services and resources: e-mail, forums, games,... Numerous business plans exist, reflecting revenue distribution methods or portal ownership. Industrial experience on value flow and profit generation has been accumulated, but fundamental scientific understanding is still lacking. Using a game theoretic model, we analyze value flow, strategic decisions, and interactions. We discuss several business models in order to explain their viability and competitiveness.

■ MA-05

Monday, 8:30-10:00

APP Askja N-128

Management Planning in Forest Based Industry

Stream: OR in Agriculture and Forest Management

Invited session

Chair: *Manfred Gronalt*, Institute of Production and Logistics, University of Natural Resources and Applied Life Sciences, Feistmantelstr. 4, A-1180, Vienna, Austria, Manfred.Gronalt@boku.ac.at

1 - OR in the management planning of forest-industry (UPM-Kymmene Ltd) owned forests in Finland

Jyrki Kangas, Forest Finland, UPM-Kymmene Ltd, P.O.Box 32, FIN-37601 Valkeakoksi, Valkeakoski, Finland, jyrki.kangas@upm-kymmene.com

Simulation of forest development is needed in describing management alternatives and in forecasting their consequences. Combined use of simulation and optimisation enables analyses of timber production possibilities and producing efficient forest plan alternatives. MCDA methods can then be used for holistic comparison of these plans so that also other information available is utilised. At UPM, simulation, optimisation, and MCDA are frequently applied, and their applications are under continuous development. A general problem in applying advanced OR tools is the poor quality of input data.

2 - Integrated wood-flow supply chain optimisation for CHP plants network

Simone Zanoni, Dipartimento di Ingegneria Meccanica, Università di Brescia, via Branze 38, 25123, Brescia, Italy, Italy, zanoni@ing.unibs.it, *Ivan Ferretti*, *Luca Zanchi*, *Lucio Zavarella*

The logistic system connected to a network of Combined Heat and Power (CHP) plants is a fundamental task. We apply our study on the area of the North-East of Italy: in this region there are 13 CHP plants. Our work led to the optimization of the wood-flow supply process for the entire network of CHP plant and pellets production plants. To this aim we have developed an integrated optimisation model with which it is possible to guarantee the right quantity of raw material at the right time at the minimum total costs.

3 - Integrated production and distribution planning for Södra Cell AB

Helene Gunnarsson, Department of Mathematics, University of Linköping, Division of optimization, 581 83, Linköping, Sweden, hegun@mai.liu.se, *Mikael Rönnqvist*, *Dick Carlsson*

We consider integrated planning of transportation of raw material, production and distribution of products of the supply chain at Södra Cell AB. Decisions included in the planning are transportation of raw materials from harvest areas to pulp mills, production mix and contents at pulp mills, distribution of pulp products from mills to customer via terminals or directly and selection of potential orders and their levels at customers. We propose a mathematical model for the entire supply chain. Five different alternatives in a case study are analyzed and evaluated.

4 - Production planning and use of material flow simulation in sawmilling industries

Manfred Gronalt, Institute of Production and Logistics, University of Natural Resources and Applied Life Sciences,

Feistmantelstr. 4, A-1180, Vienna, Austria,
Manfred.Gronalt@boku.ac.at

Sawmilling industry is faced with a strong competition. To improve their operation advanced planning methods are suggested. In sawmilling a number of by products are generated compulsorily. Customer orders and inventory figures of both timber and round wood must be considered to select the optimal cutting patterns. Our approach starts with the solution of a loading problem, which combines cutting pattern selection and inventory management. The selected orders are used as input for the simulation model which provides a detailed resource scheduling. Our approach is tested with real life data.

■ MA-06

Monday, 8:30-10:00
APP Askja N-121

OR in the public sector I

Stream: OR in the Public Sector

Invited session

Chair: *Michael Pidd*, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, m.pidd@lancaster.ac.uk

1 - Government preparedness: using simulation in the fire service to prepare for a terrorist incident

Pavel Albores, Operations and Information Management, Aston Business School, Aston Triangle, South Wing 9th Floor, B4 7ET, Birmingham, United Kingdom, p.albores@aston.ac.uk, *Duncan Shaw*

The threat of terrorism has caused governments worldwide to set up plans to deal with attacks of this type. This paper discusses the use of discrete event simulation by the British government (Fire and Rescue Service) to prepare before an incident takes place. Two models are built for this purpose. The first model deals with mass decontamination of a population following a chemical, biological, radiological or nuclear incident. The second model deals with the allocation of resources across regions, aiming to study cover level and response times and analyzing different allocations of resources.

2 - NOMS demand model (UK Home Office)

Vasso Vakalopoulou, Research Development and Statistics, Home Office, 2 Marsham Street, 3rd Seacole, SW1P 4DF, London, United Kingdom, vassiliki.vakalopoulou@homeoffice.gsi.gov.uk

The Carter Review and the introduction of NOMS (National Offender Management Services) represents a new integrated approach to offender management.

There is therefore a requirement for a comprehensive high level tool that combines existing assumptions to provide a consistent basis for quantifying the downstream impacts of policy proposals and shifts in workload across NOMS.

The NOMS demand model meets this need by simulating the flow of offenders from the point of sentence through custodial and community aspects.

3 - Improving police response in a large city

Michael Pidd, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, m.pidd@lancaster.ac.uk

Like other areas of UK public services, police forces are set targets for their performance. Some of these targets relate to the speed at which they respond to calls for assistance from the public. One such police force was failing to meet its targets and sought help from the author, asking for a simulation model of their control and resource centres. What started as a simple modelling exercise turned into a fascinating piece of detective work in which different organisational options were explored, with a simulation model at the core of this work.

■ MA-07

Monday, 8:30-10:00

APP Askja N-120

OR in Fisheries

Stream: OR in Fisheries (c)

Invited session

Chair: *Eldon Gunn*, Industrial Engineering, Dalhousie University, 5269 Morris St., B3J 2X4, Halifax, Nova Scotia, Canada, eldon.gunn@dal.ca

1 - Sustainable management of fisheries: an illustration of viability concepts and methods

Michel de Lara, CERMICS, Ecole nationale des ponts et chaussees, 6 et 8 avenue Blaise Pascal, Cite Descartes, 77455, Marne la Vallee Cedex 2, France, delara@cermics.enpc.fr

Indicators and their associated reference points are key elements of current fisheries management advice, especially in the International Council for the Exploration of the Sea precautionary approach. However, although sustainable management is claimed to be a guide for decision making, no general and long term objectives are explicitly stated. In this talk, we show how viability may help both giving a framework for setting decision making and computing operational policies. Computations are performed to test viability of current practices and to propose others.

2 - Data gathering and simulation in fish manufacturing plant

Bjarni Hjarðar, Faculty of Business Administration, University of Akureyri, Solborg, 600, Akureyri, Iceland, bh@unak.is

The fish manufacturing plant at Brim, former UA, located in Akureyri, Iceland, processes fish in a advanced manufacturing system consisting of among other things 18 manned stations where the fish is cut, rinsed and bone-cleansed. The paper describes the data gathering in the process using video-filming and data analysing, where unique and exact data was collected. A brief description of possible use of this data in improvement and decision making in the process is given, and a comprehensive example of a simulation model, system improvements and financial analysis in UA is taken.

3 - Decision Support System in the Icelandic cod industry

Sveinn Margeirsson, Icelandic Fisheries Laboratories / University of Iceland, Skulagata 4, 101, Reykjavik, Iceland, sveinnm@rf.is, *Runolfur Gudmundsson*, *Pall Jensson*, *Sigurjon Arason*

Cod processing is an important industry in Iceland. The size of the Icelandic cod stock is however limited and therefore important to maximize the value of the catch.

A Decision Support System based on a LP-model is being developed, aimed at improving profitability in the Icelandic cod industry through improved short and long term planning and better overview of the value chain. The DSS is based on research projects at the University of Iceland and Icelandic Fisheries Laboratories as well as experience of seafood specialized companies, both software providers and processing companies.

4 - An Integer Programming Model for the Management of Salmon Aquaculture: Computational Experience and Results

Eldon Gunn, Industrial Engineering, Dalhousie University, 5269 Morris St., B3J 2X4, Halifax, Nova Scotia, Canada, eldon.gunn@dal.ca, *Pall Jensson*

A size-class based Markov model of the growth and harvesting of a multi-pen salmon farm is described. Harvesting policies are restricted to size-grading policies where all fish over a given size must be harvested. The models require tight formulations in order to be solveable. Provably optimal integer solutions are difficult to obtain, but quite good, feasible integer solutions can be found for large farms (35 pens +) in reasonable computing time. An interesting observation is that there appears to be considerable economic opportunity in developing selective harvesting policies.

■ MA-08

Monday, 8:30-10:00

EDU Oddi 101

TUTORIAL: Anticipative and Incurive Dynamical Systems

Stream: Dynamical and Anticipatory Systems

Invited session

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, Odtü, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Tutorial: Anticipative and Incurive Dynamical Systems and Their Applications in Operations Research

Daniel M. Dubois, UER Operations, HEC Management School - University of Liege, Office: Institute of Mathematics, B37, Grande Traverse 12., B-4000, Liège, Belgium, daniel.dubois@ulg.ac.be

This tutorial deals with concepts, methods and tools for modelling, simulating and controlling dynamical systems with anticipatory capabilities. By definition, the dynamics of an anticipative system depends on its past and present states, but also on its potential future states. The concept of "weak anticipation" refers to an anticipation of events predicted or forecasted from a model of a system, while the concept of "strong anticipation" refers to an anticipation of events built by or embedded in a system. A mathematical tool to model dynamical anticipative systems deals with differential difference equations with retardation and anticipation. In delayed systems, it is possible to anticipate their future states by an incurive synchronization. A first application in operations research is the extended Kaldor-Kalecki model of business cycle with a computational anticipated capital stock, by synchronization. A second application will demonstrate that delay times in management systems produces instabilities while anticipation produces more stability. In 1992, we introduced the concepts of "incurion" (INclusive reCURSION) and "hyperincurion" (incurion with multiple solutions). For simulations, incurive algorithms show a better numerical stability than the Euler and Runge-Kutta ones. A first example is the incurive discrete non-linear Lotka-Volterra system. The second example deals with the incurive predictive control of the generalized Verhulst chaos map at any order. The third example of simulation will be the anticipation of the time evolution of an epidemics in a delayed susceptible-infected population, by an incurive synchronization. _____ Papers on Computing Anticipatory Systems can be downloaded at the website: <http://www.ulg.ac.be/mathgen/CHAOS>

■ MA-09

Monday, 8:30-10:00

IT Oddi 106

Bioinformatics I

Stream: Computational Biology and Bioinformatics

Invited session

Chair: *Jacek Blazewicz*, Instytut Informatyki, Politechnika Poznańska, ul.Piotrowo 2, 60-965, Poznan, Poland, jblazewicz@cs.put.poznan.pl

Chair: *Ceyda Oguz*, Department of Industrial Engineering, Koc University, Rumeli Feneri Yolu, Sariyer, 34450, Istanbul, Turkey, coguz@ku.edu.tr

1 - Metaheuristic approaches for protein structure prediction

Ceyda Oguz, Department of Industrial Engineering, Koc University, Rumeli Feneri Yolu, Sariyer, 34450, Istanbul, Turkey, coguz@ku.edu.tr

In this talk we will present a metaheuristic approach to predict protein structure by using two-dimensional hydrophobic-polar model. The results show that the proposed algorithm is efficient and effective to obtain the desired solution for the problem.

2 - DNA sequencing by hybridization with multiplicity information available

Piotr Formanowicz, Institute of Computing Science, Poznan

University of Technology, Piotrowo 2, 60-965, Poznan, Poland, piotr@cs.put.poznan.pl

In the classical sequencing by hybridization (SBH) method it is assumed that the hybridization experiment provides only information about the presence or absence of a given 1-tuple in the target DNA sequence. It follows from the interpretation of the sequencing chip image. Nevertheless, it is possible to take into account the intensity of the chip signals. This intensity is correlated with the number of repetitions of the 1-tuples in the target DNA. It leads to formulation of new combinatorial problems which arise in the SBH approach when such additional information is available.

3 - Logical Analysis of Medical Data

Nadia Brauner, Laboratoire Leibniz-IMAG, 46 avenue Felix Viallet, 38031, Grenoble, France, Nadia.Brauner@imag.fr,
Louis-Philippe Kronek, *Pierre Lemaire*

Logical Analysis of Data (LAD) is a supervised classification method of data mining. This method is based on the study of partially defined Boolean functions and combinatorial optimization methods. The main goal is to extract, from a given data set, structured information in the form of patterns that are collectively interesting. We present the method and define useful mathematical objects handled by LAD. By the simplicity of its object, this method is very appealing to non-specialists. This will be illustrated with applications in medical research.

■ MA-10

Monday, 8:30-10:00

OR Oddi 201

Vehicle Routing I

Stream: Vehicle Routing

Invited session

Chair: *J. E. Beasley*, Carisma, Brunel University, Department of Mathematical Sciences, Kingston Lane, UB8 3PH, Uxbridge, Middlesex, United Kingdom, john.beasley@brunel.ac.uk

1 - A tabu search based heuristic for dynamic dial-a-ride problems arising in in-house hospital transportation

Stefan Nickel, Chair of Logistics and Operations Research, Saarland University, Am Stadtwald, 66041, Saarbruecken, Saarland, Germany, s.nickel@orl.uni-saarland.de, *Teresa Melo*

This talk focuses on a novel tabu search based heuristic method for online routing and scheduling vehicles that serve requests for in-house transports of patients in a hospital. Hospital inherent aspects include, among others, accounting for transport priorities, different vehicle types and personnel skills, and soft time windows with respect to the desired pickup and/or drop-off times. These aspects significantly complicate the construction and modification of high-quality feasible schedules. Using real data from two German hospitals, the usefulness of the developed heuristic is shown.

2 - The split delivery vehicle routing problem: Applications, algorithms, test problems, and computational results

Edward Wasil, Kogod School of Business, American University, 4400 Massachusetts Ave, NW, 20016, Washington, DC, United States, ewasil@american.edu,
Bruce Golden, *Si Chen*

In the split delivery vehicle routing problem (SDVRP), a customer's demand can be split among several vehicles. In this paper, we review applications of the SDVRP and solution methods such as integer programming and tabu search. We develop a new heuristic that combines a mixed integer program with a record-to-record travel algorithm. Our heuristic produces high-quality solutions to six benchmark problems. Finally, we develop 21 new test problems. A near-optimal solution can be visually estimated for each problem. We apply our heuristic to these new problems and report our results.

3 - A tabu search algorithm for the single vehicle routing allocation problem

J. E. Beasley, CARISMA, Brunel University, Department of Mathematical Sciences, Kingston Lane, UB8 3PH, Uxbridge, Middlesex, United Kingdom, john.beasley@brunel.ac.uk, *Chandra Poojari*

The single vehicle routing allocation problem involves deciding a route for a vehicle (starting and ending at given locations) such that it visits some (but not necessarily all) customers. Our tabu search algorithm includes aspiration, path relinking and diversification. Computational results are presented.

■ MA-11

Monday, 8:30-10:00
TRANS Oddi 202

Transport Policy Evaluation Models

Stream: Transportation

Invited session

Chair: *Warren Walker*, Delft University of Technology, Delft, Netherlands, w.e.walker@tbn.tudelft.nl

1 - Using a Metamodel to Analyze Sustainable Transport Policies for Europe: The SUMMA Project's Fast Simple Model

Rik van Grol, Surface Transport, RAND Europe, Newtonweg 1, 2333 CP, Leiden, Netherlands, vangrol@rand.org, *Warren Walker*, *Adnan Rahman*, *Gerard de Jong*

The SUMMA (Sustainable Mobility, policy Measures and Assessment) project developed the Fast Simple Model (FSM) to help policymakers identify policies that contribute toward sustainable mobility. It includes a metamodel that estimates the effect of transport policies on transport demand in Europe – a simple aggregate model that approximates the behaviour of several national and international network-based models. Unlike the network models, the FSM is very fast. The paper explains the metamodel concept, its usefulness, and its outputs: 16 economic, 22 environmental and 10 social indicators.

2 - Application of Real Options Analysis and Exploratory Modeling to the Adaptive Implementation of ITS

Datu Agusdinata, Faculty of Technology Policy Management, Delft University of Technology, Jaffalaan 5, 2628 JD, Delft, Netherlands, b.agusdinata@tbn.tudelft.nl, *Warren Walker*, *Vincent Marchau*

Intelligent Transport Systems (ITS) have a large potential to improve road safety. Large scale implementation of ITS, however, is hampered by uncertainties. This paper suggests how new approaches to decision-making under uncertainty can be used to speed the implementation of ITS. Real options make it possible to value the flexibility of making mid-course changes (e.g. scaling down). The specification of an adaptive policy is enabled by insights gained from exploratory modeling and analysis. The results would support proceeding with ITS policy implementation despite major uncertainties.

3 - Mathematical Programming Models in Sustainable Urban Transportation

Ahmet Esat Hizir, Industrial Engineering, Sabanci University, Gayrettepe ave. Hamdiye st., no:3/6 Besiktas, 34349, Istanbul, Turkey, ahmetesat@su.sabanciuniv.edu, *S. Ilker Birbil*

Recently sustainable urban transportation has become a major research area. Most of these studies propose evaluation methods that use simulation tools to assess sustainability. To demonstrate the possible applications of mathematical programming within sustainability, we propose a bi-level optimization model that incorporates emission functions defined with respect to traffic flow to reflect the real emission values. The proposed model is solved by off the shelf solvers. Our presentation ends with a thorough discussion of solution effort as well as the interpretation of the results.

■ MA-12

Monday, 8:30-10:00
TRANS Oddi 205

Signal Traffic Control

Stream: Transportation

Invited session

Chair: *Lorenzo Meschini*, Dipartimento di Idraulica, Trasporti e Strade, Università degli Studi di Roma, Via Eudossiana, 18, 184, Roma, Italy, lorenzo.meschini@uniroma1.it

1 - Controlling Traffic Lights at a Bottleneck

Otto Moeschlin, FB Mathematik, FernUniversität, Lütowstr. 125, D-58084, Hagen, Germany, otto.moeschlin@fernuni-hagen.de

The aim is to find times of free passage minimizing the waiting times of the waiting vehicles. The solution is based on an ergodicity concept. For Poisson arrival-processes a fixed point theorem (Edelstein, Grycko) becomes meaningful; the proof for general renewal-arriving processes is based on a dominance principle for stochastic processes.

2 - An MDP-based approximation for dynamic traffic light control

René Haijema, Department of Quantitative Economics, University of Amsterdam, Roetersstraat 11, 1018WB, Amsterdam, Netherlands, r.haijema@uva.nl, *Jan Van Der Wal*

We present a new discrete time approximation for the real-time control of traffic lights using Markov Decision Processes and simulation. Straight-forward optimization is not possible. We start with a Fixed Cycle (FC) control scheme. Each flow gives a periodic Markov chain. Mean waiting times depend only on cycle length and green time. Then a 1-step policy improvement step of the FC-policy is applied with decisions on the inner cycle time. Time jumps are compared using relative values per Markov chain. Simulation shows this time jump strategy' to outperform FC and exhaustive control.

3 - A real application of traffic signal control model based on logic programming and queues estimation

Lorenzo Meschini, Dipartimento di Idraulica, Trasporti e Strade, Università degli Studi di Roma, Via Eudossiana, 18, 184, Roma, Italy, lorenzo.meschini@uniroma1.it, *Giovanni Felici*, *Maurizio Bielli*

We will present a signal control model embedded with a queue length estimation model. The control model is based on logic control rules expressed in propositional logic that show a high degree of flexibility and can be customized to the needs of a particular intersection. The queue estimation model is based on a macroscopic flow model and aims at improving the control strategy in presence of poor traffic flow information. We will discuss the application of this models to the control and coordination of two consecutive and signalized intersections on a heavy congested urban road in Rome, Italy.

■ MA-13

Monday, 8:30-10:00
TRANS Oddi 206

Maritime Supply Chain

Stream: Maritime Transportation

Invited session

Chair: *Marielle Christiansen*, Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred Getz vei 3, N-7491, Trondheim, Norway, Marielle.Christiansen@iot.ntnu.no

1 - LNG supply chain optimization

Roar Grønhaug, Norwegian University of Science and Technology, Alfred Getz veg 3, 7491, Trondheim, Norway, roar.gronhaug@iot.ntnu.no, *Marielle Christiansen*

The importance of liquefied natural gas (LNG) as an energy source is increasing, and the demand is greater than ever. We are analyzing the LNG supply chain from liquefaction to regasification. We consider both the routing and scheduling of LNG tankers between liquefaction plants and regasification terminals and the inventory management at these plants and terminals. The production and consumption of LNG is dynamic through the planning horizon. The problem is solved by a column generation solution approach. Numerical results and comparisons with a MIP version of the problem will be given.

2 - Solving a distribution chain management problem

Henrik Andersson, Dept. of Science and Technology, Linköping University, Campus Norrköping, 601 74, Norrköping, Sweden, henan@itn.liu.se

A model for a distribution chain management problem with focus on maritime transportation is presented and analyzed. The problem is extracted from a supply chain of a Swedish pulp producing company and includes besides ship routing and scheduling also multi product inventory management and distribution planning using trucks and trains. In contrast to many other applications, the customers are not located at the harbors, but multi modal transport solutions are used to distribute the pulp. The main focus of the presentation is the two-phase solution approach used to solve the problem.

3 - Complex inventory ship routing of cement

Marielle Christiansen, Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred Getz vei 3, N-7491, Trondheim, Norway, Marielle.Christiansen@iot.ntnu.no, *Kjetil Fagerholt*, *Øyvind Haugen*, *Erik Helleberg Lund*

We present a complex real planning problem where cement is transported by a fleet of ships from several production factories to many consumption silos along the Norwegian coast. The planners are responsible for both the ship routing and the inventory management at all facilities. There exist several types of cement and the various types have to be allocated in separate cargo holds onboard the ships. We present elements of the MIP model. Instances of the problem are solved both by use of commercial optimization software and by heuristic methods.

■ MA-14

Monday, 8:30-10:00
PROD Arnag 101

Revenue Management Research and Practice

Stream: Operations Management / Revenue Management

Invited session

Chair: *Robert Phillips*, Nomis Solutions, 1111 Bayhill Dr, 94066, San Bruno, CA, United States, robert.phillips@nomissolutions.com

1 - Leading Revenue Optimization

Brenda Barnes, Barnes Consulting, 140 E. 28th Street, Suite 10H, 10016, New York, NY, United States, brendaabarnes@gmail.com

Advanced revenue optimization solutions have great potential to help companies maximize profits. To successfully lead and manage a large-scale revenue transformation, executives must select the best solution provider, obtain the right resources, and effectively lead a diverse team of operations research, technology, and business experts. In this talk, an experienced revenue management leader will discuss the critical success factors that ensure the power of operations research is leveraged in the "real-world" to achieve optimal results.

2 - Price Optimisation in Unsecured Consumer Loans.

Alex Romanenko, Nomis Solutions (Europe) Ltd., 25 Floral Street, Covent Garden, WC2E9DS, London, United Kingdom, alex.romanenko@blueyonder.co.uk

In the UK, due to increased competition as well as deteriorating consumer credit quality net interest margins have been declining in the unsecured consumer loans market since 2002. Therefore, new, more sophisticated techniques are required in order to improve business profitability and/or market share. Capitalising on differences in price sensitivity exhibited by market segments price optimisation methodology delivered substantial profit improvements. The challenges and results of the first UK commercial application of the price optimisation in unsecured consumer loans are discussed.

3 - Going Bunkers: Inventory Replenishment meets Route Selection

Sergei Savin, Decision, Risk and Operations, Columbia Business School, Columbia University, 10027, New York, NY, United States, svs30@columbia.edu, *Omar Besbes*

Rising fuel costs is an important factor impacting the bottom line of marine shipping companies. Even a single-vessel fuel-cost minimization problem is a complex inventory management task in which future fuel prices at different locations are highly uncertain and the fuel capacity is limited. We consider a mixed-fleet company and formulate the fuel-cost minimization problem as a finite-horizon stochastic dynamic program. We provide characterization of the optimal refueling policies and introduce several simple-to-implement heuristics whose performance is gauged using real data.

■ MA-15

Monday, 8:30-10:00
PROD Arnag 201

Supply-Chain Management Practices

Stream: Supply Chain Management

Invited session

Chair: *Angelika Kokkinaki*, Management and MIS, Intercollege, 46 Makedonitissas Ave., P.O. Box 24005, 1700, Nicosia, Cyprus, kokkinaki.a@intercollege.ac.cy

1 - Balancing off-shore maintenance and on-shore refurbishment

Rob Zuidwijk, Decision and Information Sciences, RSM Erasmus University, Postbus 1738, 3000 DR, Rotterdam, Netherlands, rzuidwijk@rsm.nl, *Albert Veenstra*, *Jeroen van Beek*

In off-shore industry, one important issue in life cycle management of industrial assets is the balancing of maintenance during production on the one hand and major revisions (refurbishment) between projects on the other hand. We investigate the use of monitoring data which can be transformed into deterioration parameters to support such balancing decisions.

2 - Supply Chain Practice and Transformations in Cyprus

Angelika Kokkinaki, Management and MIS, Intercollege, 46 Makedonitissas Ave., P.O. Box 24005, 1700, Nicosia, Cyprus, kokkinaki.a@intercollege.ac.cy, *Harrys Kogetsidis*

In recognition of potential economic benefits and strategic competitive advantage, a notable number of Cypriot companies have invested in improving their supply chain processes in recent years. This paper examines current supply chain practices in Cyprus market and based on a set of specific elements for evaluation it provides a classification of supply chain practices and outlines further development and/or possible transformations.

3 - An Intelligent Reactive GRASP for the Vehicle Routing Problem with Time Windows

Panagiotis Repoussis, Management Science and Technology, Athens University of Economics and Business, 47A Evelpidon Street and 33 Lefkados Street, 113 62,

Athens, Greece, panagiotis.repoussis@pathfinder.gr,
Christos Tarantilis, George Ioannou, Gregory Prastacos

This paper presents a hybrid adaptive memory metaheuristic for solving the Vehicle Routing Problem with Time Windows (VRPTW). The proposed methodology hybridizes reactively the systematic diversification and intensification mechanisms of Greedy Randomized Adaptive Search Procedures (GRASP) and Tabu Search (TS). Computational results on a set of well known benchmark data sets provide high quality results indicating the efficiency and effectiveness of the proposed methodology.

■ MA-16

Monday, 8:30-10:00

PROD Arnag 301

Transport Scheduling

Stream: Scheduling

Invited session

Chair: *David Ryan*, Engineering Science, The University of Auckland, Private Bag 92019, 1, Auckland, New Zealand, d.ryan@auckland.ac.nz

1 - Routing Trains Through Railway Junctions

Jesper Larsen, Informatics and Mathematical Modelling, Technical University of Denmark, Building 305, Richard Petersens Plads 1, 2800, Kgs. Lyngby, Denmark, jla@imm.dtu.dk, *Matthias Ehrgott*, *David Ryan*, *Richard Lusby*

The problem of routing trains through a railway junction is an integral part of railway operations. Given the layout of a junction and a proposed timetable the problem involves the assignment of a route for each of the trains through the junction ensuring that at most one train occupies a track segment in any time period and also ensuring that further restrictions based on safety considerations are met. We will present a column generation framework based on solving a set partition/set packing problem as the restricted master problem and a shortest path problem as the subproblem.

2 - Timetable Synchronisation for Rail Mass Transit

Janny Leung, Systems Engineering Engineering Management Dept., The Chinese University of Hong Kong, SEEM Dept., CUHK., NT, Shatin, Hong Kong, janny@se.cuhk.edu.hk, *Rachel Wong*

In public transit systems, passengers would like to interchange between different lines with minimal delay. We propose a mixed-integer-programming model for designing timetables to minimize transfer waiting-times of all passengers. A novelty in our formulation is the correct representation of waiting-times for the "next available" train, using binary variables. Preliminary numerical results indicate significant improvements in synchronization over current practice. We also explore the trade-offs among different operational parameters and their impact on overall passenger waiting-times.

3 - Robust and Integrated Airline Scheduling

David Ryan, Engineering Science, The University of Auckland, Private Bag 92019, 1, Auckland, New Zealand, d.ryan@auckland.ac.nz, *Oliver Weide*, *Matthias Ehrgott*

The airline planning process includes the problems of schedule design, aircraft routing and crew pairing. For a given set of flights, we present an approach which integrates the crew pairing and the aircraft routing problems to find a minimal cost assignment of crew and aircraft to the schedule. We propose a Dantzig-Wolfe decomposition approach to solve the integrated problem. We also outline an extension of the model which allows for small changes in departure times for flights in order to improve the robustness of the solutions for both crew and aircraft.

■ MA-17

Monday, 8:30-10:00

PROD Arnag 303

Production and Inventory

Stream: Production and Inventory (c)

Invited session

Chair: *David Noble*, Faculty of Computing, Engineering and Technology, Staffordshire University, Leek Road, ST4 2AZ, Stoke-on-Trent, Staffordshire, United Kingdom, d.noble@staffs.ac.uk

1 - Zone sizing for class-based storage in manual order picking

Kees Jan Roodbergen, RSM Erasmus University, P.O. Box 1738, 3000 DR, Rotterdam, Netherlands, kroodbergen@fbk.eur.nl

Storage assignment policies in warehouses are used to decide which product is stored in which location. Specifically, we will evaluate which percentage of the total storage area to assign to each of the storage classes A, B, and C to minimize the average travel distance of the order pickers. The travel distances will be determined through simulation. We will use a screening and selection procedure that helps to reduce the required number of replications and simultaneously allows us to identify the optimum configuration with a pre-specified precision.

2 - Unit-Storage Networks for Modelling Production Network Problems

Sami Niemelä, Process Vision Ltd., Melkonkatu 18, 00210, Helsinki, Finland, sami.niemela@processvision.fi, *Otso Ojanen*

In this paper we present a framework for modelling multi-commodity production problems as networks consisting of production units and commodity storage components. A generalization of the modeling framework is also discussed. The framework is applied to a combined heat and power optimisation problem, which - by additional assumptions - can be solved using a specialized linear programming technique and mixed integer programming algorithm. We argue along with some examples that the model could be extended to a variety of complex production network problems.

3 - Production Scheduling - an Example from the Confectionery Industry

David Noble, Faculty of Computing, Engineering and Technology, Staffordshire University, Leek Road, ST4 2AZ, Stoke-on-Trent, Staffordshire, United Kingdom, d.noble@staffs.ac.uk

Each product has to be moulded on one of two machines, some then have to be baked whilst others just have to set before being demoulded on the same machine. The time between moulding and demoulding (cycle time) varies from product to product. Some products have fixed cycle times whilst others are more flexible. Only one product can be moulded and one product demoulded each day on each machine. This scheduling problem is solved using MIP.

4 - A product inspection strategy with inspection errors

Chih-Hsiung Wang, Industrial Engineering and Management, I-Shou University, 800, Kaohsiung County, Taiwan, chwang446@yahoo.com.tw

In this study, we extend the previous inspection/disposition (ID) model to consider inspection errors in order to facilitate the adaptation of this economic ID model to real world applications. We first obtain the related mathematical formulae. Then, an algorithm is presented for determining the optimal ID policy.

■ MA-18

Monday, 8:30-10:00

PROD Arnag 304

Discrete Location

Stream: Locational Analysis

Invited session

Chair: *Alfredo Marín*, Departamento de Estadística e Investigación Operativa, University of Murcia, Facultad de Matemáticas, Campus de Espinardo, 30100, Murcia, Spain, amarín@um.es

Chair: *Lazaro Canovas*, Statistics and Operations Research, University of Murcia, Faculty of Mathematics, Campus de Espinardo, 30100, Murcia, Spain, lcanovas@um.es

1 - An scatter search procedure for the Simple Plant Location Problem with Order

Alfredo Marín, Departamento de Estadística e Investigación Operativa, University of Murcia, Facultad de Matemáticas, Campus de Espinardo, 30100, Murcia, Spain, amarín@um.es, *Lazaro Canovas*, *Sergio García Quiles*

The SPLP problem is well known in the literature of combinatorial optimization. But no always the cheapest facility located is the one desired by the clients. In this work the problem of locating facilities when the clients have some preference of it, no necessary by the transportation cost, which are known before the decision maker locates it. This problem is NP-Hard. An scatter search procedure will be shown for solving it.

2 - The Discrete Ordered Median Problem (DOMP): New formulations and frontiers

Justo Puerto, Estadística e I.O., Universidad de Sevilla, Facultad de Matemáticas, 41012, Sevilla, Spain, puerto@us.es, *Stefan Nickel*, *Antonio Manuel Rodríguez-Chía*

In this paper we want to present new formulations to the DOMP and to extend the basic DOMP model to cope with actual requirements from logistics. We will present models taking set up costs and capacities into account. Moreover, we will have to consider different models depending on which member of the logistics network is the driving force of the planning process.

New solution approaches are presented taking advantage of the structure of the problems. Computational tests show that medium size problem are now solvable enlarging the size of problems that can be handled within this framework.

3 - A new approach for the p-median problem

Martine Labbé, computer Science, Université Libre de Bruxelles, Cp210/01, Boulevard du Triomphe, 1050, Bruxelles, Belgium, mlabbé@ulb.ac.be, *Alfredo Marín*

A set covering formulation for the p-median problem is studied. Larger instances can be solved by means of this formulation using standard commercial software. Moreover, using more elaborated methods based on these formulation, huge instances of the p-median problema have been solved for large values of p.

The formulation can be adapted to solve the Simple Plant Location Problem without any effort, and several other uncapacitated discrete location problems can be approached with more or less complicated adaptations.

■ MA-19

Monday, 8:30-10:00

PROD Arnag 311

Queuing Theory/Stochastic Process

Stream: Queuing Theory/Stochastic Process (c)

Invited session

Chair: *Eduard Ianovsky*, Industrial Engineering and Management, Ben-Gurion University of the Negev, P.O.Box 653, 84105, Beer-Sheva, Israel, ianovsky@bgumail.bgu.ac.il

1 - Throughput and waiting-time analysis of an unsignalized T-intersection

Dieter Fiems, Ghent University, St-Pietersnieuwstraat 41, 9000, Gent, -, Belgium, df@telin.UGent.be, *Herwig Bruneel*

In this talk we construct a queueing system to assess the maximal throughput and waiting times at an unsignalized T-intersection where cars on a major road have priority over cars on a one-way minor road. Given the traffic patterns on the major road, we derive an analytical expression for the maximal throughput of the minor road. Under Poisson arrival assumptions we also obtain expressions for the moments of the waiting times of the cars on the minor road. Intersections with and without pre-selection lanes are considered and we illustrate our approach by means of some numerical examples.

2 - A multi-server queueing model with Markovian arrivals and multiple thresholds

Srinivas R. Chakravarthy, Industrial and Manufacturing Engineering, Kettering University, 1700 W. Third Avenue, 48504, Flint, Michigan, United States, schakrav@kettering.edu

We consider a multi-server queueing model in which arrivals occur according to a Markovian arrival process (MAP). There is a single server, and additional servers are added or removed depending on sets of thresholds. The service times are assumed to be exponential. A comparison of this model to the classical MAP/M/c queueing model through an optimization problem yields some interesting results that are useful in practical applications. Minimum delay costs and the associated maximum set up costs so that threshold type model is to be preferred over the classical model are given.

3 - Multilevel Real-Time Systems

Joseph Kreimer, Industrial Engineering and Management, Ben-Gurion University of the Negev, P.O.Box 653, 84105, Beer-Sheva, Israel, kremer@bgumail.bgu.ac.il, *Eduard Ianovsky*

We consider a Real-Time (RT) System consisting of several service/maintenance levels. Servers of first level provide service to RT jobs, arriving via identical channels. Any part of the job that is not served in RT is lost. Servers of i-th level provide maintenance for servers of lower level. Service and maintenance times are independent exponentially distributed random variables. We obtain balance equations for steady state probabilities and traffic equations for transitions between successive levels. We show how to eliminate infeasible states. Performance characteristics are presented.

4 - A Markov decision model to obtain revision policies for a two-machine manufacturing system

Rita de Cássia Meneses Rodrigues, Laboratory for Computing and Applied Mathematics (LAC), Brazilian Institute for Space Research (INPE), Av. dos Astronautas, 1758, Jardim da Granja, 12227-010, Sao Jose dos Campos, Sao Paulo, Brazil, rita@lac.inpe.br, *Solon Carvalho*

We consider a two-machine manufacturing system. The machines are inspected in order to correct or prevent a failure. It is assumed that the life time and the revision time of the machines are independent and stochastically distributed with general distributions. The system is periodically observed, and we must decide about the operation or revision of each machine in order to minimize the long run discounted cost. A Markov Decision Model is used to obtain an optimal policy. Periodic policies are considered, and numerical results are presented.

■ MA-20

Monday, 8:30-10:00

HEUR Arnag 422

EDDA - EURO Doctoral Dissertation Award

Stream: EDDA - EURO Doctoral Dissertation Award

Invited session

Chair: *Jean-Pierre Brans*, MOSI (CSOO), V.U.B. , Pleinlaan,2, 1050, Brussels, Belgium, jpbrans@vub.ac.be

1 - EDDA - EURO Doctoral Dissertation Award (EDDA 2006)

Jean-Pierre Brans, MOSI (CSOO), V.U.B. , Pleinlaan,2, 1050, Brussels, Belgium, jpbbrans@vub.ac.be, José Rui Figueira, Maurice Shutler, Jaap Spronk

This session includes the final round of the EDDA Award (EURO Doctoral Dissertation Award). According to the EURO rules, the first task of the jury is to designate the 3 best applicants. These 3 nominees are requested to present their contribution in front of the jury and all interested participants during a special session of 1h30 (30 min each) at the next EURO conference. After these presentations the jury will decide on the laureate and the award will be bestowed at the closing session of the conference. The purpose of this session is to appreciate the contributions of the 3 nominees.

2 - Design of Survivable Networks with Bounded Length Paths

David Huygens, Département d'Informatique, Université Libre de Bruxelles, Boulevard du Triomphe CP 210-01, 1050, Brussels, Belgium, dhuygens@ulb.ac.be

Given a graph G , a set D of node pairs and two integers k, L , the k -edge connected L -hop-constrained network design problem is to find in G a minimum cost subgraph with k edge-disjoint paths of L edges between each pair of D . This arises in the design of survivable networks. We start with $-D=1$. We give an integer formulation, completely describing the polytope for small k, L . We devise a cutting plane algorithm with polynomial separations. We then consider several pairs in D and show it is NP-hard. We give classes of facets, used in a B&C algorithm. Finally we study the problem for greater k, L .

3 - Metaheuristic Algorithms for Combinatorial Optimization Problems

Manuel Iori, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, miori@deis.unibo.it

We present the main results in the author's PhD thesis, that was defended at the University of Bologna in April 2004 and supervised by professor S. Martello. The thesis proposes exact, heuristic and metaheuristic algorithms for solving some relevant combinatorial optimization problems, with particular emphasis on parallel-machine scheduling, two-dimensional cutting and packing and capacitated vehicle routing. The performance of each algorithm is tested through extensive computational experiments and comparison with other exact and heuristic approaches in the literature.

4 - Combinatorial analysis of 2D-NOESY spectra in Nuclear Magnetic Resonance spectroscopy of RNA molecules

Marta Szachniuk, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, Marta.Szachniuk@cs.put.poznan.pl

Nuclear Magnetic Resonance spectroscopy is the best method of the complete RNA 3D structure determination in solution. Structure is reconstructed on the basis of spectral data resulting from the experiments. Inspired by the data interpretation method, we propose a new combinatorial model representing the problem of NOE path assignment in 2D NOESY spectra. Construction of the model is followed by an analysis of the problem computational complexity. Finally, an enumerative algorithm and two heuristics are proposed and their application to experimental and simulated NMR data is demonstrated.

MA-21

Monday, 8:30-10:00

HEUR Arnag 423

Adaptive Neighborhoods and Advanced Search Designs

Stream: Adaptive Memory Programming (AMP)

Invited session

Chair: Leon Lasdon, Information, Risk, and Operations Management, McCombs Business School, University of Texas, 78712, Austin, TX, United States, lasdon@mail.utexas.edu

1 - An Ejection Chain Algorithm for the Vehicle Routing Problem with Time Windows

Herman Sontrop, Philips Research Laboratories, High Tech campus 34, 5656AE, Eindhoven, Netherlands, Herman.Sontrop@Philips.com, Pieter van der Horn

We present a new ejection chain algorithm for the vehicle routing problem with time-windows (VRPTW) that effectively combines the characteristics of two major reference structures to create compound neighborhoods for this problem. Computational tests on a classical set of benchmark problems show that the proposed algorithm is extremely fast in finding high quality solutions, often matching the best in the literature, while using a small fraction of the time required by leading approaches to obtain solutions of similar quality.

2 - Parallel Search Strategies for the Quadratic Assignment Problem

Tabitha James, Department of Business Information Technology, Virginia Polytechnic Institute and State University, 1007 Pamplin Hall, 24060, Blacksburg, VA, United States, tajames@vt.edu, Cesar Rego, Fred Glover

The increase in computational resources provided by parallel computing platforms opens up attractive alternatives to explore complex search spaces. The use of multiple processors to concurrently operate on a problem not only promises decreased time to find high quality solutions, but also provides for the consideration of algorithmic design alternatives for these problems specific to the architecture. We investigate the use of strategic operators in the design of parallel search algorithms for the QAP and show that high quality solutions can be obtained in decreased execution time.

3 - Improved Filters and Randomized Drivers for Multi-start Global Optimization

Leon Lasdon, Information, Risk, and Operations Management, McCombs Business School, University of Texas, 78712, Austin, TX, United States, lasdon@mail.utexas.edu, John Plummer, Zsolt Ugray, Michael Bussieck

We discuss improvements to the multistart heuristic framework for smooth global optimization developed by Ugray and Lasdon, et al. that has been available as both a standalone and GAMS solver since 2003. The method considers gradient based local NLP search from a filtered subset of points generated by a "driver". Changes to the distance and merit filters make them more adaptive to the problem instance. Stochastic drivers are proposed whose performance is comparable to the OptQuest scatter search implementation, if reasonably tight bounds on all variables are imposed.

MA-22

Monday, 8:30-10:00

OPT Adal 050

Vector and Set-Valued Optimization

Stream: Vector and Set-Valued Optimization

Invited session

Chair: César Gutiérrez, Departamento de Matemática Aplicada, Universidad de Valladolid, E.T.S.I. Informática, Cº. Cementerio s/n, Campus Miguel Delibes, 47011, Valladolid, Spain, cesargv@mat.uva.es

1 - Optimality conditions for set-valued optimization problems with set optimization criterion

Elvira Hernández, Matemática Aplicada, Universidad Nacional de Educación a Distancia, Juan del Rosal 12, 28040, Madrid, Spain, ehernandez@ind.uned.es, Luis Rodríguez-Marin, Miguel Sama

We consider the recent concept of l -minimal set introduced by Kuroiwa in 1999 and establish several conditions for the existence of this kind of efficient sets for a family of subsets in a topological linear space ordered by a convex cone. Finally, we apply our results to give optimality conditions for a set-valued optimization problem under some continuity assumption.

2 - Contingent epiderivatives and set-valued optimization problems with set partial orderings

Miguel Sama, Matemática Aplicada, Universidad Nacional de Educación a Distancia, C/Juan del Rosal, 12, 28040, Madrid, Spain, msama@ind.uned.es, *Luis Rodriguez-Marin, Elvira Hernández*

In this work we study set-valued optimization problems. With the aim of obtaining vectorial solutions, (epi-)graphical derivatives have widely been used in the literature. However it is still unknown the relationship between the recent set optimization criterion and such derivatives. We show that under determined hypothesis, necessary and sufficient optimality conditions can be given in terms of contingent epiderivatives.

3 - Parametric representations for epsilon-efficient sets in vector optimization problems

César Gutiérrez, Departamento de Matemática Aplicada, Universidad de Valladolid, E.T.S.I. Informática, C°. Cementerio s/n, Campus Miguel Delibes, 47011, Valladolid, Spain, cesargv@mat.uva.es, *Bienvenido Jimenez, Vicente Novo*

In this work, we deal with approximate (epsilon-efficient) solutions of vector optimization problems. We introduce a notion of parametric representation for epsilon-efficient sets and several of them are obtained in convex and nonconvex problems via an epsilon-efficiency concept due to Kutateladze (1979) and Loridan (1984). In attaining these representations, various scalarizations given by monotone and gauge functionals are used.

■ MA-23

Monday, 8:30-10:00

OPT Adal 051

Approximation Algorithms for Scheduling

Stream: Approximation Algorithms

Invited session

Chair: *Rafi Hassin*, Department of Statistics and Operations Research, Tel Aviv University, Tel Aviv, Israel, hassin@math.tau.ac.il

1 - Scheduling in Algorithmic Game Theory

Evrpidis Bampis, IBISC, CNRS FRE 2873, Université d'Evry Val d'Essonne, Evry Cedex, France, bampis@ibisc.fr, *Eric Angel, Fanny Pascual*

A central notion in the field of algorithmic game theory is the notion of Nash equilibrium defined as a combination of (deterministic or randomized) strategies, one for each agent, from which no agent has an incentive to unilaterally deviate. In order to evaluate the impact of the selfishness of the agents on the efficient use of the system, the notion of the price of anarchy has been introduced. Here, we survey some recent directions of research related to the notion of price of anarchy and we illustrate them on different scheduling models involving selfish agents.

2 - Multi Index Assignment Problems: Approximation and Applications

Frits Spieksma, Applied Economics, Katholieke Universiteit Leuven, Naamsestraat 69, 3000, Leuven, Belgium, Frits.Spieksma@econ.kuleuven.be

In this presentation we deal with approximation algorithms for, and applications of multi index assignment problems (MIAPs). In particular, we focus on the complexity and approximability of special cases of MIAPs. A prominent example of a MIAP is the so-called axial three index assignment problem which has many applications in different areas of production planning, target tracking, and other fields. We show how various assumptions on the cost-coefficients c_{ijk} (motivated by an application) lead to results on the approximability of the resulting problem.

3 - An Approximation Algorithm for Scheduling with Restricted Availabilities

Gregory Mounie, ID, IMAG, 51 Avenue Jean Kuntmann, 38330, Montbonnot, France, Gregory.Mounie@imag.fr, *Lionel Eyraud, Denis Trystram*

In this work, we introduce the problem of scheduling a set of independent parallel jobs on a m identical machines with restricted availabilities. We establish first an absolute lower bound, then, we derive several lower bounds for list scheduling algorithms. Finally, we propose a list scheduling algorithm with a performance guarantee close to the absolute lower bound.

4 - The After Salesman Problem

Joris Van de Klundert, Department of Mathematics, Maastricht University, Tongerestraat 6, PO Box 616, 6200 MD, Maastricht, Netherlands, j.vandeklundert@math.unimaas.nl

The customer contact taking place after a sales transaction, and the services involved, are of increasing importance in contemporary business models and so is the scheduling of service operations. Responsiveness to requests is crucial to the service quality. We consider the problem of optimizing responsiveness to service requests arriving in real time. We consider various models and formulations and present computational results on known solution methods. In particular we consider an ILP based solution method for a set partitioning formulation which we have implemented in practice.

■ MA-25

Monday, 8:30-10:00

OPT Adal I-111

Complementarity Problems and Equilibrium

Stream: Mathematical Programming

Invited session

Chair: *Sandor Zoltan Nemeth*, School of Mathematics, The University of Birmingham, The Watson Building, Edgbaston, B15 2TT, Birmingham, United Kingdom, nemeths@for.mat.bham.ac.uk

1 - Complementarity properties of cone and algebra automorphisms in Euclidean Jordan algebras

Roman Sznajder, Mathematics, Bowie State University, 14000 Jericho Park Road, 20715-9465, Bowie, Maryland, United States, rsznajder@bowiestate.edu

In this talk we establish the equivalence of complementarity properties such as R_0 , P , global uniqueness (GUS), and global solvability (Q) for automorphisms on the Lorentz algebra, and quadratic representation on any Euclidean Jordan algebra.

2 - Dynamic Modeling of Network Expansion - The Case of European Natural Gas Infrastructure

Franziska Holz, International Economics, DIW Berlin, Koenigin-Luise-Str. 5, 14195, Berlin, Germany, fholz@diw.de, *Christian von Hirschhausen*

We develop a complementarity model of imperfect market relations in a dynamic game structure and include investments. The model is applied to the European natural gas market over the period 2003-2030. This market is characterized by a two-stage structure of imports to Europe and wholesale trade between European traders; trade on both market stages is limited by infrastructure availability. We extend the initial MCP model (Holz et al, 2005) by two aspects: a network representation of the transport infrastructure and investment decisions in the infrastructure, based on a NPV optimization.

3 - A quasi-variational inequality approach to the financial equilibrium problem

Laura Scrimali, CORE, Université catholique de Louvain, 34 voie du Roman Pays, 1348, Louvain-la-Neuve, Belgium, scrimali@core.ucl.ac.be

The aim is to discuss the time-dependent, multi-agent and multi-activity financial equilibrium problem in the framework of the variational inequality theory. In particular, since budget constraints are assumed to be moving and following the market equilibrium distribution, the problem is formulated as an infinite dimensional quasi-variational inequality. Qualitative properties of solutions are investigated and an equivalent formulation in terms of Wardrop-type principle is provided. Finally, a numerical experience is illustrated and the trend of equilibria is graphically showed.

4 - REFE-acceptable mappings and a necessary and sufficient condition for the non-existence of the regular exceptional family of elements

Sandor Zoltan Nemeth, School of Mathematics, The University of Birmingham, The Watson Building, Edgbaston, B15 2TT, Birmingham, United Kingdom, nemeths@for.mat.bham.ac.uk, George Isac

By considering the notion of regular exceptional family of elements (REFE) we define the class of REFE-acceptable mappings. We prove that a complementarity problem on a Hilbert space defined by a REFE-acceptable mapping and a closed convex cone either has a solution or a REFE. By using REFE-acceptable mappings, we present necessary and sufficient conditions for the non-existence of regular exceptional family of elements. These conditions are used for generating several existence and uniqueness theorems for complementarity problems.

■ MA-26

Monday, 8:30-10:00

OPT Adal III=231

Metaheuristic Algorithms for Combinatorial Optimization Problems

Stream: Combinatorial Optimization

Invited session

Chair: Paolo Toth, Deis, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, ptoth@deis.unibo.it

1 - GRASP for continuous global optimization

Mauricio Resende, Algorithms Optimization Research, ATT Labs Research, 180 Park Avenue, Room C241, 07932, Florham Park, NJ, United States, mgcr@att.com, Michael Hirsch, Claudio Meneses, Panos Pardalos

We describe a method adapted from Feo and Resende's GRASP metaheuristic, first proposed for solving combinatorial optimization problems, to solve global optimization problems with continuous objective functions and box constraints. In computational experiments, the algorithm is shown to avoid the trappings of local minima, always converging to a global minimum. This method is very easy to implement, is applicable to any global optimization problem, and does not make use of derivative information, thus making it a well-suited general approach for solving global optimization problems.

2 - A Set-Covering Based Heuristic Approach for a Weighted Vertex Coloring Problem

Paolo Toth, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, ptoth@deis.unibo.it, Enrico Malaguti, Michele Monaci

We consider a weighted version of the well known Vertex Coloring Problem (VCP) where each vertex of the graph has an associated positive weight. Like in the classical VCP one has to assign a color to each vertex so that colors on adjacent vertices are different. The objective is to minimize the sum of the costs of the colors used, where the cost of a color is the maximum weight of the vertices assigned to it. The problem is known to be NP-hard. We present a two-phase heuristic approach based on the "Set-Covering" formulation. Computational results on instances from the literature are reported.

3 - A LP-based heuristic for a network design problem

Inmaculada Rodríguez Martín, DEIOC - Matemáticas, Universidad de La Laguna, Fac. Matemáticas, Av. Francisco Sánchez s/n, 38296, La Laguna, Tenerife, Spain, irguiez@ull.es, Juan José Salazar González

This paper addresses a network problem consisting of choosing the routes and hubs to use in order to send a set of commodities from sources to destinations in a given capacitated network at minimum cost. The capacities and costs of the arcs and hubs are given, and the graph connecting the hubs is not assumed to be complete. To solve this problem we propose a heuristic approach based on a linear programming relaxation. The heuristic turns out to be very effective and the results of the computational experiments show that near-optimal solutions can be derived rapidly for instances of large size.

■ MA-28

Monday, 8:30-10:00

OPT Adal VI=207

Linear Complementarity and Feasibility Problems

Stream: Linear Optimization

Invited session

Chair: Tamas Terlaky, Computing and Software, McMaster University, 1280 Main Street West, L9B 2S9, Hamilton, Ontario, Canada, terlaky@mcmaster.ca

1 - On Computer-Assisted Proofs for Solutions of Linear Complementarity Problems

Uwe Schaefer, Institut fuer Angewandte Mathematik, Universitaet Karlsruhe, 76128, Karlsruhe, Germany, Uwe.Schaefer@math.uni-karlsruhe.de

The LCP models many important mathematical problems and there exist several algorithms for calculating numerical solutions of the LCP. Meanwhile, validation methods were presented that prove by the use of a computer guaranteed bounds on the distance between a numerical solution and an exact solution of the LCP. In this talk, we extend these ideas to the case that (due to rounding errors, for instance) the components of M and q are not exactly known, but can be enclosed in intervals.

2 - Interior point algorithms for general linear complementarity problems: possibilities and restrictions

Marianna Nagy, Operation Research Department, Eötvös Loránd University, Pázmány Péter stny. 1/C., H-1117, Budapest, Hungary, nmariann@cs.elte.hu, Tibor Illes, Tamas Terlaky

Many real life problems leading to linear complementarity models (LCP), like bimatrix games, does not guarantee nice properties for the matrix of LCP. However, LCP without any assumption on the matrix of problem is NP-hard. The largest matrix class where the interior point algorithms are polynomial is the class of sufficient matrices. We intend to generalize the interior point methods such that it either solves an LCP or gives a certificate that proves infeasibility, or that the matrix of problem is not sufficient. Such an algorithm can be constructed within the framework of EP-theorems.

3 - Colourful Linear Feasibility

Antoine Deza, Computing and Software, McMaster University, 1280 Main Street West, L8S 4K1, Hamilton, Ontario, Canada, deza@mcmaster.ca, Sui Huang, Tamon Stephen, Tamas Terlaky

We study a colourful generalization of the linear programming feasibility problem, comparing the algorithms introduced by Barany and Onn with new methods. We perform benchmarking on generic and ill-conditioned problems, as well as recently introduced highly structured problems. We also present related results and bounds on the number of feasible solutions, that is, the colourful simplicial depth and apply our results to the problem of bounding monochrome (non-colourful) simplicial depth.

4 - A new anti-degeneracy method for linear feasibility problems

Zsolt Csizmadia, Operations Research, Eötvös Loránd University, Pázmány Péter Sétány 1/c, H-1117, Budapest, Hungary, zsolt.csizmadia@gmail.com, Tibor Illes

We define a variant of Anstreicher and Terlaky's (1994) monotonic build-up (MBU) simplex algorithm for linear feasibility problems. A new procedure is used to handle degenerate problems. On a degenerate pivot tableau, the pivot positions are restricted to a subtableau, and the same algorithm is performed. The subproblem is either solved and a nondegenerate pivot is made or infeasibility is detected for the larger problem, or a new subproblem is identified. The maximum depth of recursion is $2m$. A complexity guess is also presented.

■ MA-29

Monday, 8:30-10:00

OPT Adal VII=225

New Methods for Global Optimization

Stream: Global Optimization: Deterministic and Stochastic Methods

Invited session

Chair: *David Bulger*, Department of Statistics, Macquarie University, North Ryde, 2109, Sydney, NSW, Australia, dbulger@efs.mq.edu.au

1 - Optimizing the running-structure of genetic-based docking algorithms

Rafael Ördög, Computer science, Eotvos University, Pázmány Péter sétány 1/C, 1117, Budapest, Hungary, devill@t-online.hu, *Vince Grolmusz*

To understand underlying mechanisms, of protein-ligand automated docking using GA-LS we studied runtime log files containing the minimal energy after n evaluations. Running the algorithm with different seeds resulted in an unacceptable deviation even after a high number of evaluations. We examined changing population size, population generating method, selection strategies, and mutation/crossover rates. Our main result is the optimization of the number of the runs and their length if the total number of evaluations used by the different runs together is a given number.

2 - A DIRECT-based approach exploiting local minimizations for the solution of large-scale global optimization problems

Giampaolo Liuzzi, Dept. of Computer and System Sciences, University of Rome, Via Buonarroti 12, 00185, Rome, Italy, liuzzi@dis.uniroma1.it, *Stefano Lucidi*, *Veronica Piccialli*

In this talk we propose a new deterministic method for global optimization. The method hinges on the reciprocal effect of global and local searches. The global search is carried out by incorporating the sampling strategy of DIRECT algorithm which is guaranteed to produce a dense set of trial points. In order to increase the convergence of the global search, local minimizations are carried out in a distributed fashion starting from the most promising points among those generated by the global search itself. Numerical results are reported which show the competitiveness of our method.

3 - Global Optimization Technique for Constructing Collective Causal Maps through Multi-Dimensional Scaling

Vitaly Podobedov, Cognition, Decision and Management Research Center, Bordeaux Business School, Domaine de Raba - 680, cours de la Libération, 33405, Talence Cedex, France, podobedov@paytech.ru

Multi-dimensional scaling (MDS) is a useful approach for visualizing the structure of a set of objects of an arbitrary nature and revealing latent links or associations among them. In the field of operations management, collective causal maps produced by MDS are often considered: they integrate estimations of proximities between the objects, given by various experts. Criterion used in MDS transformation is essentially multiextremal, so a global optimization technique combining global exploration and local refining is proposed for executing MDS in a case of several tens of objects and experts.

■ MA-30

Monday, 8:30-10:00

NONL Adal X=220

Linear Semi-Infinite Optimization I

Stream: Linear Semi-Infinite Optimization

Invited session

Chair: *Marco A. López-Cerdá*, Statistics and Operations Research, Alicante University, Ctra. San Vicente de Raspeig s/n, 3071, Alicante, Spain, marco.antonio@ua.es

1 - Farkas-Minkowski systems in convex optimization

Miguel Goberna, Estadística e Investigación Operativa, Universidad de Alicante, Ctra. San Vicente s/n, 03080, San Vicente del Raspeig, Alicante, Spain, mgoberna@ua.es, *Marco A. López-Cerdá*

This talk deals with KKT and saddle point optimality conditions, duality theorems and stability theorems for consistent convex optimization problems posed in locally convex topological vector spaces. All the involved functions are assumed to be convex, lower semicontinuous and proper (but not necessarily real-valued). The main results in the paper are obtained under a suitable Farkas-type constraint qualifications and/or a closedness assumption introduced by V. Jeyakumar.

2 - On balancedness of infinite one-sided and two-sided market models

Natividad Llorca, Operations Research Center, Miguel Hernández University, Avda. del Ferrocarril s/n, (Edif. Torretamarit), 03202, Elche, Spain, nllorca@umh.es, *Joaquín Sánchez-Soriano*, *Vito Fragnelli*, *Stef Tijs*

Shapley and Shubik studied assignment situations in a game-theoretic setting. Tijs et al introduce permutation games. Transport and pooling games can be seen as a generalization of assignment and permutation situations. The main question is whether there exist allocations that all agents find reasonable. Core elements can be obtained via optimal dual solutions of the finite linear programs. When we move to infinite games the first question we have to face is the possibility of existence of a duality gap. We will show that the linear problems have no duality gap and the core is nonempty.

3 - LSIP and cores: a review

Marco Dall'Aglio, Dipartimento di Scienze, Università d'Annunzio, Viale Pindaro, 42, 65127, Pescara, Italy, marco.dallaglio@unich.it

We consider several applications of Linear Semi-Infinite programming in game theory, with particular attention to the computation of cores. In particular we examine and extend a recent work by Montrucchio and Marinacci, where the core of a measure game, defined a function of a vector measure, is linear, i.e. it consists of linear combinations of the components of the game itself.

■ MA-31

Monday, 8:30-10:00

NONL Adal XI=222

OD(A)E- and PD(A)E-Constrained Optimization I

Stream: Industrial Application of Nonlinear Programming Algorithms

Invited session

Chair: *Dietmar Hoemberg*, Weierstrass Institute for Applied Analysis and Stochastics, Mohrenstrasse 39, 10117, Berlin, Germany, hoemberg@wias-berlin.de

1 - Trajectory Optimization in the Presence of Uncertainty

John Betts, The Boeing Company, P.O. Box 3707, MC 7L-21, 98124-2207, Seattle, Washington, United States, john.t.betts@boeing.com

The design of a trajectory for an aerospace vehicle can be formulated using modern optimal control and/or nonlinear programming techniques. Typically, the optimal trajectory is constructed assuming an ideal operating environment and conditions. A real vehicle must have some mechanism to compensate for "off-nominal" conditions. Environmental factors all contribute to uncertainty in the performance of a vehicle. This paper describes how modern trajectory optimization techniques can incorporate statistical constraints as part of the mission design process to compensate for uncertainty.

2 - Convergence of a Nonsmooth Newton's Method for Control-State Constrained Optimal Control Problems

Matthias Gerdts, Department of Mathematics, University of Hamburg, Bundesstrasse 55, 20146, Hamburg, Germany, gerdts@math.uni-hamburg.de

We investigate optimal control problems subject to mixed control-state constraints. The necessary conditions are stated in terms of a local minimum principle. By use of the Fischer-Burmeister function the minimum principle is transformed into an equivalent nonlinear and nonsmooth equation in appropriate Banach spaces. This nonlinear and nonsmooth equation is solved by a nonsmooth Newton's method. We will show the local quadratic convergence under certain regularity conditions and suggest a globalization strategy based on the minimization of the squared residual norm.

3 - Free Material Optimization for Shell Structures

Stefanie Gaile, Institute for Applied Mathematics II, University Erlangen-Nuremberg, Martensstr. 3, 91058, Erlangen, Germany, steffi@am.uni-erlangen.de, *Günter Leugering*, *Michael Stingl*

Free Material Optimization is an efficient approach for finding the stiffest elastic structure in a domain, which is subjected to a set of given loads. The underlying physical model is based on elastic solid bodies. Difficulties arise when searching for an optimal design of thin-walled structures like aircrafts. A remedy is to describe these elastic bodies as shells. This yields not only better adaption to industrial applications, but also saves numerical effort and eases the interpretation of the results. We present modeling, analysis and numerical treatment using Naghdi's shell model.

4 - Suboptimal Control of a Molten Carbonate Fuel Cell

Hans Josef Pesch, Department of Mathematics, University of Bayreuth, Chair of Mathematics in Engineering Sciences, 95440, Bayreuth, Germany, hans-josef.pesch@uni-bayreuth.de, *Kurt Chudej*, *Kati Sternberg*

This paper is addressed to molten carbonate fuel cells by which energy can be produced efficiently and environmentally friendly. Their dynamical behavior can be described by a large scale system of 2D quasilinear partial differential algebraic equations (PDAEs) of dimension 28. The equations are of mixed parabolic-hyperbolic type with integral terms in the right hand side and initial and complicated nonlinear boundary conditions. Numerical results, both for simulations and optimal control, are presented. The latter for almost time optimal load changes.

■ MA-32

Monday, 8:30-10:00
NONL Adal XIII=218

Optimization Methods in Signal Processing

Stream: Convex Optimization Methods

Invited session

Chair: *Amir Beck*, Faculty of Industrial Engineering and Management, Technion - Israel Institute of Technology, Technion city, 32000, Haifa, Israel, becka@ie.technion.ac.il

1 - Dominating and Admissible MSE-Bounds using Saddle-Point Methods

Yonina Eldar, Electrical Engineering, Technion - Israel Institute of Technology, Technion City, 32000, Haifa, Israel, yonina@ee.technion.ac.il

We treat the problem of evaluating estimator performance for estimating a deterministic parameter vector x , with the mean-squared error (MSE) as the performance measure. Since the MSE depends on x , direct comparison between estimators is a difficult problem. Here we develop a framework for MSE comparison based on the concepts of admissible and dominating estimators. Using a saddle-point framework we reduce these concepts to a concrete convex optimization problem, which can then be analyzed by utilizing the machinery of convex optimization.

2 - Optimal Correction of an Indefinite Estimated MA Spectral Density Matrix

Peter Stoica, IT Dept, Uppsala University, PO Box 337, 751 05, Uppsala, Sweden, peter.stoica@it.uu.se, *Luzhou Xu*, *Jian Li*, *Yao Xie*

A simple estimate of the spectral density matrix of a vector moving average (MA) sequence can be obtained by applying the Fourier transform to the corresponding sample covariance matrices. However, this nonparametric estimate of the spectral density matrix can easily become indefinite at some frequencies, and thus invalid, due to the estimation errors. We provide a computationally efficient procedure that can be used to obtain the optimal valid approximation to the estimated spectral density matrix in a polynomial time, by means of a semidefinite programming algorithm.

3 - A Convex Optimization Approach for Minimizing the Ratio of Indefinite Quadratic Functions over an Ellipsoid

Amir Beck, Faculty of Industrial Engineering and Management, Technion - Israel Institute of Technology, Technion city, 32000, Haifa, Israel, becka@ie.technion.ac.il, *Marc Teboulle*

We consider the nonconvex problem (RQ) of minimizing the ratio of two nonconvex quadratic functions subject to a possibly degenerate ellipsoid. This formulation is motivated by the so-called Regularized Total Least Squares problem (RTLs), which is a special case of the problem's class we study. We prove that under a certain mild assumption on the problem's data, problem (RQ) admits an exact semidefinite programming relaxation. We then study a simple iterative procedure which is proven to converge superlinearly to an epsilon-global optimal solution of (RQ).

■ MA-33

Monday, 8:30-10:00
NONL Adal A=313

Global Optimization: Software and Applications I

Stream: Global Optimization: Software and Applications

Invited session

Chair: *Licister Mason*, Primary Recovery and Optimization, Shell International Exploration and Production B.V., Psothbus 60, 2280 AB, Rijswijk, Netherlands, ThomasLicister.Mason@shell.com

1 - Selected Applications of Global Optimization in the Oil and Gas Industry

Licister Mason, Primary Recovery and Optimization, Shell International Exploration and Production B.V., Psothbus 60, 2280 AB, Rijswijk, Netherlands, ThomasLicister.Mason@shell.com, *Janos D. Pinter*, *Frank Kampas*

Oil and gas will continue to be important energy sources, at least over the next decades. The optimization of energy production opportunities often leads to global optimization problems. In this talk, we present production models and their solution using the MathOptimizer Professional software. The latter is based on the LGO nonlinear optimization software linked to the Mathematica model development environment.

2 - Finding and Identifying Objects Based on Noisy Data: A Global Optimization Approach

Larry Deschaine, Physics, SAIC Chalmers University of Technology, 35 Varden Drive, Suite F, 29803, Aiken, SC, United States, Larry.M.Deschaine@alum.mit.edu, *Melissa McKay*, *Seth Blanchard*, *Janos D. Pinter*, *Frank Francone*

Automated object recognition of images or signals is important, to identify items of interest, or anomalies (such as tumors in tissues). In such analyses it is often necessary to deal with noise in the values observed. Such noise complicates automated search procedures, and can affect the solution. In our example, the location, orientation and dimensions of an elliptical object are determined based on noisy data from electromagnetic surveys. We then use a global optimization approach to find the best function fit. Our results demonstrate the success of this general approach.

3 - Nonlinear Programming in Engineering Sciences - Past, Present, Future

Klaus Schittkowski, Dept. of Computer Science, University of Bayreuth, Postfach, 95440, Bayreuth, Germany, klaus.schittkowski@uni-bayreuth.de

In general terms, we will try to characterize 'typical' optimization problems in engineering sciences. The role of SQP methods in practical applications over the last 25 years is outlined in form of a review based on subjective experience with a self-made code. In future, we will be faced with increasing complexity of mathematical models, distributed computing in heterogeneous networks, interdisciplinary design optimization systems, and very large scale optimization problems. Also design cycles will be automated in future; an example is given.

■ MA-34

Monday, 8:30-10:00

DEC VR II V-138

General Models

Stream: Systems and Game Theory

Invited session

Chair: Ruediger Ehlers, University of Dortmund, Kuithanstrasse 86, 44137, Dortmund, Germany, Ruediger.Ehlers@uni-dortmund.de

1 - Search Game On Three Arcs With Any Starting Point

Ljiljana Pavlovic, Institute of Mathematics, Faculty of Natural Sciences and Mathematics, Radoja Domanovića 12, 34 000, Kragujevac, Serbia and Montenegro, pavlovic@knez.uis.kg.ac.yu, Marina Stojanovic

We consider a search game for an immobile hider on three arcs of unit length which join two points and the starting point of the searcher is anywhere. We find optimal strategies and the value of a restricted game, which are probably optimal strategies and the value of nonrestricted game.

2 - Game theoretic AHP for the case of 2-player zero-sum games

Masaaki Shinohara, Nihon University, 1-2-1 Izumi-chou, Narashino, 275-8575, Chiba, Japan, m7sinoha@cit.nihon-u.ac.jp, Keikichi Osawa

Hierarchical decomposition is applied to the payoff matrix of a 2-player zero-sum game. Relationship between the strategy vector of the integrated payoff matrix and the strategy vector of each decomposed payoff matrix is studied. For the case of 2x2 zero-sum game with purely mixed strategies, a simple formula which relates the strategy vector of the integrated payoff matrix and the strategy vector of each decomposed payoff matrix is established; the strategy vector of the integrated payoff matrix is obtained as a weighted combination of the strategy vector of each decomposed payoff matrix.

3 - Advanced strategy representations for the iterated prisoner's dilemma

Ruediger Ehlers, University of Dortmund, Kuithanstrasse 86, 44137, Dortmund, Germany, Ruediger.Ehlers@uni-dortmund.de, Karlheinz Schmitt, Bastian Baranski, Thomas Bartz-Beielstein, Thusinthan Kajendran, Björn Kosslers, Jörn Mehnen, Ralf Reimholz, Jens Schmidt, Danny Seis, Rafael Slodzinski, Nils Wiemann, Simon Steeg, Marc Zimmermann, Tomasz Polaszek

Although many studies have been conducted on evolving strategies for the iterated prisoners dilemma (IPD) using evolutionary algorithms, most of them use rather simple representations like look-up tables. The representation is a major design criterium and simple representations disclose many possible solutions from the set of strategies that can be generated. In this paper we introduce an advanced, exhaustive representation based on linear genetic programming. It is used in coevolution and evolution against a fixed set of strategies as well.

4 - Bourse Mode of Emissions Trading in China

Li Lijun, School of Economic and Management, Shijiazhuang Railway Institute, 050043, Shijiazhuang, Hebei Province, China, lilj@sjzri.edu.cn

The emissions trading is one kind of sustainable development measures that is based on market mechanism. Most of emissions permits transactions in China are organized by government environment authority, which make it lack of market function. Emissions permits is kind of property rights, important, profitable, and its market obviously possesses the two-class of original allocation and second-time transfer. There are some deciding differences between emissions permits and ordinary transaction object, the specialized bourse for emissions trading should be built.

■ MA-35

Monday, 8:30-10:00

DEC VR II V-147

PSMs and the Public Sector

Stream: Problem Structuring Methods / Soft OR

Invited session

Chair: Leroy White, Management, University of Bristol, Willes Memorial building, Queens Rd, BS8 1RN, Bristol, United Kingdom, leroy.white@bris.ac.uk

1 - Pointing to value priorities in organisations

Humphrey Bourne, Management, University of Bristol, Willes Memorial Building, Lewis Wing, Queen's Road, BS8 1RJ, Bristol, United Kingdom, humphrey.bourne@bristol.ac.uk

Developments in theoretical concepts of value systems provide means of identifying more clearly value priorities of organisations than do two-parameter models. Findings from one qualitative and one quantitative study are mapped onto Schwartz's value types model to reveal preferred and rejected values in two commercial and one local government organisation. The resulting value maps reveal differences in each organisation's orientation of values, allowing for comparison. The mapping of values onto this model provides the potential for new avenues of inter-organisational research and practice.

2 - Voices and Values: enhancing participation in problem structuring methods

Leroy White, Management, University of Bristol, Willes Memorial building, Queens Rd, BS8 1RN, Bristol, United Kingdom, leroy.white@bris.ac.uk

It is now widely accepted that public policy development requires both an appreciation of public values and an ability to involve insights from local people. This paper presents some research about values and local people's voices in public policy making, which the authors believe present a challenge to OR/MS and to the use of problem structuring methods (PSM). The paper will describe a framework for understanding values and exploring insights into including local voices in policy-making using PSMs.

■ MA-36

Monday, 8:30-10:00

DEC VR II V-155

Energy and Petrochemical decision making

Stream: Multicriteria Decision Analysis

Invited session

Chair: Carlos Escobar-Toledo, Faculty of Chemistry, Building D - 310, National University of Mexico (UNAM), Circuito Institutos, Ciudad Universitaria, 04510, Mexico City, Mexico, carloset@servidor.unam.mx

1 - MCDMA applied to maintenance strategy selection.

Edgar Sevilla, UNAM, Circuito Institutos, Facultad de Química, UNAM, 04510, Mexico City, Mexico, edsevijr@hotmail.com, *Carlos Escobar-Toledo*

This paper describes an application of the PROMETHEE-GAIA for selecting the best maintenance strategy for a Mexican oil refinery. We considered preventive, predictive, condition-based and corrective maintenance. The best maintenance policy will be selected for each facility. The equipment are clustered in homogeneous groups after a critically analysis. Several aspects which characterize each of the mentioned maintenance strategies, are arranged in a hierarchic structure. To improve the effectiveness of the methodology, we utilize the GAIA software for sensitivity analysis.

2 - Multilevel planning and the use of MCDMA, to reduce the complexity of a very combinatorial problem: The case of the Petrochemical Industry.

Claudia Garcia-Aranda, Faculty of Chemistry, Cd. Universitaria, D.F., 04100, Mexico City, Mexico, cloud_pq@yahoo.com.mx, *Carlos Escobar-Toledo*

Considering multilevel planning, we present a methodology for planning a very complex system as the petrochemical industry. The technological routes to be followed (final, intermediate, and basic petrochemicals), is a huge network with a many possibilities (a combinatorial problem). To solve it and to induce better decisions, we model the system utilising network analysis and MCDA. There are four criteria and all of them are associated with each product/process along the chain of production. We evaluate also the value of a given petrochemical with the income of only export crude oil.

3 - Increasing the eco-efficiency and economy of an energy system: a multiobjective optimization approach

Carlos Escobar-Toledo, Faculty of Chemistry, Building D - 310, National University of Mexico (UNAM), Circuito Institutos, Ciudad Universitaria, 04510, Mexico City, Mexico, carloset@servidor.unam.mx

We propose a multiple objective model for planning the energy supply sector, the environment effects of it and the implications to the whole economy. The system is based on integration of input-output analysis. The first subsystem represents the energy sector, producing different forms of secondary energy. The second, is non-energy sector of the economy. The third, is an energy-environmental link. The whole system has four objective functions relating the energy policy, macroeconomic and environmental variables, energy supply technologies and the future investments in a horizon to 2025.

MA-37

Monday, 8:30-10:00

DEC VR7 V-156

AI and Neural Networks I

Stream: AI and Neural Networks

Invited session

Chair: *Christophe Mues*, School of Management, University of Southampton, SO17 1BJ, Southampton, United Kingdom, C.Mues@soton.ac.uk

1 - Rates of growth of covering numbers of certain convex hulls

Marcello Sanguineti, DIST, University of Genoa, Via Opera Pia, 13, 16145, Genova, Italy, marcello@dist.unige.it

Estimates of rates of growth of covering numbers of convex hulls cover important roles in density estimation, empirical processes, machine learning, etc. When convex hulls contain orthogonal sets of elements with norms decaying "slowly enough", we show that covering numbers must be "large". Our approach combines properties of quasi-orthogonal dimension of Euclidean spaces with exponential growth of generalized Hadamard matrices. For convex hulls of sets with power-type covering numbers, we derive tight estimates. We give examples from machine learning and nonlinear approximation schemes.

2 - Formalization of knowledge using mathematical modelling

Helena Brozova, Dept. of Operational and Systems Analysis, Czech University of Agriculture, Kamycka 129, 165 21, Prague 6 - Suchdol, Czech Republic, brozova@pef.czu.cz, *Tomas Subrt*

Formalization of the sequence of categories "symbol - data - information - knowledge - wisdom" in the frame of life cycle of knowledge is the aim of our contribution. Qualitative distinctions among these categories are formalized using mathematical tools and finally applied to a mathematical model as a representative of a tacit knowledge. Such tacit type of knowledge represents an expert's ability to select the best type of model, to construct it and to find the best solution method. On the other hand the model solution in itself points to an explicit knowledge.

3 - Knowledge discovery and implementation using neural network rule extraction and decision tables

Christophe Mues, School of Management, University of Southampton, SO17 1BJ, Southampton, United Kingdom, C.Mues@soton.ac.uk, *Bart Baesens*, *David Martens*, *Hsin-Vonn Seow*, *Reza Shahi*

While, in many application domains, the use of neural network (NN) techniques has produced accurate classifiers, the black-box nature of a NN often hinders its subsequent validation by practitioners and its integration into the existing business and ICT environment. Hence, we propose a framework covering this entire trajectory, that centres on the use of NN rule extraction to produce a powerful rule set classifier that can then be visualized as a decision table (DT) for validation. We will compare NN rule extraction algorithms and discuss subsequent implementation strategies based on DTs.

MA-38

Monday, 8:30-10:00

DEC VR7 V-157

Theory and Methodology of DEA

Stream: DEA and Performance Measurement

Invited session

Chair: *Victor Podinovski*, Warwick Business School, University of Warwick, Gibbet Hill Road, CV4 7AL, Coventry, United Kingdom, v.podinovski@warwick.ac.uk

1 - Constrained PCA and DEA

Shubhabrata Das, QMIS, Indian Institute of Management Bangalore, Faculty Block C 2nd Floor, Bannerghatta Road, 560076, Bangalore, India, shubho@iimb.ernet.in

DEA is often compared with PCA in ranking DMUs. But, traditional PCA is ill-suited for such a comparison since signs of the weights should be predetermined (typically nonnegative) in those PCs. We consider PCA where such constraints are built in the optimization procedure and draw parallel with DEA. Constrained principal components of higher orders are developed for this purpose. In the second phase of the interplay between the two analyses, we inspect the relevance of constrained PCA in PCA-DEA where the input and output variables to be used in DEA are selected by constrained PCA.

2 - A methodology for cross-evaluation in DEA

Nikolaos Argyris, Operational Research, London School of Economics, Houghton Street, WC2A 2AE, London, United Kingdom, n.argyris@lse.ac.uk, *Gautam Appa*, *H. Paul Williams*

We provide a new approach for cross-evaluation in DEA. An examination of the link between cross-evaluation and the DEA production possibility set reveals flaws in the current methodology. This is compounded by problematic cases permitted by existing approaches. Our approach is based on information on all weighting schemes for all DMUs. We show how this overcomes existing problems, provide new tools for the identification of maverick DMUs that make use of unrealistic weighting schemes and introduce the concept of under-achieving DMUs.

3 - Enhancing DEA by the use of proportionality assumptions

Victor Podinovski, Warwick Business School, University of Warwick, Gibbet Hill Road, CV4 7AL, Coventry, United Kingdom, v.podinovski@warwick.ac.uk

The assumption of full proportionality is incorporated in the constant returns-to-scale (CRS) technology and allows for proportional scaling of inputs and outputs of production units. The assumption of selective proportionality was recently incorporated in the hybrid returns-to-scale (HRS) technology in which only a subset of outputs is proportional to a subset of inputs. In this paper we identify production technologies that exhibit both types of proportionality. DEA models based on such technologies provide better discrimination than the CRS and HRS models.

■ MA-40

Monday, 8:30-10:00

SOC VR11 V-257

Sustainable Supply Chain Management Stream: Environmental Planning

Invited session

Chair: *Joao Quariguasi Frota Neto*, Decision Science, Erasmus University, Burgemeester Oudlaan 50, PO Box 1738, 3062 PA, Rotterdam, Netherlands, jquariguasi@rsm.nl

Chair: *Jacqueline Bloemhof*, Decision and Information Sciences, RSM Erasmus University, Burgemeester Oudlaan 50, 3062 PA, Rotterdam, Netherlands, jbloemhof@rsm.nl

1 - A Parallel Metaheuristic for the Disassembly Scheduling Problem

Belarmino Adenso-Diaz, Engineering School at Gijon, Universidad de Oviedo, Campus de Viesques, 33204, Gijon, Spain, adenso@epsig.uniovi.es, *Sebastián Lozano*, *Santiago Carbajal*

Disassembly is a very important practice today as governments are forcing recycling. Finding efficient ways for determining disassembly sequences is an important challenge. When the number of components to extract is high, heuristics are a suitable tool, and if the size of the instance is very large, sequential algorithms seems to be too slow. Here a GRASP based metaheuristic is defined using a parallel computation structure. It is tested on a previously developed product samples so to demonstrate its higher performance when comparing with some previous sequential approaches.

2 - Life Cycle Costing for Strategic Evaluation of Remanufacturing Systems

Thomas Spengler, Produktion und Logistik, TU Braunschweig, Katharinenstr.3, 38106, Braunschweig, Germany, t.spengler@tu-bs.de

Considering the economic potential of closed-loop supply chains, the development of measures concerning product related environmental protection is necessary. Remanufacturing is the most valuable product recovery option since here the value that was originally added to the product can be preserved. The goal of this contribution is the development of a strategic planning approach for remanufacturing systems, based on life cycle costing and economic evaluation of decision alternatives.

3 - Sustainable Logistic Networks in the Electrical and Electronic Sector

Joao Quariguasi Frota Neto, Decision Science, Erasmus University, Burgemeester Oudlaan 50, PO Box 1738, 3062 PA, Rotterdam, Netherlands, jquariguasi@rsm.nl, *Jacqueline Bloemhof*, *Jo van Nunen*

In this paper we intend to analyse the design and evaluation of Sustainable Logistic Networks (SLN) for the Electrical and Electronic Equipment Sector. More specifically we intend to i) determine the main factors influencing environmental performance and costs in logistic networks ii) present a framework and mathematical formulation, based on multi-objective programming, iii) point out opportunities for efficiency gains in such SLNs and iv) introduce a technique to evaluate the efficiency of existing logistic networks.

4 - Modelling Energy for Sustainable Rural Livelihoods

Judith Cherni, Centre for Environmental Policy, Imperial College London, South Kensington Campus, SW7 2AZ, London, j.cherni@imperial.ac.uk, *Isaac Dyrer*, *Gloria Patricia Jaramillo*

A large number of problems arise when planning energy provision for poor rural areas. The multi-criteria Sustainable Rural Energy Decision Support System, SURE was developed to address these complexities. The model employs a sustainable livelihoods approach along with technical and scientific information. We discuss the SURE system and model trade-offs of energy options on a rural community in a Latin American country. It is part of the Renewable Energy for Sustainable Rural Livelihoods RESURL project on clean energy technology, poverty reduction and sustainability in developing countries.

■ MA-41

Monday, 8:30-10:00

SOC VR11 V-258

Social and Economic Problems

Stream: Behavioural and Experimental Economics

Invited session

Chair: *Andranik Tangian*, WSI, Hans Boeckler Foundation, Hans Boeckler Str. 39, 40476, Duesseldorf, Germany, andranik-tangian@boeckler.de

1 - Fractional Criterion Function and Intervals of Validity of Dual Prices

Marija Cileg, Quantitative methods in economy, Faculty of Economics, Segedinski put 9-11, 24000, Subotica, Serbia, Serbia and Montenegro, macileg@yahoo.com, *Tibor Kis*

This paper deals with the analysis of dual models and proposes a method of determination of interval of validity of dual prices of linear models with fractional criterion function. The procedure suggested in this paper enables investigations in effects of fluctuations of resources on the value of the fractional criterion function dependent on the sign and ratio of dual prices. Also economic indicators are derived about the resources preferred to be enlarged.

2 - Assistance or Subjugation: The Impact of Microcredit on the Poor

Ozge Aytulun, International Relations, Koc University, Acarlar Sitesi E30/ 12 Sariyer, 34346, Istanbul, Turkey, ozgeaytulun@yahoo.com, *Gokce Gunel*

The application of microcredit as an instrument of poverty alleviation is a recent phenomenon in Turkey. This article argues that through microcredit the poverty alleviation discourse is being used in order to promote market integration and deepening, thereby connecting the poor with the global economy. It is also a part of the neo-liberal governance structure, subjugating the poor to the market forces. Drawing on elite interviews with policy makers and civil society members, and primary sources, this study aims at contributing to the on-going debates by looking through the Turkish lens.

3 - Monitoring flexicurity policies in the EU with dedicated composite indicators

Andranik Tangian, WSI, Hans Boeckler Foundation, Hans Boeckler Str. 39, 40476, Duesseldorf, Germany, andranik-tangian@boeckler.de

To monitor effects of flexicurity policies in Europe flexicurity indices are constructed from scores of the strictness of employment protection legislation provided by the OECD, qualitative juridical data on social security benefits (unemployment insurance, public pensions, etc.), and data on the dynamics of employment types (permanent, temporary, full-time, part-time, self-employed, etc.). The empirical investigation shows that, contrary to political promises and theoretical opinions, the current deregulation of European labour markets is not compensated with improvements in social security.

■ MA-42

Monday, 8:30-10:00

SOC VR II V-261

Modeling Social Systems I

Stream: Modeling Social Systems

Invited session

Chair: *Markus Schwaninger*, Institut für Betriebswirtschaft, Universität St.Gallen, St.Gallen, Switzerland, markus.schwaninger@unisg.ch

1 - "Saving a Valley" - A Systemic, Model-Based Approach

Markus Schwaninger, Institut für Betriebswirtschaft, Universität St.Gallen, St.Gallen, Switzerland, markus.schwaninger@unisg.ch

This contribution gives substance to the notion of "systemic decision-making", on the basis of a pertinent case. The Austrian Gastein Valley, a nature oasis, was threatened by the construction of a heavy-duty railway. A system study was carried out to ascertain the potential consequences for the socio-economic and ecological conditions in the valley. Based on a dynamic model, the impact of several variants was examined. The results of the study led to a decision for the most expensive but least invasive construction. This essentially "saved" the quality of life in the affected micro-region.

2 - Viable System Model Application on Regional and Urban Planning in a University Context

José Pérez Ríos, Business Organization, Universidad de Valladolid, ETSI Informatica, Campus Miguel Delibes, 47011, Valladolid, Spain, rios@uva.es, *Xosé L. Martínez Suárez*

The purpose of this work is to demonstrate the usefulness of Beer's Organizational Cybernetics, in particular the Viable System Model - VSM -, to the field of Regional and Urban Planning. The complexity of the environment where regional and urban planners operate requires a systemic approach capable of taking into consideration the variety of relationships among the diversity of variables - sociological, economic, political, physical, etc. - involved in any intervention of this kind. Our argument is illustrated by a real case of VSM use in the management of a public Spanish university.

3 - A Cybernetic Approach to Organizational Design

Matej Janovjak, CILAG AG, Hochstr. 208, 8205, Schaffhausen, Switzerland, mjanovja@cilch.jnj.com

This contribution reflects on the organizational design, aimed to achieve supply chain excellence, in a company with worldwide operations. The focus is on the globally operated technology platforms, i.e., an overarching process related to organizational design. In order to make the complexity at hand understandable, the management reverted to System Dynamics methodology. A model of the relationships between technology platform, stakeholders and processes was worked out. A roll out model has been implemented. The use of these models is an important contribution to organizational viability.

■ MA-43

Monday, 8:30-10:00

FIN Endur Room 1

Hydropower management via stochastic programming

Stream: Stochastic Programming

Invited session

Chair: *Stein-Erik Fleten*, Industrial Economics and Technology Management, NTNU Norway, Alfred Getz v. 3, NO-7491, Trondheim, Norway, stein-erik.fleten@iot.ntnu.no

Chair: *Trine Krogh Kristoffersen*, Department of Operations Research, University of Aarhus, Ny Munkegade, Bygning 1530, 8000, Aarhus C, Denmark, trinek@imf.au.dk

1 - Physical asset valuation via multistage stochastic programming

Jens Guessow, ior/cf-HSG, University of St. Gallen, Bodanstrasse 6, 9000, St. Gallen, Switzerland, jens.guessow@unisg.ch

The derivative character of electricity and related contracts restricts analytical valuations. Multistage stochastic models are capable to reflect periodic rebalancing opportunities as in pumped storage hydro power stations exposed to price and volume uncertainties. The underlying decision process is subject to restrictions at definite times plus to integral and differential limitations. Based on optimized exercise strategies a distribution analysis is used for valuations and risk management. The methodology also applies for equivalent financial contracts specific to electricity markets.

2 - Stochastic programming for optimizing bidding strategies of a hydro-power producer

Trine Krogh Kristoffersen, Department of Operations Research, University of Aarhus, Ny Munkegade, Bygning 1530, 8000, Aarhus C, Denmark, trinek@imf.au.dk, *Stein-Erik Fleten*

A framework is provided for determining optimal bidding strategies of a price-taking hydro-power producer trading in the day-ahead power market while facing price uncertainty. Realistic price scenarios are generated and a stochastic mixed-integer linear programming model that takes in both production and trading aspects is developed. The effects of including uncertainty into optimization is explored and the stochastic approach is compared to a deterministic one. The model is illustrated with data from a Norwegian hydro-power producer and the Nordic power market at Nord Pool.

3 - Dispatch of hydropower stations under uncertainty

Stein-Erik Fleten, Industrial Economics and Technology Management, NTNU Norway, Alfred Getz v. 3, NO-7491, Trondheim, Norway, stein-erik.fleten@iot.ntnu.no, *Trine Krogh Kristoffersen*

Using multistage mixed-integer stochastic programming, we develop short-term production plans for a small hydropower plant under uncertainty. Dispatching the production in the day-ahead market while adhering to the commitments from the last day, the production must be allocated among the reservoirs of the plant such as to maximise the sum of current and expected future profits. The intention is to investigate the differences between a deterministic and a stochastic approach. A demonstration with data from a Norwegian hydropower producer and the Nordic power exchange Nord Pool is presented.

■ MA-44

Monday, 8:30-10:00

FIN Endur Room 2

Information and Stock Prices

Stream: Long Term Financial Decisions

Invited session

Chair: *Bernhard Nietert*, Department of Business Administration and Economics, Passau University, Chair of Finance, Innstrasse 27, 94032, Passau, Germany, nietert@uni-passau.de

1 - No News is Not Good News

Walter Reinhart, Loyola College, 2034 Greenspring Drive, 21093, Timonium, MD, United States, reinhart@loyola.edu, *Lisa Fairchild*, *Ellie Nall*

The purpose of the research is to understand whether companies' stock prices are affected by news that appears on the first page of the Wall Street Journal. The hypothesis is that investors (and hence stock prices) react to news and that this 'reaction' is short-term and in the long-term returns are 'normalized.' The empirical results support the hypothesis. Additionally the research has implications for behavioral finance (e.g., herd behavior) and efficient markets.

2 - Tertium datur - Or Pricing Derivatives on Several Assets in a Complete Market Setting

Andreas Rathgeber, Wirtschaftswissenschaften, Universität Augsburg, Universitätsstraße 16, 86135, Augsburg, Germany, andreas.rathgeber@wiwi.uni-augsburg.de

Since pricing models for derivatives on more than one asset in discrete time are in most cases incomplete, we present a discrete time complete model to price derivatives on several securities. The approach is calibrated similar to the well known CRR model, with one difference: We employ basis vectors of simple random variables which are linearly transformed to achieve a process with the desired parameters. Because our methodology guarantees an optimal convergence, it is especially applicable to problems with huge total variances and consequently to the pricing of options with long maturities.

3 - Limited Time for Stock Analysis and its Consequences to Portfolio Selection

Bernhard Nietert, Department of Business Administration and Economics, Passau University, Chair of Finance, Innstrasse 27, 94032, Passau, Germany, nietert@uni-passau.de, Armin Dolzer

Private investors have limited time available for stock analysis because they have to split time between stock analysis and work. This paper analyzes the influence of time constraints on portfolio selection and derives besides the optimal portfolio selection the optimal time allocation between stock analysis and work. Under time constraints, rational private investors show portfolio choices similar to investors with bounded rationality, i.e., insufficient diversification, and excessive trading.

■ MA-45

Monday, 8:30-10:00

FIN Endur Room 3

Computational Economics and Finance

Stream: Optimization in Financial Mathematics

Invited session

Chair: *Esma Gaygisiz*, Dept. of Economics, Middle East Technical University, 06531, Ankara, Turkey, esma@metu.edu.tr

1 - New Approaches to Regression in Financial Mathematics by Generalized Additive Models

Pakize Taylan, Institute of Applied Mathematics, Technical University of Middle East, 06531, Ankara, Turkey, ptaylan@metu.edu.tr, Gerhard-Wilhelm Weber

Generalized additive models, consisting of an intercept and functions summed up which are separating the predictors, are a modern tool in the approximation of financial data, e.g., from stock market. We present a mathematical modeling by splines based on a new clustering approach for the input data, their density, and the variation of the output data. Second order terms (curvature) are bounded (penalized) for a more robust regression. For this refined situation, we present a modified version of backfitting algorithm and recommend a usage of optimization theory for future research.

2 - Optimal Mortgage Choice and Stochastic Programming: Experiences from Denmark

Rolf Poulsen, Applied Math. and Statistics, University of Copenhagen, Universitetsparken 5, DK-2100, Copenhagen, Denmark, rolf@math.ku.dk

With Danish mortgage market as an example, we discuss how stochastic programming can be used to formulate and solve mortgage financing problems for individual home-owners.

3 - A new approach credit rating with Hidden Markov Model about Turkish economy

Rengin Ak, Economy - IAM, Yuzuncu Yil University - METU, Iktisadi ve Idari Bilimler Fakultesi Zeve Kampusu VAN, 65080, Van, Turkey, rengin_ak2000@hotmail.com, Gerhard-Wilhelm Weber

We study credit rating in Turkish financial sector by a Hidden Markov Model, representing the effect of credit rating, credit and interest rate in short and long period. We extend the model of Thomas et al., by introducing a third "neutral" state of the economy. We also show that the effect of all state on tourism, textile, automobile and service sector.

4 - Government Debt Management In Turkey With A Stochastic Optimization Approach

Nuray Celebi, Financial Mathematics, Institute of Applied Mathematics, 100. Yil Mah. Yildiz B Blok C Kanat Daire:19, Balgat, 06530, Ankara, Turkey, e114484@metu.edu.tr, Esma Gaygisiz

In this study, we model and solve the government debt management problem by using the stochastic programming method. Our aim is to minimize the expected cost of the debt portfolio in the medium run subject to risk and liquidity constraints. We construct a macroeconomic simulation model for Turkey by taking into account regime switches, volatilities and changes in volatilities through time. After applying k-means clustering method to generate scenarios from the simulated data, we find the optimal debt composition, maturity and interest rate structure by considering the cost and risk trade-offs.

■ MA-46

Monday, 8:30-10:00

FIN Endur Room 4

Control of Stochastic Networks

Stream: Applied Probability

Invited session

Chair: *Ulrich Rieder*, Abteilung Mathematik VII, Universitaet Ulm, Helmholtzstrasse 18, 89069, Ulm, Germany, rieder@mathematik.uni-ulm.de

1 - Performance Bounds for Controlled Stochastic Networks with Delayed Dynamics

Harald Bauer, Optimization and Operations Research, University of Ulm, Helmholtzstr. 18, 89081, Ulm, Germany, hbauer@mathematik.uni-ulm.de

Fluid approximation is a common tool to examine the performance and control of stochastic networks which are analytically intractable. In this talk, we derive performance bounds for network models with state dependent dynamics and delay, based on a fluid approximation. These bounds are obtained from the solution of a deterministic hereditary differential system with infinite-dimensional state space. We give conditions under which a reduction to a finite-dimensional problem is possible so that classical solution techniques can be applied. The results are underpinned by some simulation studies.

2 - Simulation-Based Approaches to a Simple Queueing System

Thomas Bösel, Optimierung und Operations Research, Ulm University, Sammlungsgasse 2, 89073, Ulm, Germany, thomas.boesel@mathematik.uni-ulm.de

The need to overcome the Curse Of Dimensionality gave rise to understand approximate algorithms for solving large stochastic control problems. Recent research has shown, that approximate linear programming (ALP) is indeed feasible and may produce near optimal solutions. Here we would like to apply the ALP methodology and constraint reduction methods to a simple multiclass queueing problem. Preliminary evaluations of this methodology, especially compared to other approximate solution methods derived from Neuro-Dynamic Programming (i.e. TD- or Q-learning), will be presented.

3 - Control of a Markovian Jump Process under Partial Information

Jens Winter, Optimization and Operations Research, University of Ulm, Helmholtzstr. 18, 89069, Ulm, Germany, jwinter@mathematik.uni-ulm.de

A control model in continuous time is considered, where the state process is a controlled Markovian jump process, which is not completely observable. With the help of an observation process, whose distribution depends on the unobservable state process, and with the help of the filter technique the control model with partial information is transformed into a model with a complete information structure. This transformed model is then solvable with the well-known control theory. Some applications are also considered.

■ MA-47

Monday, 8:30-10:00

FIN Endur Room 5

Optimal Portfolio Choice

Stream: Financial Modelling

Invited session

Chair: *Jaap Spronk*, Finance & Investments, Erasmus University, P.O.Box 1738, 3000DR, Rotterdam, Netherlands, spronk@few.eur.nl

1 - A Goal Programming model for Portfolio Selection based on Expert Betas

Maria Victoria Rodriguez-Uria, Economia Cuantitativa, University of Oviedo, Avda. del cisto s/n, 33006, Oviedo, Spain, vrodr@uniovi.es, *Bilbao-Terol Amelia*, *Jimenez-Lopez Mariano*, *Arenas Parra Mar*, *Antomil José*, *Perez Gladish Blanca*

The aim of the paper is to design flexible models for decision making in the field of portfolio selection. Sharpe's single-index model involves estimations of the index Beta for each potential asset; these estimations are obtained from past data using statistic methods but financial markets include a lot of uncertainty about forthcoming market performance. Fuzzy Logic permits model these situations. In this paper a Single-Index model including imprecise expert knowledge and imprecise preferences arising from analysts and investors is proposed based on "Expert Betas" and Goal Programming.

2 - Information Loss in Hierarchical Asset Allocation

Haikun Ning, Finance and accounting, Erasmus University Rotterdam, room H9-05, Burgemeester Oudlaan 50, 3062 PA, Rotterdam, Netherlands, hning@few.eur.nl, *Winfried Hallerbach*, *Jaap Spronk*

A new method is proposed to improve decision-making in a multi-level investment setting (stock picking, industry selection and asset allocation). By including the Sharpe tangent portfolio, minimum risk portfolio and the benchmarks (either equally weighted or market cap weighted) in the top-level decision process, the resulting efficient frontier approaches the "utopia" frontier, which is constructed with full information to the top-level management. The improvement increases if we allow for the lower level efficient frontier to be communicated to the higher levels.

3 - Dynamic Risk Management in Contingent Portfolio Programming

Janne Kettunen, Systems Analysis Laboratory, Helsinki University of Technology, Postilokero 1100, 02015, Tkk, Finland, janne.kettunen@tkk.fi, *Ahti Salo*

Contingent Portfolio Programming is a recent framework for the Mixed Asset Portfolio Selection problem. We extend this framework by introducing Value-At-Risk constraints to ensure that the optimal portfolio satisfies the investor's preferences. We also formulate the Risk Constraint Matrix which permits the specification of multiple risk constraints for different time periods and risk levels. Our experiments suggest that the models are computationally tractable for problems of realistic size, and that extreme risks can be significantly reduced without appreciable reduction in expected value.

Monday, 10:30-12:00

■ MB-01

Monday, 10:30-12:00

PLEN HBio Big Stage

Opening Session - Plenary

Stream: Plenary Sessions

Invited session

Chair: *Tuula Kinnunen*, Kirkkotie 285, FI-21370, Aura kk, Finland, euro@tuulakinnunen.fi

1 - Opening Session - Plenary

Birna Kristinsdottir, Alcan Iceland, Straumsvik, 222, Hafnarfjordur, Iceland, birnak@alcan.com, *Alexis Tsoukiàs*, *Martin Grötschel*, *Snjolfur Olafsson*, *Tuula Kinnunen*

The opening session will be chaired by Tuula Kinnunen, the Chair of the Programme Committee. The president of ICORS (The Icelandic OR Society), Birna B. Kristinsdottir will start by welcoming the participants to the conference and then give a short presentation about ICORS and its activities. The President of EURO, Alexis Tsoukiàs will then follow by delivering a short talk aimed particularly at the members of the Member Societies of EURO. Next, the highest distinction of the Association of European Operational Research Societies - the EURO Gold Medal - will be presented and awarded, followed by a plenary presentation of the laureate(s). Finally, the chairs of the Organising and the Programme Committee will present the latest information concerning the conference.

2 - EURO Gold Medal Presentation

Martin Grötschel, Vice President, Konrad-Zuse-Zentrum für Informationstechnik, Takustrasse 7, D-14195, Berlin, Germany, groetschel@zib.de

The EURO Gold Medal is the highest distinction within OR in Europe. It is conferred to a prominent person or institution, for an outstanding contribution to the Operational Research science.

The Award, which officially is bestowed in conjunction with a EURO Conference, is not only a significant honour for the Laureate personally, but also important for the general promotion of OR as leading scholars and their contributions are made better known via the Medal. Laureates of the EURO Gold Medal are invited to all future EURO Conferences without payment of the registration fees.

Nominations of candidates are solicited from the national societies in the year prior to each EURO conference. To emphasize the European flavour of the Award, all societies are strongly urged not to propose a candidate from their own country. Moreover, no currently active officer of EURO (Executive Committee Member, EURO Gold Medal jury member, Organising and Programme Committees Chairman of the conference where the EURO Gold Medal will be awarded) is eligible. The societies are responsible for providing a recent and detailed CV of their nominee, as well as a written motivation stating the reasons why their nominee deserves the EURO Gold Medal.

The jury evaluates the proposed candidates essentially on basis of their scientific activities (papers in excellent journals, editorials, jobs, number of PH.D. students). The proposed laureate should also have contributed to the promotion of OR, in particular in Europe.

Monday, 12:30-13:30

■ MC-01

Monday, 12:30-13:30

PLEN HBio Big Stage

Simulated Optimization Lecture

Stream: Semi-Plenary Sessions

Invited session

Chair: *Erhan Erkut*, Faculty of Business Administration, Bilkent University, Bilkent, 06800, Ankara, Turkey, erkut@bilkent.edu.tr

Chair: *Raymond Bisdorff*, Applied Mathematics Unit, University of Luxembourg, L-1511, Luxembourg, Luxembourg, raymond.bisdorff@uni.lu

1 - Back to School

Erhan Erkut, Faculty of Business Administration, Bilkent University, Bilkent, 06800, Ankara, Turkey, erkut@bilkent.edu.tr

Operations Research is a difficult subject to teach. While OR Professors find the subject exhilarating, many business students regard it as a low point in their education. A monologue-based and method-driven lecture is a proven way to alienate business students with relatively weak mathematical backgrounds and no innate motivation to learn about algorithms and theorems.

The management science group at the University of Alberta believes they have found the holy grail of OR teaching after years of experimentation and fine-tuning. The solution combines a rethinking of the curriculum with an engaging delivery style, in-class activities, and aggressive use of technology. There is considerable empirical evidence that the methods work well in the OR classroom.

Dr. Erkut will deliver a short Alberta-esque lecture and then deliberate on the components of the winning formula. Many of the techniques employed are transferable across countries, institutions, faculties, programs, and class sizes. If you are not fully happy with the way students perceive your OR class, then it is likely that you will walk away from this session with several ideas to improve your OR course.

■ MC-02

Monday, 12:30-13:30

PLEN HBio Hall 1

Problem Structuring and Sustainable Development

Stream: Semi-Plenary Sessions

Invited session

Chair: *Jonathan Rosenhead*, Operational Research, London School of Economics and Political Science, Houghton Street, WC2A 2AE, London, United Kingdom, J.Rosenhead@lse.ac.uk

Chair: *Maurice Shutler*, Operational research, London School of Economics, 23 Admington Drive, Hatton Park, CV35 7TZ, Warwick, United Kingdom, maurice.shutler@tiscali.co.uk

1 - Problem Structuring and Sustainable Development

Jonathan Rosenhead, Operational Research, London School of Economics and Political Science, Houghton Street, WC2A 2AE, London, United Kingdom, J.Rosenhead@lse.ac.uk

Development is one of the greatest challenges facing the world, and lack of sustainability is its Achilles heel. Sustainability is not only a matter of the environment. Sustainability means that a change continues in being once the original impetus has run its course. Failure can result from lack of resources, generation of by-products, or violation of cultural norms or expectations.

Knowledge about these dimensions is dispersed. Therefore sustainability of development requires that the beneficiaries' of research or planning should be active subjects in the definition of their problem, taking into account the action consequences of accepting that definition. However, complex formulations will tend to exclude them from this active involvement.

Development planning's Rapid Rural Appraisal and Participatory Rural Appraisal now have a sophisticated repertoire of participatory methods. These provide ways to elicit and structure the factors that are important to local participants. However the assistance they do not incorporate processes for linking actions to consequences. This function is a key feature of Problem Structuring Methods' (PSMs), approaches which can facilitate dialogue within groups characterised by heterogeneous interests or knowledge bases. They do this by the participative construction of models representing the factors and relationships which group members see as relevant. PSMs lend themselves to use in action research mode, providing assistance to participants while also contributing to generalisable theory. This paper will provide an introduction to Problem Structuring Methods and their applications, and a discussion of the potential complementarity between them and the participative methods of RRA and PRA.

■ MC-03

Monday, 12:30-13:30

PLEN HBio Hall 2

Sustainable Development in Times of Globalization: Balance or Destruction

Stream: Semi-Plenary Sessions

Invited session

Chair: *Franz Josef Radermacher*, Research Institute for Applied Knowledge Processing/n FAW/n, Lise-Meitner-Str. 9, 89081, Ulm, Baden-Württemberg, Germany, radermacher@faw-neu-ulm.de

Chair: *Ulrike Leopold-Wildburger*, Statistics and Operations Research, Karl-Franzens-University, Universitätsstraße 15/E3, 8010, Graz, Austria, ulrike.leopold@uni-graz.at

1 - Sustainable Development in Times of Globalization: Balance or Destruction

Franz Josef Radermacher, Research Institute for Applied Knowledge Processing/n FAW/n, Lise-Meitner-Str. 9, 89081, Ulm, Baden-Württemberg, Germany, radermacher@faw-neu-ulm.de

The alarm signals cannot be ignored: population explosion, famine, clear-cut rain forests, exploited mineral deposits, global warming. As it stands, the current world economic system is driving mankind into ruin - through overexploitation of nature and raw materials and the lack of social and cultural balances between the countries and the cultures of the world. Within the framework of an unleashed globalized economy we are in the process of assaulting the social, cultural, and ecological capital. The globalization of the economy, triggered above all by the incredible new possibilities of information technology, leads into the wrong direction due to inadequate worldwide rules. The body of rules governing world trade today as represented mainly by the World Trade Organization, together with the worldwide closely linked financial systems, increasingly determines economy around the globe. Questions concerning environment, society and cultural diversity are rarely asked. The result is uncoordinated growth and increasing social divisions in nearly all countries. The pressure on economically weaker cultures is increasing. Herein lies one of the main reasons for the conflicts between the West and the Islamic world. The talk will look into these issues, asking for the interplay between issues such as globalization, information technology, sustainability and the future. Three attractors for future development are identified: collapse, brasilianization and the eco-social market economy model. The chances for different futures, a Global Marshall Plan and the crucial role of science in this context will be discussed. This also concerns OR as an important field concerning with complex structures.

www.faw-neu-ulm.de, www.globalmarshallplan.org, www.bwa-deutschland.de

■ MC-04

Monday, 12:30-13:30

PLEN HBio Hall 3

NP-hard Optimization Problems: Approximation Algorithms and Modern Application

Stream: Semi-Plenary Sessions

Invited session

Chair: *Dorit Hochbaum*, IE&OR department, UC Berkeley, Etcheverry Hall, 94720, Berkeley, CA, United States, hochbaum@ieor.berkeley.edu

Chair: *Jakob Krarup*, Dept. of Computer Science, University of Copenhagen, Universitetsparken 1, DK-2100, Copenhagen, Denmark, krarup@diku.dk

1 - Unified Approaches and Techniques for Approximation Algorithms to NP-hard Problems

Dorit Hochbaum, IEOR department, UC Berkeley, Etcheverry Hall, 94720, Berkeley, CA, United States, hochbaum@ieor.berkeley.edu

We describe a unified technique for intractable problems and generating approximation algorithm, consisting of a transformation of the problem formulation's constraint matrix into a totally unimodular matrix. The transformed problem is solvable in polynomial time. In many cases, the inverse transformation of the integer solution maps it to non-integers that are integer multiples of 1/2. That half integral solution is superoptimal and thus provides a bound on the optimum solution. It is often possible to derive 2-approximate solutions from this superoptimal solution.

■ MC-05

Monday, 12:30-13:30

PLEN Askja N-132

Pricing and Revenue Management with Endogenous Demand and Repeated Interactions

Stream: Semi-Plenary Sessions

Invited session

Chair: *Ioana Popescu*, Decision Sciences, Insead, Blvd. de Constance, 77300, Fontainebleau, France, ioana.popescu@insead.edu

Chair: *Peter Bell*, Richard Ivey School of Business, University of Western Ontario, N6A 3K7, London, Ontario, Canada, pbell@ivey.ca

1 - Pricing and Revenue Management with Endogenous Demand

Ioana Popescu, Decision Sciences, INSEAD, Blvd. de Constance, 77300, Fontainebleau, France, ioana.popescu@insead.edu

Recent revenue management research integrates operational inventory decisions with pricing and demand management, but adopts a highly simplified view of the consumer. In repeated interaction settings, consumers react to the firm's current, past and future decisions. We present realistic demand models where consumers either remember past prices or stock outs, or they anticipate future prices or rationing risk. We investigate the impact of consumer risk aversion, behavioral biases and strategic behavior on the firm's optimal pricing and inventory policies.

Monday, 14:00-15:30

■ MD-01

Monday, 14:00-15:30

KEY Askja N-132

TUTORIAL: Support Vector Machines

Stream: Industrial Application of Nonlinear Programming Algorithms

Invited session

Chair: *Klaus Schittkowski*, Dept. of Computer Science, University of Bayreuth, Postfach, 95440, Bayreuth, Germany, klaus.schittkowski@uni-bayreuth.de

1 - TUTORIAL: Kernel Methods for Pattern Analysis

John Shawe-Taylor, School of Electronics and Computer Science, University of Southampton, Highfield Campus, SO17 1BJ, Southampton, Hants, United Kingdom, jst@ecs.soton.ac.uk

The lectures will introduce the kernel methods approach to pattern analysis through the particular example of support vector machines. The presentation touches on generalization, optimization, dual representation, kernel design and algorithmics. We then broaden the discussion to general kernel methods by introducing different kernels, different learning tasks, and subspace methods such as kernel PCA. The aim is to give a view of the subject that will enable newcomers to the field to find their bearings so that they can readily identify research issues or applications of interest to them.

2 - Biological Data Mining by using SVM and Pattern Analysis

Süreyya Özogür, Institute of applied Mathematics, Middle East Technical University, ODTU Fen Edebiyat Fakültesi, Dekanlığı Binası Uygulamalı Matematik Enstitüsü No:205, 06530, Ankara, Turkey, sozogur@metu.edu.tr, *Gerhard-Wilhelm Weber*, *John Shawe-Taylor*

In recent years, studies in the field of computational biology and bioinformatics are rapidly growing by the help of new technologies and innovative methods. Scientific researchers are studying on how biological data are well understood by means of their features and behaviors in reality. In this study, biological sequence analysis is carried out by using suffix array methods and MEME software for pattern searching. The application will be mainly done in pro-peptide cleavage site prediction by both pattern searching method and by using SVM which is one of the powerful classification methods.

■ MD-02

Monday, 14:00-15:30

APP Askja N-131

Health Services Planning

Stream: OR in Health Care

Invited session

Chair: *Korina Katsaliaki*, School of Management, University of Southampton, Highfield Campus, SO17 1BJ, Southampton, United Kingdom, korina@soton.ac.uk

1 - Functional capacity of the elderly in the city of Sao Jose dos Campos, Sao Paulo, Brazil

Mischel Carmen N. Belderrain, Instituto Tecnológico de Aeronautica, Caixa Postal 6022 - CTA, 12228-970, Sao Jose dos Campos, SP, Brazil, carmen@ita.br, *Amanda Silva*, *Paula Vianna*

This paper aims to assess the functional ability of the elderly and to identify the socio-economic variables that affect their performance. Functional ability was assessed through the Lawton Index. The influence of variables was analyzed through Logistic Regression. The result showed by this index is directly connected with a poor quality of life, influenced by gender, education, age, economic condition and marital status. Such reality should alert health planners to build cross-boundaries policies in order to set up services that meet the demand which the elderly.

2 - Modelling the impact of workforce change in Social Services

Sally Brailsford, University of Southampton, School of Management, SO17 1BJ, Southampton, United Kingdom, s.c.brailsford@soton.ac.uk, *Pei Shan Ang*, *Peter Knight*

Change in workforce roles is currently a major issue in health and social care. This paper describes work carried out for Hampshire Social Services, who were considering retraining their van drivers. In addition to delivering specialist equipment to clients' homes, the drivers would also be able to instruct clients in the use of this equipment, a task currently performed by Occupational Therapists. A simulation model showed that the proposed change would be cost-effective, and interviews with staff found that that the change would be welcomed by both drivers and OTs.

3 - Developing existing cancer information for more effective use in managing cancer services

Christopher Sherlaw-Johnson, Clinical Operational Research Unit, University College London, Gower Street, WC1E 6BT, London, United Kingdom, c.sherlaw-johnson@ucl.ac.uk

Within the English National Health Service, large amounts of data are collected in relation to cancer services, and range from information about care structures to the process of care and outcomes. The data are collected by different organisations for different purposes, without coordination or linkage between them. In this paper we describe a study to establish how these data sets can be better used to improve the management of cancer services. We will focus, in particular, on how the data can be used to guide decision making to improve quality of care.

4 - Managing the inventory and logistics of blood banks using standalone and distributed simulations

Korina Katsaliaki, School of Management, University of Southampton, Highfield Campus, SO17 1BJ, Southampton, United Kingdom, korina@soton.ac.uk

This study analyses policies for managing the blood inventory system within the UK. The supply chain from donor to recipient is modelled by broken it down into material and information flows. Costs and health safety risks represent performance measurements. Unfortunately, supply chain systems often result in massively large and complicated models, which cannot run efficiently. This paper presents both the standalone and distributed discrete-event simulation models which were developed to determine ordering policies leading to reductions in shortages and wastage and increased service levels.

■ MD-03

Monday, 14:00-15:30

APP Askja N-130

Auctions in Practice

Stream: Auctions

Invited session

Chair: *Wedad Elmaghraby*, Georgia Institute of Technology, United States, wedad@isye.gatech.edu

1 - Price competition with non-convex costs: an experimental approach

Wedad Elmaghraby, R.H. Smith School of Business, University of Maryland, Decision and Information Technology, 20742, College Park, MD, United States, welmaghr@rsmith.umd.edu

Auctions are increasingly becoming standard instruments for procurement. However, the performance of procurement auctions when suppliers have non-convex costs are poorly understood. Because many industries are characterized by some variant of a fixed plus variable cost structure, improving our understanding of how auctions perform in this context is of practical importance. We present results from a series of experiments with human subjects at the University of Maryland. We find that the largest determinant of the efficiency of the auction is the bid structure.

2 - The combined Target Costing and Goal Programming Approach for Project Bidding Improvement

Tomasz Blaszczyk, Department of Operations Research, University of Economics in Katowice, ul. Bogucicka 14, 40-226, Katowice, Poland, tblaszcz@ae.katowice.pl

The trade-off between several conflict goals is a typical multi-criterial decision making (DM) problem. It appears in the majority of real-life DM situations, including the bid's preparation. Whereas, the process of preparing the best bids and gaining contracts belongs mainly to the project's performers who are oriented towards the external-customers. In this work, the synthesis proposal of two, well known methodologies: the Target Costing and Goal Programming is described. Its application is especially dedicated for decision makers who participate in the competitive bidding process.

3 - Resource coordination in large-scale sensor networks

Abhijit Deshmukh, DMI, National Science Foundation, Room 550, 4201 Wilson Blvd., 22230, Arlington, VA, United States, deshmukh@ecs.umass.edu, *Timothy Middelkoop*

Currently the scale and efficiency of sensor networks is severely limited by our ability to design, deploy and manage these large-scale, distributed systems. This presentation focuses on a key barrier in engineering large-scale sensor networks, namely distributed resource coordination. The sensor coordination model is formulated as a multi-linked bargaining market. We discuss a set of bargaining strategies and present a distributed fixed-point method that allows efficient (real-time) computation of the equilibrium solution.

4 - Hype or High Market Efficiency? An Empirical Analysis of Ebay Auctions

Appa Rao Korukonda, Computer Management Information Systems, Bloomsburg University of Pennsylvania, 400 East Second Street, Room 247 Sutliff Hall, College of Business, 17815, Bloomsburg, PA, United States, akorukon@bloomu.edu

Since its inception, eBay has dramatically altered the market structure and transaction costs of many product lines and has been instrumental in reducing entry barriers. Using historical data on successful no-reserve auctions of automobiles and comparing them to fair market values, this paper aims to examine whether eBay transactions demonstrate an increase in market efficiency and consumer surplus. Implications for future research are presented.

■ MD-04

Monday, 14:00-15:30

APP Askja N-129

Network and Layout Design Problems

Stream: Telecommunications (c)

Invited session

Chair: *Martin Zachariasen*, Dept. of Computer Science, University of Copenhagen, Universitetsparken 1, DK-2100, Copenhagen, Denmark, martinz@diku.dk

1 - Mathematical modeling of the optimal planar radii-based relationship diagrams

Wandee Udomwongyont, Assumption University, Huamark, 10500, Bangkok, Thailand, wandee.udomwongyont@gmail.com

An important preliminary step to layouts design is the closeness relationship diagrams development. Thus far, there has been no methodology to confirm the optimality of the diagrams, which, in turn, affects the construction of optimal layouts. This research proposes a mathematical model for developing the optimal closeness relationship diagrams.

2 - Multi-layered survivable network design problems

Benoit Lardeux, CORE, France Telecom Division RD, France Telecom Division R&D, 38-40, rue du Général

Leclerc, 92794, Issy-les-Moulineaux, France,
benoit.lardeux@rd.francetelecom.com

This abstract deals with the problem of designing survivable multi-layered telecommunication networks (MLSND). The graph topologies and link designs are computed to route traffic requirements even if failures occur. We present models based on the polyhedral study of the dominant polyhedron of multi-commodity flows. Efficient exact methods are proposed: Optimal solving of MLSND sub-problems is combined with a constraint generation procedure exploiting the structure of the metric cone. Optimal solutions are reached until 12 node network instances for two layers with fully meshed demand graphs

3 - How to situate broadband access nodes and construct a minimal cost fibre optic cable network

Bertram Wassermann, Telekom Austria AG, Lassallestrasse 9, A-1020, Vienna, Austria,
bertram.wassermann@telekom.at, Ivana Ljubic

We present a solution to the following network optimization problem: Internet broadband customers have to be supplied with higher bandwidth. Therefore access nodes (AN) are situated along the existing net under a maximal distance constraint: the distance between customer and its AN is bounded. The existing copper net is used as a last mile access net between the ANs and the customers. A (not existing) fibre optic cable network connecting ANs to a given source has to be optimized too. Known are potential paths along which cables can be laid and costs. The goal is to plan a minimal cost net.

4 - Uniform and non-uniform Steiner trees: Algorithms and applications

Martin Zachariassen, Dept. of Computer Science, University of Copenhagen, Universitetsparken 1, DK-2100, Copenhagen, Denmark, martinz@diku.dk

The fixed orientation Steiner tree problem in the plane is to determine a minimum length interconnection of a set of points in the plane, given that only a fixed set of line orientations are allowed. We survey recent developments for this problem, in particular linear programming models and fast polynomial algorithms for computing shortest trees for a given topology. Current and future applications are outlined.

■ MD-05

Monday, 14:00-15:30

APP Askja N-128

Sequential Optimisation in Agriculture and Forestry I

Stream: OR in Agriculture and Forest Management

Invited session

Chair: *Lars Relund Nielsen*, Research Unit of Statistics and Decision Analysis, Danish Institute of Agricultural Sciences (DIAS), P.O. Box 50, 8830, Tjele, Denmark, lars@relund.dk

1 - The 'curse of animal disease' and the 'curse of dimensionality': A new decision support framework for the control of foot-and-mouth disease epidemics

Lan Ge, Business Economics, Wageningen University, Hollandseweg 1, 6708CT, Wageningen, Netherlands,
lan.ge@wur.nl, Anders Kristensen, Monique Mourits, Ruud Huirne

Epidemics of foot-and-mouth disease (FMD) pose recurrent threat to countries with large population of susceptible animals and intensive livestock production. The decision problem in FMD control is fraught with uncertainty and complexity. This paper presents a new decision-support framework for the control of FMD epidemics based on dynamic models and the Multi-level hierarchic Markov process (MLHMP). While providing a formal structure of dynamic decision process, the MLHMP formulation facilitates simultaneous optimization of strategic decisions and operational decisions.

2 - An approach to the optimal design of a pig production chain

Lluís Pla, Mathematics, University of Lleida, JaumeII,73, 25001, Lleida, Spain, lmpa@matematica.udl.es

In this work the author presents a tactical Supply Chain model of pig production. The model is a first approach to a wider Supply Chain model. It intends to structure the chain in terms of number of farms per stage required to satisfy a weekly presteated demand, therefore is formulated for tactical purposes. The chain includes commercial herds integrated vertically and demand is represented by the number of heads processed by a slaughterhouse. Seasonal effects on production are taken into account. The objective function is to maximise revenues keeping an optimal herd structure.

3 - Optimization of delivery strategies for slaughter pigs

Merete Stenner Hansen, Department of Large Animal Science, Royal Veterinary and Agricultural University, Groennegaardsvej 2, Frederiksberg C, DK-1870, Copenhagen, Denmark, merete@stenner.dk, Anders Kristensen

In slaughter pigs, automatic weighing equipment is currently being investigated. In an attempt to utilise such registrations, a Decision Support System for slaughter pig marketing has been created. The DSS is based on a fairly new development of Bayesian Networks denoted as Limited Memory Influence Diagrams. A LIMID is represented graphically as a directed acyclic graph consisting of variables represented as chance, decision and utility nodes connected by directed edges. The model constructed here assumes, that individual weight data are available from all pigs during the finishing period.

4 - A quadratic programming model for optimal reforestation

Emili Valdero, Departament de Matemàtica Econòmica, Universitat de Barcelona, Facultat d'Econòmiques, Avda. Diagonal 690, 08034, Barcelona, Spain, evaldero@ub.edu

In several countries Government reforestation policies have been introduced aiming to reverse the ongoing forest loss due to fires, floods or the harvesting of timber. The purpose of this paper is to develop a Quadratic Programming model for an optimal landscape reforestation which could result in policies which might enhance social and ecological goals. The model maximizes the biodiversity of the reforestation area measured by Simpson's Diversity Index which takes into account the number of tree species, as well as the abundance of each one. An application example is also discussed.

■ MD-06

Monday, 14:00-15:30

APP Askja N-121

OR in the public sector II

Stream: OR in the Public Sector

Invited session

Chair: *Nisha de Silva*, Rds Noms, Home Office, 2nd floor (SE), Fry Building, 2 Marsham Street, SW1P 4DF, London, United Kingdom, nisha.desilva@homeoffice.gsi.gov.uk

1 - The EDY Algorithm: A New Ruler for Waiting-Time Equity in Allocating Organs for Transplant

Israel David, Industrial-Engineering and Management, Ben-Gurion University, Ben-Gurion St., 84105, Beer-Sheva, Israel, idavid@bgu.ac.il, Amir Alalouf

FCFS is considered the model policy for fairness, to which all kidney-allocation regimes are compared. We challenge this in context of donor-receptient matching and propose a new policy. When a kidney arrives candidates are offered to choose on the basis of "first come". The first candidate chooses based on the individually optimal stopping rule. If rejected the offer goes to the next candidate. We analyze the algorithm and present simulation results pertaining to its performance in equity and utility, compared to other regimes such as the American UNOS point system.

2 - Modelling Drug Market Supply Disruptions: Where Do All the Drugs Not Go?

Jonathan Caulkins, H. John Heinz III School of Public Policy Management, Carnegie Mellon University, 5032

Forbes Avenue, 15289, Pittsburgh, United States,
caulkins@andrew.cmu.edu

Recent disruptions of opium cultivation in Afghanistan and cocaine production in Colombia suggest effects on consumption can vary dramatically across downstream markets. This paper models how production deficits are "allocated" across downstream markets. It appears that cocaine markets outside the US serve as a sort of "shock absorber", partially shielding US markets from fluctuations in supply. Data limitations preclude parameterizing the model for opium control in Afghanistan's, but qualitative analysis suggests even more pessimistic result for effects on European heroin consumption.

3 - Projecting the prison population in England and Wales

Nisha de Silva, RDS NOMS, Home Office, 2nd floor (SE),
Fry Building, 2 Marsham Street, SW1P 4DF, London,
United Kingdom, nisha.desilva@homeoffice.gsi.gov.uk

Prison population projections help manage demand for prison places. Prison population fluctuates significantly due to predictable factors (e.g., seasonality) and uncontrollable environmental factors (e.g., sentence behaviour). The modelling exercise draws on a simulation model of the complex criminal justice system, a long-term prison population model based on a theory of re-offending, a detailed flow model based on receptions and discharges from prison, and an overarching analytical exercise that addresses underlying assumptions & scenarios, the analysis of historical trends & new legislation.

■ MD-07

Monday, 14:00-15:30

APP Askja N-120

Excellence in Practice Award I

Stream: Excellence in Practice Award

Invited session

Chair: *Gautam Mitra*, CARISMA, Brunel University,
Department of Mathematical Sciences, Kingston Lane, UB8
3PH, Uxbridge, Middlesex, United Kingdom,
gautam.mitra@brunel.ac.uk

Chair: *Jitka Dupacova*, Probability and Math. Statistics, Charles
Univ, Faculty of Math. and Physics, Sokolovska 83, CZ-18675,
Prague, Czech Republic, dupacova@karlin.mff.cuni.cz

Chair: *Stefan Voss*, Wirtschaftsinformatik/Information Systems,
University of Hamburg, Von-Melle-Park 5, 20146, Hamburg,
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Chair: *Paolo Toth*, DEIS, University of Bologna, Viale
Risorgimento 2, 40136, Bologna, Italy, ptoth@deis.unibo.it

Chair: *Catherine Roucairol*, PRISM lab. - CNRS, Univ. of
Versailles Saint Quentin en Yvelines, 45, avenue des Etats-Unis,
78035, Versailles Cedex, France,
Catherine.Roucairol@prism.uvsq.fr

1 - Models for Nuclear Smuggling Interdiction

David Morton, Graduate Program in Operations Research,
The University of Texas at Austin, 1 University Station,
C2200, 78712-0292, Austin, TX, United States,
morton@mail.utexas.edu, *Feng Pan*, *Kevin Saeger*

We describe two stochastic network interdiction models for thwarting nuclear smuggling. The smuggler selects a path that maximizes the probability of evading detection, and the interdictor installs radiation sensors to minimize that evasion probability. Our two models differ in the information available to the smuggler regarding the network parameters. For both models, we develop the important special case in which the sensors can only be installed at border crossings of a single country. In this special case, a class of valid inequalities significantly reduces the computation time.

2 - An Optimization Based Decision Support System for Strategic and Operational Planning in Process Industries

Goutam Dutta, Production and Quantitative Methods Area,
Indian Institute of Management, Wing 3, PMQ Area,,

Vastrapur, 380015, Ahmedabad, Gujarat, India,
goutam@iimahd.ernet.in, *Robert Fourer*

We describe how a generic multi-period optimization based decision support system can be used for strategic and operational planning in process industries. Built on five fundamental elements- materials, facilities, activities, time period and storage areas this system requires little direct knowledge of optimization techniques to be used effectively. Results based on the real data from an American integrated steel company demonstrate significant potential for improvement in revenue and profit. We are working on capability improvement and application of this technology in two other industries.

■ MD-08

Monday, 14:00-15:30

EDU Oddi 101

TUTORIAL AMP: Advances and Applications

Stream: Adaptive Memory Programming (AMP)

Invited session

Chair: *Fred Glover*, Leeds School of Business, University of
Colorado, Ucb 419, 80309-0419, Boulder, Colorado, United
States, Fred.Glover@Colorado.edu

1 - TUTORIAL: Advances and Prospects in Adaptive Memory Metaheuristics

Cesar Rego, School of Business Administration, University
of Mississippi, University, 38677, Oxford, MS, United
States, crego@bus.olemiss.edu

Adaptive Memory Programming (AMP) has been the source of numerous important developments in metaheuristics in the last decade. On the other hand, relaxation techniques have been widely used to provide bounds for tree search procedures as well as to produce heuristic algorithms. Relaxation Adaptive Memory Programming (RAMP) is a metaheuristic that integrates these two key developments by proposing a unified framework for the design of dual and primal-dual metaheuristics. This talk will review some of these major advances and results and discuss potential directions for future developments.

2 - Scatter Search for the Facility Location Problem

Peter Greistorfer, Institut für Industrie und
Fertigungswirtschaft, Karl-Franzens-University,
ReSoWi-Zentrum,, Universitätsstraße 15/G2, 8010, Graz,
Austria, peter.greistorfer@kfunigraz.ac.at, *Dorabela
Gamboa*, *Cesar Rego*

The Scatter Search (SS) approach has proved effective in solving a variety of complex optimization problems. We examine a SS algorithm that makes effective use of adaptive memory programming (AMP) for the uncapacitated facility location problem and present a computational study on standard and other particularly difficult instances.

■ MD-09

Monday, 14:00-15:30

IT Oddi 106

Bioinformatics II

Stream: Computational Biology and Bioinformatics

Invited session

Chair: *Jonathan Garibaldi*, Computer Science & IT, University
of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB,
Nottingham, United Kingdom, jmg@cs.nott.ac.uk

1 - A new idea for the haplotypes constructing algorithm

Marcin Jaroszewski, University of Nottingham,
Nottingham, United Kingdom, mxj@cs.nott.ac.uk, *Jonathan
Garibaldi*

A construction of haplotypes is one of the stages of genotyping strategies, and is important for extraction of information from underlying data. Nowadays, haplotypes are constructed using non-deterministic approaches which are mainly based on EM or MCMC. These algorithms have two flaws: (i) reliance on HWE; (ii) good results are yielded only for very small instances of the problem (up to the size of 6). In the future much larger problem instances are likely to be processed. To address this issue, we propose a combinatorial algorithm for the construction of haplotypes.

2 - Supervised Scoring of Protein Models using Kernels on Statistical Potentials

Paolo Frasconi, Sistemi e Informatica, Università degli Studi di Firenze, Via di Santa Marta 3, 50139, Firenze, Italy, p-f@dsi.unifi.it, *Alessio Ceroni*, *Lawrence Kelley*

We develop and test new algorithms for ranking alternative 3D protein conformations. The method enriches traditional approaches based on statistical pairwise potentials (PP) with supervised preference learning. This is obtained by (1) interpreting traditional PP modeling as maximum likelihood unsupervised learning, (2) deriving kernels to measure the similarity between two conformations, and (3) applying SVM ordinal regression to learn a ranking function over alternative conformations. Empirical tests on a realistic set of PDB proteins show significant improvements over the plain PP approach.

3 - On the complexity of the DNA Simplified Partial Digest Problem

Jacek Blazewicz, Instytut Informatyki, Politechnika Poznańska, ul. Piotrowo 2, 60-965, Poznań, Poland, jblazewicz@cs.put.poznan.pl, *Marta Kasprzak*

The problem to be addressed is one of the genome mapping of DNA molecules. The new approach - the Simplified Partial Digest Problem (SPDP), is analyzed. This approach is easy in laboratory implementation and robust with respect to measurement errors. In the paper, SPDP is formulated in terms of combinatorial search problem and proved to be strongly NP-hard for the general error-free case. For a subproblem of the SPDP, a simple $O(n \log n)$ -time algorithm is given, where n is a number of restriction sites.

■ MD-10

Monday, 14:00-15:30

OR Oddi 201

Vehicle Routing II

Stream: Vehicle Routing

Invited session

Chair: *Luis Gouveia*, DEIO, University of Lisbon, Campo Grande, Bloco C6, 1749-016, Lisbon, Portugal, legouveia@fc.ul.pt

1 - Branching approaches for the integrated vehicle and crew scheduling

Marta Mesquita, Depart. Matematica, Instituto Superior de Agronomia, Tapada da Ajuda, 1349-017, Lisboa, Portugal, marta@math.isa.utl.pt, *Ana Paiais*, *Ana Respicio*

We propose an integer formulation that combines a multicommodity flow model with a set partitioning/covering model. The linear relaxation of the model is solved using implicit column generation. The columns are generated by solving exactly or approximately constrained shortest paths. If the linear relaxation solution is not integer two strategies are proposed. On the first one, a feasible solution is obtained performing branch-and-bound over the set of generated duties. On the second one, an optimal solution is obtained by a branch-and-price algorithm. Computational experience is reported.

2 - On a time-dependent formulation for routing problems

Luis Gouveia, DEIO, University of Lisbon, Campo Grande, Bloco C6, 1749-016, Lisbon, Portugal, legouveia@fc.ul.pt, *Maria Teresa Godinho*, *Thomas Magnanti*, *Pierre Pesneau*, *José Pires*

We discuss the use of a time-dependent formulation due to Picard and Queyranne for routing problems. We present a computational comparison between multicommodity flow formulations and the time dependent formulation for the TSP with and without flow costs. We produce a formulation combining features of the two previous classes of models. We produce some inequalities which result from projecting the feasible LP set of the PQ formulation into the space of flow and design variables and into the space of design variables alone. We show how to adapt similar ideas for the VRP.

3 - Combining routing and inventory when transporting animals to slaughter

Arne Lokketangen, OIS, Molde College, Bitveien 2, 6411, Molde, Norway, Arne.Lokketangen@hiMolde.no, *Johan Oppen*

We present a problem that deals with collection of animals for slaughter. The problem is taken from the Norwegian meat industry, and may be viewed as a rich Vehicle Routing Problem extended with constraints regarding inventory and planned production at the slaughterhouse. This means that we have both a hard VRP and an inventory problem to solve at the same time, which strongly suggests the use of heuristic solution methods. We have developed a tabu search based metaheuristic for the Livestock Collection Problem, and computational results for this method will be presented.

■ MD-11

Monday, 14:00-15:30

TRANS Oddi 202

CO-DESNET : Collaborative Demand Supply Networks

Stream: Transportation

Invited session

Chair: *Walter Ukovich*, ORTS - DEEI, University of Trieste, via Valerio, 10, 34127, Trieste, Italy, ukovich@units.it

1 - Modelling Collaborative Demand & Supply Networks (CODESNET)

Agostino Villa, Department of Production Systems and business Economics, Polytechnic University, corso Duca degli Abruzzi, 24, I-10129, Turin, Italy, agostino.villa@polito.it

In the European industrial world there exist some types of "groups of Small-Mid Enterprises - SME", which characterized the industrial evolution in the last twenty years. Recently mainly in Italy, industrial districts pass through a deep crisis. A methodology of performance evaluation able to analyse network structure, governance, interactions with the socio-economic context, are needed. This motivates the EU-funded CODESNET project, with 22 partners of 11 countries. This paper describes the theoretical methodology on which the CODESNET project is based.

2 - Innovation paths in enterprises clusters

Maurizio Bielli, Institute of Systems Analysis and Informatics, Viale Manzoni 30, 185, Rome, Italy, bielli@iasi.cnr.it

Within the European CO-DESNET project relative to industrial districts organisation, the need for SMEs support by suitable methods and tools concentrates on information and knowledge exchange, project management and strategic decisions. A case study is outlined, relative to Net Economy transition of SMEs in the Lazio Region in Italy, with the aim to design a road map of innovation paths in the development of ICT applications.

3 - A heuristic approach to a dynamic set partitioning problem

Walter Ukovich, ORTS - DEEI, University of Trieste, via Valerio, 10, 34127, Trieste, Italy, ukovich@units.it, *Luca Coslovich*, *Raffaiele Pesenti*

This paper describes a heuristic solution approach to the set partitioning problem, in a particular dynamic setting. The tackled real-world scenario, originating from vehicle routing and scheduling, is the following: starting from a feasible solution of the set partitioning problem obtained with a static heuristic, try to deal with another task that shows up at the last minute. Our dynamic algorithm tries to find a good overall solution exploiting the knowledge of the feasible solution previously obtained. The developed heuristic makes use of the static solution algorithm in a dynamic fashion.

■ MD-12

Monday, 14:00-15:30

TRANS Oddi 205

Multiple criteria decision making in transportation

Stream: Transportation

Invited session

Chair: *Jacek Zak*, Faculty of Working Machines and Transportation, Poznan University of Technology, 3 Piotrowo street, 60-965, Poznan, Poland, jacekzak@put.poznan.pl

1 - A multi-criteria topological method for solution selection in the Urban Road Network Design Problem

Antonino Vitetta, DIMET, University Mediterranea di Reggio Calabria, Feo di Vito, 89100, Reggio Calabria, Italy, vitetta@unirc.it, *Francesco Russo*

In this paper a method for systematically sorting and reducing the number of different possible solutions to a Urban Road Network Design Problem is proposed and applied. This is achieved first by defining a topological similarity measurement and then by applying cluster analysis. Finally, the best solutions are selected in relation to topological and criteria values, which appears to provide a sound and novel way of tackling the problem of multi-criteria evaluation. The proposed topological indicator is not the only one possible but it is particularly simple.

2 - Public transport interchanges evaluation

Jorge Freire de Sousa, Industrial Management Unit, Faculty of Engineering University of Porto, Rua Roberto Frias, 4200-465, Porto, Portugal, jfsousa@fe.up.pt, *Teresa Stanislaw*

An interchange is a complex system that should be environmentally integrated, influencing and being influenced by its clients and stakeholders behaviour. The study of interchanges location and the evaluation of its operation are complex processes; therefore, the application of a Soft Systems Methodology seems to be the most adequate one for structuring the problem. Once the problem is structured and a conceptual model for interchange evaluation developed, a multiple criteria methodology is defined to proceed with the evaluation. The methodology will be used in a Portuguese case study.

3 - Integrating optimization criteria within the urban bus crew scheduling process

Leena Suhl, Int. Graduate School of Dynamic Intelligent Systems, University of Paderborn, Decision Support & OR Lab, Warburger Str. 100, 33098, Paderborn, Germany, suhl@upb.de

We consider the crew scheduling process in urban public bus transport. The schedule generation is usually based on an optimization model minimizing the total cost under complex restrictions, such as break rules and maximal duty lengths. However, from a practical point of view other optimization criteria have to be considered as well. We discuss the problem of combining regular and irregular trips within a given schedule. The goal is to maximize the regularity of the individual driver schedules, simultaneously considering cost effects and fairness aspects.

4 - Formulation and solution procedure for the multiple criteria fleet selection problem

Jacek Zak, Faculty of Working Machines and Transportation, Poznan University of Technology, 3 Piotrowo street, 60-965, Poznan, Poland, jacekzak@put.poznan.pl

A fleet selection problem for a long-haul passenger road transportation company is considered. Different types of coaches are analyzed. The decision problem is formulated as a multiple criteria ranking problem. A consistent family of evaluation criteria is defined. Various aspects and interests of different stakeholders are considered. Modeling of the DM's preferences is presented. Several multiple criteria ranking methods, such as: Electre, AHP, UTA, Oreste, Promethee and Mappac as potential solution procedures and their suitability are analyzed. Results of computational tests are presented.

■ MD-13

Monday, 14:00-15:30

TRANS Oddi 206

Ship Routing with Flexible Loads

Stream: Maritime Transportation

Invited session

Chair: *Geir Hasle*, Applied Mathematics, Sintef Ict, P.O. Box 124 Blindern, 314, Oslo, Norway, Geir.Hasle@sintef.no

1 - Heuristic column generation for ship scheduling with flexible cargo sizes

Bjørn Nygreen, Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred getz vei 3, NO-7491, Trondheim, Norway, bjorn.nygreen@iot.ntnu.no, *Geir Brønmo*, *Jens Lysgaard*

We study a ship scheduling problem where the contracts say that the revenues for the cargos increase with their sizes in their defined intervals. We solve the problem by a column generation approach. Columns are dynamically generated in a shortest path problem where we use discrete cargo sizes. Before we transfer a column to the master problem, we fix the geographical route and re-optimize the schedule with use of continuous cargo sizes. A consequence of this is that the normal convergence criterion for column generation fails and we end up with a heuristic algorithm.

2 - Solving a Vessel Routing Problem with Inventory Constraints

Oddvar Kloster, Applied Mathematics, SINTEF ICT, P.O. Box 124, 0314, Oslo, Norway, Oddvar.Kloster@sintef.no, *Truls Flatberg*

We consider the problem of transporting a single commodity by sea between producing and consuming factories within a company, using a fleet of vessels. The objective is to minimize transportation costs while ensuring satisfactory inventory levels at all factories. We present a solution method that combines exact and heuristic methods. The structure of the plan is optimised using an iterative improvement algorithm, while the sub-problem of determining arrival times and load/discharge quantities is formulated as a mixed integer program.

3 - Ship scheduling with flexible cargo quantities: A heuristic solution approach

Kjetil Fagerholt, Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred Getz vei 3, 7491, Trondheim, Norway, kjetil.fagerholt@iot.ntnu.no, *Jarl Eirik Korsvik*, *Geir Brønmo*

We present a planning problem faced by many shipping companies dealing with transport of bulk products. These shipping companies typically have a certain amount of contract cargoes that they are committed to carry, while trying to maximize the profit from optional spot cargoes. The cargo quantities are often flexible within an interval. Therefore interwoven with the scheduling decisions, the planner has to decide the optimal cargo quantities. In order to ensure quick decision support to the planner, we propose a heuristic to solve the problem.

■ MD-14

Monday, 14:00-15:30

PROD Arnag 101

Call Centers I

Stream: Operations Management / Revenue Management

Invited session

Chair: *Shane Henderson*, Operations Research and Industrial Engineering, Cornell University, School of ORIE, 230 Rhodes Hall, 14853, Ithaca, NY, United States, sgh9@cornell.edu

1 - Nearest neighbour algorithms for forecasting call arrivals in call centers

Sandjai Bhulai, Faculty of Sciences, Vrije Universiteit Amsterdam, De Boelelaan 1081a, 1081HV, Amsterdam, Netherlands, sbhulai@few.vu.nl, *Wing Hong Kan*, *Elena Marchiori*

We study a nearest neighbour algorithm for forecasting call arrivals to call centers. The algorithm does not require an underlying model for the arrival rates, and it can be applied to historical data without pre-processing it. The algorithm is also able to take correlation structures, that are usually found in call center data, into account. Numerical experiments show that smaller errors in the forecast and better staffing levels in call centers are obtained. The results can be used for a more flexible workforce management in call centers.

2 - Queueing Models for Call Centre Queue Management

David Worthington, The Management School, Lancaster university, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, d.worthington@lancaster.ac.uk

A Discrete Time Modelling approach for queueing systems has been successfully applied to incorporate important features of call centre queues, viz. time-dependent arrival rates, balking and any general distribution of service time - some or all of which are absent from models currently used to plan staffing levels. This presentation will describe the basics of the approach and some easy-to-use results that have been discovered via its use.

3 - Many Server Queue Approximations for Membership Services

Francis de Vericourt, Fuqua School of Business, Duke University, United States, fdv1@duke.edu

We propose modelling service centers that are exclusively dedicated to fixed client constituencies (as in health care, professional or warranty services) as closed multi-server queueing systems. We provide diffusion approximations for the number of users within the membership who are requesting service. Accordingly, we propose staffing rules designed to meet a certain desired performance criterion. Numerical evaluations of our proposed scheme indicate that, although justified for large systems, the staffing rule performs well for memberships of all sizes.

4 - Service systems with a random arrival rate

Shane Henderson, Operations Research and Industrial Engineering, Cornell University, School of ORIE, 230 Rhodes Hall, 14853, Ithaca, NY, United States, sgh9@cornell.edu

The arrival process of customers to service systems such as call centres is typically modeled as a time-dependent Poisson process. However, several authors have reported that the arrival process often exhibits greater variability than a Poisson process should. We provide an update on our work on this phenomenon.

■ MD-15

Monday, 14:00-15:30

PROD Arnag 201

Supply Chain Coordination, Collaboration and Risk Management

Stream: Supply Chain Management

Invited session

Chair: *Arnd Huchzermeier*, Production Management, WHU Otto Beisheim School of Management, Burgplatz 2, 56179, Vallendar, Germany, ah@whu.edu

1 - A Framework for Collaborative Planning

Hartmut Stadler, Institute for Logistics and Transport, University of Hamburg, Von-Melle-Park 5, 20146, Hamburg, Germany, h.stadler@t-online.de

Supply Chain Management (SCM) is concerned with the coordination of material, information and financial flows within and across legally separated organizational units. Coordination of flows requires to adapt plans of supply chain (SC) partners at various levels of a planning hierarchy. We will define Collaborative Planning (CP) as the alignment of plans at the same planning level between independent organizational units having agreed on a supplier-buyer partnership.

2 - Procurement Options in the CGI Supply Chain

Stefan Spinler, Production Management, Beisheim School of Management, WHU, Burgplatz 2, 56179, Vallendar, Germany, sspinler@whu.edu, *Arnd Huchzermeier*

In this talk, we present results on to what extent flexible contracting arrangements can be used to in the consumer goods industry to mitigate inventory-related risk, e.g., in promotional environments. We provide an analytical model which captures the specifics of the CGI supply chain and provide empirical evidence on the impact thus generated. We show how supply contracting can be incorporated into the bigger picture of corporate-wide risk management.

3 - The Value of Upstream Information

Daniela Burkhardt, Production Management, Otto Beisheim Graduate School of Management (WHU), Burgplatz 2, 56179, Vallendar, Germany, daniela.burkhardt@whu.edu, *Arnd Huchzermeier*, *Ananth Iyer*

When receiving upstream information on competitive pressure in the market, retailers could value the information by adapting their price setting behaviour. We explore the actual value of this upstream information for oligopolist retailers who compete for switching customers in a differentiated Bertrand competition. The value of the upstream information in this environment is empirically verified with scanner data on the diapers category of the 5 major German retailers.

■ MD-16

Monday, 14:00-15:30

PROD Arnag 301

Scheduling with Batching

Stream: Scheduling

Invited session

Chair: *Jonathan Whitehead*, School of Mathematics, University of Southampton, Highfield Campus, SO17 1BJ, Southampton, Hampshire, United Kingdom, J.D.Whitehead@soton.ac.uk

1 - A Batch Production Scheduling Problem

Jan Pelikan, Dept. of Econometrics, University of Economics Prague, W. Churchills sq. 4, 13067, Prague 3, Czech Republic, pelikan@vse.cz

The aim of the contribution is to minimize a total makespan of given production batches. The problem is based on the case study of the production process in which batches are assigned to parallel machine tools in the production hall. An adjuster has to adjust the machine tool before running the batch. Thus, the adjustment of the machine for a batch can be considered as a serial processing of the batches and the production as their parallel processing. Both mathematical model and a heuristic method are proposed. Computational experiments were executed on real data.

2 - Procedures for Batch Scheduling on the Single Machine Total Tardiness Problem

Manuel Mateo, Departament Business Administration, Universitat Politècnica Catalunya, Avda Diagonal, 647, 7th, E-08028, Barcelona, Spain, manel.mateo@upc.edu, *Imma Ribas*, Ramon Companys

Jobs with sequence batch setup times on a single machine can be scheduled to minimize the total tardiness. We propose a Greedy Randomized Adaptive Search Procedure (GRASP) with a new cost function and a new variant of non-exhaustive descent search algorithm, and an exact method based on Bounded Dynamic Programming (BDP) approach which requires less exploration than a branch and bound. The procedures are tested on instances with several numbers of jobs and families and on benchmarks from literature for a particular case of the problem. Results show a very competitive performance.

3 - On-Line Algorithms for Single Machine Scheduling with Family Setup Times

Jonathan Whitehead, School of Mathematics, University of Southampton, Highfield Campus, SO17 1BJ, Southampton, Hampshire, United Kingdom, J.D.Whitehead@soton.ac.uk, *Chris Potts*, *Vitaly Strusevich*

A single machine scheduling problem is considered, where families of jobs are specified and a setup is run every time a batch of jobs of the same family starts. The goal is to minimize the makespan. Information about the jobs becomes available over time, with the scheduler knowing the number of families and the setup time of each family in advance. We give a lower bound on the competitive ratio of any on-line algorithm and prove that it is tight for two families. As the number of families increases, the lower bound approaches 2 and we give a simple algorithm with a competitive ratio of 2.

■ MD-17

Monday, 14:00-15:30

PROD Arnag 303

Production and Inventory II

Stream: Production and Inventory (c)

Invited session

Chair: *Nico Vandaele*, Faculty of Applied Economics, University of Antwerp, Prinsstraat 13, 2000, Antwerp, Belgium, nico.vandaele@ua.ac.be

1 - Multi-item inventory system with an order-based service level

Marco Bijvank, Department of Mathematics, Vrije Universiteit Amsterdam, De Boelelaan 1081a, 1081HV, Amsterdam, Netherlands, mbijvank@few.vu.nl

High customer service is becoming an important strategy to increase the competitiveness of a firm. Since customers perceive a good quality of service when all the items they demand are on stock, it becomes more realistic to model customer satisfaction with an order-based service level. A well known problem from literature is the repair kit problem. Most models implement a cost minimization objective, while a service requirement is neglected. We have improved the most general heuristic for both models, such that we achieve near-optimal solutions which indicate which parts to keep in stock.

2 - An Aggregate Queueing Model to support load based POLCA execution

Nico Vandaele, Faculty of Applied Economics, University of Antwerp, Prinsstraat 13, 2000, Antwerp, Belgium, nico.vandaele@ua.ac.be

In this paper we show how the aggregate output from a queueing network analyser is used to support and guide a load based Polca execution system. All parameters, lead times, authorization times, workload and throughput, are obtained from a queueing network. Then the characteristics of the Load Based Polca system are derived. This is illustrated with an instructive and an industrial example.

3 - Optimal Production and Inventory Control of Multi-Stage Assembly Systems with Multiple Demand Classes

Mohsen Elhafsi, Anderson Grad. School of Management, University of California, 203 Anderson Hall, 92521, Riverside, CA, United States, mohsen.elhafsi@ucr.edu

We consider an assembly system consisting of m components, one end-product, and n customer classes. The system is dynamic, where at any time, a manager must decide whether to assemble a component/end-item or not, and when an order arrives, whether to satisfy it or reject it. We formulate the problem as a Markov decision process and characterize the structure of the optimal policy. We show that an optimal assembly policy for each component is a state-dependent base-stock policy. We show that an optimal inventory allocation policy is a state-dependent multi-level rationing policy.

■ MD-18

Monday, 14:00-15:30

PROD Arnag 304

Location-Routing

Stream: Locational Analysis

Invited session

Chair: *Gábor Nagy*, Kent Business School, University of Kent, CT2 7PE, Canterbury, United Kingdom, G.Nagy@kent.ac.uk

1 - A Location-Routing Problem for Three-Level Logistic Distribution System

Ue-Pyng Wen, Industrial Engineering and Engineering Management, National Tsing Hua University, 101 Kung Fu Road, Sec. 2, 300, Hsinchu, Taiwan, upwen@ie.nthu.edu.tw, *Yi-Ting Hung*

This paper incorporates the location-allocation for plants and distribution centers together with vehicle routing for retailers into an integrated model to minimize the total setup and operational costs. We formulate an integrated mixed integer linear programming model to solve this problem. Computational results are provided to demonstrate the effectiveness of the proposed algorithms.

2 - A Decision-Making Tool for a Capacitated Location-Routing Problem

Carlos Ferreira, Dep. of Economics, Management and Industrial Engineering, University of Aveiro, Campus Universitário de Santiago, 3810-143, Aveiro, Portugal, carlosf@egi.ua.pt, *Sérgio Barreto*, *Beatriz Sousa Santos*, *Rui Borges Lopes*

In this paper we consider a discrete Capacitated Location-Routing Problem (CLRP) with two levels (depots and customers) and a capacitated and homogeneous vehicle fleet. Using this model we developed a decision making tool allowing the exploration of the process in a way easily understandable by the user, thus fostering a greater insight of the problem and allowing better judgments. This tool was developed for Windows platforms with an architecture easily allowing the integration of new functionality.

3 - Improved variable neighborhood search for the vehicle routing problem with accessibility constraints

Mahdi Souid, Institut supérieur d'Informatique et de Multimédia de Gabés, 14 Rue De La République, 5035, Sayada, Tunisia, mahdi.souid@alinto.com, *Slaheddine Jarboui*, *Said Hanafi*, *Frédéric Semet*

The Vehicle Routing Problem with Accessibility constraints (VRPA) is a location and routing problem, used to determine the optimal route for a road-train making deliveries to a set of customers, while satisfying both capacity constraints and accessibility restrictions. We present an improved Variable Neighborhood Search (VNS) heuristic for solving the VRPA. Different VNS methods are proposed that exploit the connections existing between the VRPA and classic routing problems. Computational results demonstrate that VNS provides good quality solutions.

4 - Local Improvement in Planar Facility Location using Vehicle Routing

Gábor Nagy, Kent Business School, University of Kent, CT2 7PE, Canterbury, United Kingdom, G.Nagy@kent.ac.uk, Niaz Wassan, Said Salhi

Location-routing is the study of solving locational problems such that routing considerations are taken into account. We present an iterative heuristic for the location-routing problem on the plane. For each depot the Weber problem is solved using the end-points of the routes found previously as input nodes to the Weiszfeld procedure. Although the improvements found are usually small they show that it pays not to ignore the routing aspects when solving continuous location problems. Possible research avenues in continuous location-routing will also be suggested.

■ MD-19

Monday, 14:00-15:30

PROD Arnag 311

Queueing Theory with Applications I

Stream: Queueing Theory with Applications

Invited session

Chair: Douglas Down, Computing and Software, McMaster University, 1280 Main Street West, L8S 4L7, Hamilton, Ontario, Canada, downd@mcmaster.ca

Chair: Sunil Kumar, Graduate School of Business, Stanford University, 518 Memorial Way, 94305, Stanford, California, United States, skumar@stanford.edu

1 - Probing mechanisms for endpoint admission control

Ayalvadi Ganesh, Microsoft Research, 7 J J Thomson Avenue, CB3 0FB, Cambridge, United Kingdom, ajg@microsoft.com

In order to support applications which have minimum bandwidth requirements over a shared medium such as the Internet, it is necessary to perform admission control to ensure that the network isn't overloaded. Can admission control decisions be made by end users without centralized control from the network? What sort of congestion indication from the network is required to enable this? We address these questions in this talk. (Joint work with Key, Polis and Srikant.)

2 - Resource Scheduling in Finite Buffer Service Networks

Kevin Ross, Technology and Information Management, University of California Santa Cruz, 1156 High St, SOE3, 95064, Santa Cruz, CA, United States, kross@soe.ucsc.edu

We discuss the effect of finite buffers on network throughput. Workers/servers can be allocated to give combinations of service over multiple stations. Infinite queues are usually assumed but not practicable and dropping jobs at full buffers is undesirable. Here, jobs arrive to one of several ingress stations and receive service at a sequence of stations before departing. We characterize the minimum buffer at each station for which there is no job loss and the network throughput is equivalent to having infinite buffers, presenting policies for scheduling coordinated sequences of service.

3 - Operational Analysis of Subscription Services

Sunil Kumar, Graduate School of Business, Stanford University, 518 Memorial Way, 94305, Stanford, California, United States, skumar@stanford.edu

We study whether offering a subscription service offers operational benefits to a monopolist service provider. Analyzing the diffusion limits of a multi-server loss model, we show that the provider obtains benefits from being able to hedge risk better. Thus a firm may want to offer subscription service even in the absence of competition.

■ MD-20

Monday, 14:00-15:30

HEUR Arnag 422

Metaheuristics for Applications

Stream: Metaheuristics

Invited session

Chair: Dario Landa Silva, Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, jds@cs.nott.ac.uk

1 - Utopia in a bi-objective genetic heuristic for nurse (re)rostering

Margarida Moz, Dept. Matemática, ISEG (Univ. Técn. Lisboa), Centro de Investigação Operacional, FC (Univ. Lisboa), Rua do Quelhas n° 6, 1200-781, Lisboa, Portugal, mmoz@iseg.utl.pt, Margarida Pato

Nurse rostering deals with the assignment of tasks to nurses of a hospital unit over the planning period. Rostering arises when at least a nurse announces she will be unable to perform tasks previously assigned. (Re)rostering must comply with specific contractual rules and also meet the nurses' preferences for specific task sequences, while introducing as few alterations as possible to their previously published schedules. A bi-objective genetic algorithm, enhanced with utopic strategies, will be presented for these problems, as well as computational results obtained with real instances.

2 - Experiments with a form of double iterated search for use on hard combinatorial problems with many objectives

Mike Wright, The Management School, Lancaster University, Dept. Of Management Science, LA1 5AG, Lancaster, Lancashire, United Kingdom, m.wright@lancaster.ac.uk

This paper reports results of experiments of a new technique for solving problems where a single objective function is made up of several sub-costs. The technique embeds approaches which proceed by continually modifying the weights of the objectives within an Iterated Local Search (ILS) framework. Essentially this is a Double ILS: the inner loop is a standard ILS, whereas in the outer loop cost weightings are modified at local optima in a way which is to some extent affected by the recent progress of the search. The problem used for the experiments is a cricket umpire scheduling problem.

3 - The bus driver scheduling problem: a new mathematical model and a GRASP approximate solution

Paola Festa, Dept. of Mathematics and Applications, University of Naples Federico II, Compl. MSA - Via Cintia, 80126, Napoli, Italy, paola.festa@unina.it, Renato De Leone, Emilia Marchitto

This talk will address the problem of determining the best scheduling for Bus Drivers subject to a variety of rules and regulations that must be enforced such as the spreadover and the working time. We propose a new mathematical formulation of the Bus Driver Scheduling Problem that unfortunately results useful to solve only small or medium instances. For large instances, a Greedy Randomized Adaptive Search Procedures (GRASP) is proposed. Results are reported for a set of real-world problems and its comparison is made with an exact method.

4 - Heuristics for sports competitions on multiple neutral venues

Dario Landa Silva, Computer Science, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, jds@cs.nott.ac.uk

We propose the application of heuristic and meta-heuristic methods for constructing schedules for sports competitions on multiple venues that are neutral to all N competitors. The aim is to construct a schedule that also ensures a balanced use of all M available venues. A constructive heuristic is used to generate a feasible schedule which is then improved by means of a hybrid simulated annealing approach. We consider the case in which $N = 2M$ and hence, no competitor should play more than twice in each venue. Our experiments show that our approach is capable of finding good quality schedules.

■ MD-22

Monday, 14:00-15:30

OPT Adal 050

Multiobjective Combinatorial Optimization I

Stream: Multiple Objective Optimization

Invited session

Chair: *Matthias Ehrgott*, Engineering Science, University of Auckland, Private Bag 92019, 1001, Auckland, New Zealand, m.ehrgott@auckland.ac.nz

1 - A hierarchical multicriteria routing model in multi-media networks

João Clímaco, University of Coimbra and INESC Coimbra, 3000-033, Coimbra, Portugal, jclimaco@inescc.pt, *José Craveirinha*, *Marta Pascoal*

Routing problems in multiservice communication networks involve the calculation of paths satisfying multiple constraints and seek simultaneously to "optimise" the relevant metrics. We propose a bilevel multicriteria routing model. The objective functions of the first level seek to minimise the negative impact of the use of a path in the remaining flows of the network, while the second level objective functions seek to optimise QoS parameters of the associated with the chosen path. A resolution and its application to video-traffic are presented. Extensive comparative results are discussed.

2 - A Multiple Objective Model for the Identification of Load Management Actions

Carlos Antunes, DEEC, University of Coimbra and INESC Coimbra, Rua Antero de Quental 199, 3000-033, Coimbra, Portugal, ch@deec.uc.pt, *Alvaro Gomes*, *António Martins*

Even in unbundled electricity markets, load management actions keep their potential attractiveness, due to operational issues and economic benefits. Multiple objectives are relevant in the design and selection of load control actions, such as minimizing maximum power demand, losses, and discomfort caused to customers, and maximizing profits. Evolutionary algorithms (EAs) are well suited for complex combinatorial MO problems since they work with a set of potential solutions in each generation. This study describes the use of an EA in the identification and selection of loads control actions.

3 - Finding Mines in a Line: A Biobjective Formulation

Luis Paquete, Faculdade de Economia, Universidade do Algarve, Campus de Gambelas, 8000, Faro, Portugal, lpaquete@ualg.pt, *Marco Pranzo*, *Manbir Sodhi*, *Thomas Stützle*

We describe a real-life application for finding underwater mines using an Autonomous Underwater Vehicle (AUV). The search area is defined as a line partitioned into small segments and the probability of finding a mine for each segment is known in advance. The main goal is to define which segments have to be visited by the AUV such that the sum of the corresponding probabilities is maximized and the total mission time is minimized. We discuss algorithms for solving the biobjective problem in terms of Pareto optimality and present computational results.

4 - Multiobjective metaheuristic solution procedures for R&D project selection under uncertainty

Christian Stummer, Dept. of Business Studies, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, christian.stummer@univie.ac.at, *Markus Günther*, *Walter Gutjahr*

More often than not research and development (R&D) managers face the problem of selecting the "best" (feasible) portfolio from among an extensive set of project proposals. In practice, the problem is even more complicated because the decision-making process is usually driven by several conflicting (stochastic) objectives. In order to provide interactive decision support, efficient portfolios have to be determined which implies solving the underlying multiobjective combinatorial optimization (MOCO) problem. In our talk we outline proper metaheuristic solution procedures for this task.

■ MD-23

Monday, 14:00-15:30

OPT Adal 051

Approximating Layout and Packing Problems

Stream: Approximation Algorithms

Invited session

Chair: *Roberto Solis-Oba*, Department of Computer Science, University of Western Ontario, Middlesex College Building, N6A5B7, London, Ontario, Canada, solis@csd.uwo.ca

Chair: *Frits Spieksma*, Applied Economics, Katholieke Universiteit Leuven, Naamsestraat 69, 3000, Leuven, Belgium, Frits.Spieksma@econ.kuleuven.be

1 - Approximation Algorithms for 2D Strip Packing Problems

Klaus Jansen, Institut für Informatik und Praktische Mathematik, Universität Kiel, Olshausenstr. 40, 24098, Kiel, Germany, kj@informatik.uni-kiel.de, *Rob van Stee*

We consider the following packing problem: Given a rectangular strip of fixed width 1 and large height and a set of demand rectangles R_1, \dots, R_n with widths w_i and heights h_i in the interval $[0,1]$, the problem is to cut the strip into the demand rectangles while minimizing the total height used. In the talk we describe first an AFPTAS by Kenyon and Remila for the 2D strip packing problem. Next we present an AFPTAS by Jansen and van Stee for the 2D strip packing problem when rotations of 90 degrees are allowed. Finally we show some recent results for several variants of the problem.

2 - Approximation Schemes for Packing with Item Fragmentation

Hadas Shachnai, Department of Computer Science, Technion - Israel Institute of Technology, 32000, Haifa, Israel, hadas@cs.technion.ac.il

We consider two variants of the classical bin packing problem in which items may be fragmented. While both variants do not belong to the class of problems that admit a polynomial time approximation scheme (PTAS), we show that the two problems admit a dual PTAS, an asymptotic PTAS, and a dual asymptotic fully polynomial time approximation scheme (AFPTAS). Our AFPTASs are based on a non-standard transformation of the mixed packing and covering linear program formulations of our problems into pure covering programs, which enables to efficiently solve these programs.

3 - Approximation Algorithms for Global Routing in VLSI Design

Tamas Terlaky, Computing and Software, McMaster University, 1280 Main Street West, L9B 2S9, Hamilton, Ontario, Canada, terlaky@mcmaster.ca, *Hu Zhang*, *Anthony Vannelli*

We consider two global routing problems in VLSI design. In the first problem, given a lattice graph and a collection of nets (subsets of the vertex set) to be connected by trees, we try to maximize the number of routed nets with respect to the edge capacities. In the second problem, we try to minimize a combination of the total tree length and the total number of bends while routing all nets. We design the first approximation algorithms for both problems, which have theoretical approximation bounds and polynomial running times. This is joint work with M. Saad, T. Terlaky and A. Vannelli.

■ MD-24

Monday, 14:00-15:30

OPT Adal 052

Software Design for Dynamical and Anticipatory Systems

Stream: Dynamical and Anticipatory Systems

Invited session

Chair: *Stig C Holmberg*, Information Technology and Media, Mid Sweden University, Mid Sweden University, Itm - Q351, 83125, Östersund, Sweden, shbg@ieee.org

Chair: *Tai-Yue Wang*, Dept. of Industrial and Information Management, National Cheng Kung University, 1 University Road., 70101, Tainan, Taiwan, tywang@mail.ncku.edu.tw

1 - Long term preservation of electronic information - an anticipative approach

Viveca Asproth, Information Technology and Media, Mid Sweden University, Östersund, Sweden, viveca.asproth@miun.se

Information technology has led to that much of the information that earlier was produced on paper is now being produced in electronic form. The e-government services, where the whole idea is to exchange information electronically, will radically redirect paperbound information towards electronically generated and managed information and documents. The challenges associated with digital preservation are strategic, organizational and structural as well as technological. In this paper some research directions connected to digital preservation are identified and discussed.

2 - Enhancing a GA-based BPN Forecasting Model by Employing the Taguchi Method

Tai-Yue Wang, Dept. of Industrial and Information Management, National Cheng Kung University, 1 University Road., 70101, Tainan, Taiwan, tywang@mail.ncku.edu.tw

BPN is the most commonly employed form of ANN and has a tendency to become trapped at local minima. This causes the forecasting results of the BPN to be inconsistent and unpredictable. The use of heuristic techniques to optimize the BPN has been proposed to address this problem. This study adopts the Taguchi method to calibrate the controllable factors of a GA-based BPN forecasting model. The solutions obtained from the proposed model for a chaotic time series problem are compared to those presented in literature. The results have shown better performance than those from previous research.

3 - ASTE, Anticipatory Simulation of Tempo-Spatial Enterprise Operations

Stig C Holmberg, Information Technology and Media, Mid Sweden University, Mid Sweden University, Itm - Q351, 83125, Östersund, Sweden, shbg@ieee.org, *Darek Eriksson*

ASTE - The Anticipatory Simulation of Tempo-Spatial Enterprise Operations - is a computer software package for simulation of complex enterprise operations in form, time, and space. ASTE is build on the STEM modelling language by help of free software components. By making ASTE simulations, dynamic e-logistic operations may be coordinated and managed in an anticipatory way. Further benefits may be obtained by integrating ASTE with a set of established and well proven Operations Research methods.

■ MD-25

Monday, 14:00-15:30

OPT Adal I-111

Methods and applications for large-scale linear programming

Stream: Mathematical Programming

Invited session

Chair: *Coralia Cartis*, Computing Laboratory, Oxford University, Wolfson Building, Parks Road, OX1 3QD, Oxford, United Kingdom, ccartis@comlab.ox.ac.uk

1 - Progress in solving large scale multi-depot multi-vehicle-type bus scheduling problems with integer programming

Uwe Suhl, Operations Research, Freie Universitaet Berlin, Garystr. 21, 14195, Berlin, Germany, suhl@wiwiss.fu-berlin.de

We discuss solution methods of multi-depot, multi-vehicle-type bus scheduling problems. Key elements are a MIP-model and a customized version of the mathematical optimization system MOPS. We discuss aspects to solve the initial LP, improving the LP-relaxation, selection of the starting heuristic, branching and node selection strategies. Real life applications with over one million integer variables and about 1600000 constraints were solved in an acceptable time by the optimizer MOPS. A key role plays also the architecture of new Windows workstations with Intel 64 bit processors.

2 - Fast computation of the prenucleolus of cooperative linear production games

J. Frederic Bonnans, Projet Sydoco, INRIA, Domaine de Voluceau, B.p. 105, 78153, Le Chesnay, France, Frederic.Bonnans@inria.fr

Coauthor: *Mathieu ANDRE*, Direction de la Recherche, GDF
The computation of leastcore and prenucleolus is an efficient way of allocating a common resource among N players, but has the drawback of being a linear programming problem with $2N-2$ constraints. We show how to generate constraints by solving small size linear programming problems, with both continuous and integer variables. The approach is extended to games with symmetries (identical players), and to games with partially continuous coalitions. We display encouraging numerical results.

3 - Finding a well-centred point within a polyhedron

Coralia Cartis, Computing Laboratory, Oxford University, Wolfson Building, Parks Road, OX1 3QD, Oxford, United Kingdom, ccartis@comlab.ox.ac.uk, *Nicholas Gould*

Starting point computations for certain interior point methods applied to linearly-constrained optimization problems, as well as numerous applications, require a feasible point of a polyhedron that is "far" from constraint boundaries. The notion of the analytic centre of a polytope has often proved useful in this respect. We introduce a Newton-based method for computing this centre, and present its very good global and asymptotic convergence properties, together with numerical experiments.

■ MD-26

Monday, 14:00-15:30

OPT Adal III=231

Lower and Upper Bounds for NP-hard Problems

Stream: Combinatorial Optimization

Invited session

Chair: *Silvano Martello*, Deis, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, smartello@deis.unibo.it

Chair: *Andrea Lodi*, D.E.I.S., University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, alodi@deis.unibo.it

1 - The Power of Semidefinite Programming Relaxations for MAXSAT

Willem-Jan van Hoeve, Computer Science, Cornell University, 4130 Upson Hall, 14853, Ithaca, NY, United States, vanhoeve@cs.cornell.edu, *Carla P. Gomes*, *Lucian Leahu*

Recently, LP-based relaxations have been shown promising in boosting the performance of exact MAX-SAT solvers. We compare them with Semidefinite Programming (SDP)-based relaxations for MAX2SAT. We show how SDP relaxations are powerful, providing much tighter bounds than LP relaxations. SDP relaxations can be computed very efficiently, thus quickly providing tight lower and upper bounds on the optimal solution. We also show the effectiveness of SDP relaxations in providing heuristic guidance for iterative variable setting, significantly more accurate than the guidance based on LP relaxations.

2 - Experiments on the Quadratic Knapsack Problem

Daniel Grainger, The Management School, Lancaster University, Dept. Of Management Science, 4 Devonshire Street, LA1 4TQ, Lancaster, Lancashire, United Kingdom, d.grainger@lancaster.ac.uk, *Adam Letchford*

The quadratic knapsack problem is a well-known generalisation of the knapsack problem, with applications in telecommunications, facility location and finance. A variety of Linear Programming relaxations have been proposed for it, and, more recently, authors have looked at semidefinite relaxations. We show how many of the relaxations can be better understood, and in some cases improved, by considering the projection of the feasible region onto a certain 2-dimensional subspace. We also give the results of some computational experiments.

3 - Packing into the Smallest Square: Worst-Case Analysis of Lower Bounds

Silvano Martello, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, smartello@deis.unibo.it, *Alberto Caprara*, *Andrea Lodi*, *Michele Monaci*

We address the problem of packing a given set of rectangles into the minimum size square. We consider three versions of the problem, arising when the rectangles (i) are squares; (ii) have a fixed orientation; (iii) can be rotated by 90 degrees. For each case we study lower bounds, and analyze their worst-case performance ratio. In addition, we evaluate through computational experiments their average performance on instances from the literature.

■ MD-27

Monday, 14:00-15:30

OPT Adal V=229

Optimization Solvers

Stream: Software for OR/MS

Invited session

Chair: *Janos D. Pinter*, PCS Inc. & Dalhousie University, 129 Glenforest Drive, B3M 1J2, Halifax, NS, Canada, jdpinter@hfx.eastlink.ca

1 - The Xpress-MP Optimizer: Recent Developments

Oliver Bastert, Dash Optimization, Leam House, 64 Trinity Street, CV32 5YN, Leamington Spa, United Kingdom, oliver.bastert@dashoptimization.com

As a leading provider of modelling and optimization software, Dash Optimization constantly improves on its product XPress-MP. We report on recent advances of the XPress-MP MIP Solver. Among other improvements, we will discuss new cut selection routines. Cutting planes are crucial in state of the art MIP solvers and are often vital to prove optimality of computed solutions. Since on the other hand cuts enlarge the problem formulation and thus slow down the node LPs, cuts have to be selected with care. We demonstrate the success of the new developments by looking at computational results.

2 - Advances in the KNITRO Optimization Software Package

Richard Waltz, Electrical Engineering and Computer Science, Northwestern University, 2145 Sheridan Road, 60208, Evanston, IL, United States, rwaltz@ece.northwestern.edu

KNITRO is a leading software package for solving nonlinear, continuous optimization problems. This talk will give an overview of KNITRO and discuss some of the recently added features. A summary of the different algorithms, capabilities, interfaces and key user options will be presented. Emphasis will be placed on recently developed features such as tools for solving complementarity problems, multi-start global optimization techniques, and preconditioners for large-scale problems. Examples and numerical results will be provided.

3 - Global Optimization in Modeling Environments

Janos D. Pinter, PCS Inc. Dalhousie University, 129 Glenforest Drive, B3M 1J2, Halifax, NS, Canada, jdpinter@hfx.eastlink.ca

PCS and partners have been developing global optimization software with links to prominent modeling environments, including AIMMS, GAMS, MPL, Maple, Mathematica, and Matlab (via Tomlab). An overview of these implementations is provided with comparative notes and illustrative examples.

■ MD-28

Monday, 14:00-15:30

OPT Adal VI=207

LP Algorithms: Codes and Analysis of Algorithms

Stream: Linear Optimization

Invited session

Chair: *Petra Huhn*, Institute for Mathematics, Technical University Clausthal, Erzstr. 1, 38678, Clausthal-Zellerfeld, Germany, huhn@math.tu-clausthal.de

1 - Further developments of multiple centrality correctors

Marco Colombo, School of Mathematics, University of Edinburgh, Jcmb 6320, King's Buildings - Mayfield Road, EH9 3JZ, Edinburgh, United Kingdom, m.colombo@ed.ac.uk, *Jacek Gondzio*

The practical performance of Interior Point Methods for LP can be improved by using multiple centrality correctors in addition to Mehrotra's predictor-corrector direction.

Recent theoretical studies show that second-order correctors can occasionally fail. A remedy to such problem is to weight the contribution of the corrector.

We extend this idea to multiple centrality correctors and show that the proposed weighting scheme leads to major savings over other implementations. This strategy is 10%-30% faster on large problems, with even bigger savings on the largest problems in our set.

2 - Morphology of LP Codes: A Structured Design Process

Heiner Müller-Merbach, Wirtschaftswissenschaften, Universität Kaiserslautern, Postfach 3049, 67653, Kaiserslautern, Germany, hmm@bior.de

A morphological survey of (simplex-based) LP codes will be presented. It will cover the totality of all the possible revised simplex algorithms, centred around the LU representation of the "core inverse" (related to the "basic inverse"). The morphological survey serves the purpose of designing individual high-speed LP computer codes. A meta LP code could even enable the user to have his individual LP code generated automatically.

3 - A computational study of phase-1 of the dual simplex method

Istvan Maros, Computing, Imperial College London, Exhibition Road, SW7 2AZ, London, United Kingdom, i.maros@imperial.ac.uk

The paper deals with the theoretical and computational analysis of a new dual phase-1 procedure for the simplex method. It points out that the GDPO procedure is capable of substantially outperforming the traditional dual phase-1 algorithms. Experimental results obtained on 48 test problems indicate that the theoretically advantageous features of GDPO are realized in computational practice to a large extent.

4 - On the condition number of random linear conic systems

Felipe Cucker, Department of Mathematics, City University of Hong Kong, 83 Tat Chee Avenue, Kowloon, Hong Kong, macucker@math.cityu.edu.hk, *Raphael Hauser*, *Dennis Cheung*

We study the distribution of $C(A)$ and $\log C(A)$, where $C(A)$ is a condition number for the linear conic system $Ax \leq 0$, with A an n times m real matrix. For Gaussian A we show that $P[C(A) \leq t]$ is c/t for large t , where c depends only on m and n . We derive moment estimates for $C(A)$ and $\log C(A)$ and various limit theorems for the cases where m and/or n are large. Combined with condition number based complexity analyses, these results yield tail information on the distribution of running times an roundoff error for interior-point methods designed to solve the feasibility problem $Ax \leq 0$.

■ MD-29

Monday, 14:00-15:30

OPT Adal VII=225

Nonconvex Programming

Stream: Global Optimization: Deterministic and Stochastic Methods

Invited session

Chair: *Fabio Tardella*, Dip. di Matematica - Facoltà di Economia, Università di Roma, Via del Castro Laurenziano, 9, 00161, Roma, Italy, fabio.tardella@uniroma1.it

1 - Rigorous affine lower bound functions for multivariate polynomials and their use in global optimization

Juergen Garloff, Faculty for Computer Science, University of Applied Sciences/ FH Konstanz, Postsach 100543, D-78405, Konstanz, Germany, garloff@fh-konstanz.de

We address the problem of finding tight affine lower bound functions for multivariate polynomials, which may be employed when constrained global optimization problems involving polynomials are solved with a branch and bound method. These bound functions are constructed by using the expansion of the given polynomial into Bernstein polynomials. We construct an affine lower bound function from an affine approximation of the control points calculated from the coefficients of the polynomial. We show how a verified lower bound function is obtained in the presence of uncertainty and rounding errors.

2 - A New Solution Technique for MIMO System of Unconstrained Quadratic Optimization Problems Using State Space Approach

Necati Özdemir, Department of Mathematics, Balikesir University, Faculty of Arts and Science, Cag#305;s Campus, 10145, Balikesir, -, Turkey, nozdemir@balikesir.edu.tr, *Firat Evirgen, Ramazan Yaman, Gulsen Yaman*

We present a quadratic unconstrained optimization problem solution technique with Multiple Input, Multiple Output systems (MIMO) in control theory. Some numerical calculations have been presented. With this applied technique, it always gives a stable system. The globally asymptotically stable point of $x(t)$ is always global optimal solution value of the problem when t goes to infinity. Finally, it has been developed an algorithm to generate a global optimal solution for unconstrained quadratic problems. In order to solve sample problems, Matlab scripts have been used.

3 - New approach to nonconvex optimization

Alexander Strelakovsky, Laboratory of Global Optimization Methods, Institute of System Dynamics and Control Theory SB RAS, Lermontov st., 134, 664033, Irkutsk, Russian Federation, strelak@icc.ru

We consider optimization problem with differences of two convex functions (d.c. fncts.). For these problems we developed Global Search Theory consisting of the following components: - Special local search methods the principal element of which is the linearized problems solving. - Initialization of a new local search at points from an approximation of level surfaces of level surfaces of convex functions involved into GOC. The numerous computational testings have shown the effectiveness of the approach for d.c. (even dynamical) optimization problems as well as for some combinatorial ones.

■ MD-30

Monday, 14:00-15:30

NONL Adal X=220

Linear Semi-Infinite Optimization II

Stream: Linear Semi-Infinite Optimization

Invited session

Chair: *Miguel Goberna*, Estadística e Investigación Operativa, Universidad de Alicante, Ctra. San Vicente s/n, 03080, San Vicente del Raspeig, Alicante, Spain, mgoberna@ua.es

1 - Evenly convex functions: Properties.

Margarita Rodríguez Álvarez, Dpto. Estadística e Investigación Operativa, Universidad de Alicante, Ctra. Alicante-San Vicente s/n, 03080, San Vicente del Raspeig, Alicante, Spain, marga.rodriguez@ua.es, *Valentín Jornet*

A set is evenly convex if it is the intersection of some family (possibly empty) of open halfspaces. We consider functions with evenly convex epigraphs (evenly convex functions) and we study the main properties of this class of convex functions that contains the subclass of closed convex functions.

2 - Semi-infinite Optimization in the fuzzy portfolio selection problem

Enriqueta Vercher, Statistics and Operations Research, Universitat de València, C/ Dr. Moliner 50, 46100, Burjassot, Spain, Enriqueta.Vercher@uv.es

We introduce the formulation of the linear semi-infinite programming problem associated with the fuzzy portfolio selection where the returns on the assets are modelled by LR-fuzzy numbers and the expected return is approximated by mean-intervals. The investor's problem is to find the portfolio which minimizes the risk in achieving a given level of expected return. We use a fuzzy downside risk function to measure the investment risk. Optimal portfolios are derived using our hybrid semi-infinite programming method. We consider the returns on some assets of the IBEX35 to illustrate our approach.

3 - New Concepts of Immobile Points and Immobility Orders in Convex Semi Infinite Programming

Tatiana Tchemisova, Mathematical Department, Aveiro University, Campus Universitário de Santiago, 3810-193, Aveiro, Portugal, tatiana@mat.ua.pt, *Olga Kostyukova*

We introduce new concepts of immobile points and of their immobility orders for problems of Semi-Infinite Programming with continuum of constraints. Given a convex SIP problem, we use these concepts to construct a special finite nonlinear problem and prove that an optimal solution of the original SIP problem should be optimal in the NLP problem constructed. That permits to obtain new efficient optimality conditions for convex SIP using the known results of the optimality theory of NLP. The algorithm of determination of immobile points and the correspondent immobility orders is proposed.

4 - Excess of Information in Linear Optimization

Mariola Molina Vila, Estadística e Investigación Operativa, Universidad de Alicante, Carretera Alicante-SanVicente s/n, 03080, San Vicente del Raspeig, Alicante, Spain, mariola.molina@ua.es, *Miguel Goberna, Valentín Jornet*

We consider a parametric linear optimization problem (called primal) and its corresponding dual problem, where the parameters are the cost vector and the right-hand-side vector, respectively. Our work characterizes those constraints of the primal problem (variables of the dual problem, respectively) which can be eliminated without modifying its feasible set mapping, its optimal set mapping, and its value mapping. The relationships between all these phenomena are also analyzed.

■ MD-32

Monday, 14:00-15:30

NONL Adal XIII=218

Disciplined Convex Programming

Stream: Convex Optimization Methods

Invited session

Chair: *Michael Grant*, Electrical Engineering, Stanford University, 1025 Windsor Drive, 94025, Menlo Park, CA, United States, mcgrant@stanford.edu

Chair: *Stephen Boyd*, Electrical Engineering, Stanford University, 264 Packard, 94305, Stanford, CA, United States, boyd@stanford.edu

1 - CVXOPT - a Python package for convex optimization

Joachim Dahl, Communication Technology, Aalborg University, Fr. Bajersvej 7A-208, 9220, Aalborg, Denmark, joachim@kom.aau.dk

CVXOPT is a free software package for convex optimization, written in Python. Python is an interpreted language that runs on a wide range of platforms, including embedded devices, and offers a large collection of libraries (network and database interfaces, plotting and visualization, GUIs, etc.). CVXOPT includes routines for basic dense and sparse matrix operations, interfaces to free linear algebra packages (BLAS, LAPACK, UMFPACK, CHOLMOD) and convex solvers written in Python. We present the current state of CVXOPT, and show examples of algorithms and applications implemented in Python.

2 - CVX: a framework for modeling disciplined convex programming

Michael Grant, Electrical Engineering, Stanford University, 1025 Windsor Drive, 94025, Menlo Park, CA, United States, mcgrant@stanford.edu, *Stephen Boyd*, *Yinyu Ye*

In this presentation we introduce CVX, a modeling system for constructing, analyzing, and solving disciplined convex programs. The system turns Matlab into a modeling language, allowing constraints and objectives to be specified in natural Matlab syntax.

3 - Engineering optimization using CVX

Stephen Boyd, Electrical Engineering, Stanford University, 264 Packard, 94305, Stanford, CA, United States, boyd@stanford.edu, *Michael Grant*

Over the last 10 years, convex optimization has been applied to a wide variety of practical problems in engineering, in areas such as control systems, signal processing, machine learning, communications, networking, and circuit design. In this talk we will show how CVX can be used to rapidly develop convex optimization models for these applications.

■ MD-33

Monday, 14:00-15:30

NONL Adal A=313

Global Optimization: Software and Applications II

Stream: Global Optimization: Software and Applications

Invited session

Chair: *Zelda B. Zabinsky*, Industrial Engineering, University of Washington, Box 352650, 98195, Seattle, WA, United States, zelda@u.washington.edu

1 - A reduction type method for solving semi-infinite programming problems

Ana Pereira, Polytechnic Institute of Braganca, Campus de Sta Apolonia, Apartado 134, 5301-857, Braganca, Portugal, apereira@ipb.pt, *Edite Fernandes*

A reduction type method for solving semi-infinite programming problems is presented. The multi-local optimization procedure relies on a simulated annealing algorithm combined with a function stretching technique. An appropriate descent direction is obtained by solving the locally finite reduced problem using a quasi-Newton penalty technique. To guarantee the global convergence of the algorithm, a sufficient reduction in an extended exponential merit function is forced through an Armijo condition. The numerical results seem to show that the algorithm has a satisfactory computational behaviour.

2 - Solving a nonlinear nonconvex problem with fractional objective function

Paula Amaral, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, Departamento de Matemática, Campo da Caparica, 2829-516, Caparica, Lisbon, Portugal, paca@fct.unl.pt, *Joaquim Judice*, *Hanif Sherali*

In this talk we describe two global optimisation approaches for solving a non-convex nonlinear problem where the objective function is a sum of fractional functions. One algorithm uses a linearization of the denominators in the objective function. The second algorithm exploits Reformulation-Linearization techniques (RLT). The problem we are dealing with arises in the context of the correction of an inconsistent linear system. By correction we mean a perturbation of both the matrix of coefficients and right-hand-side of the linear system of inequalities.

3 - Simulated Annealing with Hit-and-Run for Mixed Continuous/Discrete Global Optimization

Zelda B. Zabinsky, Industrial Engineering, University of Washington, Box 352650, 98195, Seattle, WA, United States, zelda@u.washington.edu

Simulated annealing algorithms using the Hit-and-Run sampling method as a generator of candidate points have been successful in a continuous domain, from both a theoretical analysis and from numerical experiments. Recent work will be presented on new versions of Hit-and-Run for discrete and mixed discrete-continuous domains. The underlying Markov chain Monte Carlo sampling method uses a random bi-directional walk, and three versions will be presented, Sphere, Box, and Mixed Biwalk. Some analytical results and computational results for global optimization will be presented.

■ MD-34

Monday, 14:00-15:30

DEC VR11 V-138

Game Theory

Stream: Systems and Game Theory

Invited session

Chair: *Dmitrii Lozovanu*, Institute of Mathematics and Computer Science, Academy of Sciences, Kishinev, Moldova, Republic Of, lozovanu@math.md

1 - A characterization of convex games by means of bargaining sets

Josep M Izquierdo, Economic Mathematics, Universitat de Barcelona, Diagonal 690, E-08034, Barcelona, Catalunya, Spain, jizquierdo@ub.edu, *Carles Rafels*

We give two characterization results of convexity for TU games. To this end we define the concepts of max-marginal worth vector and max-Weber set which is the convex hull of all max-marginal worth vectors. The first characterization states that a game is convex if and only if the max-Weber set is included in the Weber set and this latter is a subset of the Mas-Colell bargaining set. The second one only applies to super-additive games and it states that a game is convex if and only if the max-Weber set is included in the Weber set and this latter is a subset of the Davis-Maschler bargaining set.

2 - A new characterization of the extreme core allocations of the assignment game

Marina Nunez, Economic and Financial Mathematics, University of Barcelona, Av Diagonal, 690, 08034,

Barcelona, Spain, mnunez@ub.edu, *Josep M Izquierdo, Carles Rafels*

We introduce a set of vectors, one for each ordering on the set of agents, which give the extreme core allocations of the assignment market. For a fixed ordering on the set of agents, the corresponding vector is obtained recursively only making use of the assignment matrix (no need of the characteristic function). Each extreme core allocation of an assignment market coincides with one of these vectors. Moreover, if the assignment market has large core (dominant diagonal and doubly dominant diagonal matrix) this set of vectors is precisely the set of extreme core allocations of the market.

3 - The vector lattice structure of the n-person TU games

Carles Rafels, Economic and financial mathematics, University of Barcelona, Av Diagonal, 690, 08034, Barcelona, Spain, crafels@ub.edu, *Francesc Llerena*

We show that any cooperative TU game is the maximum of a finite collection of a specific class of the convex games: the almost positive games. These games have non-negative dividends for all coalitions of at least two players. As a consequence of the above result we show that the class of modular games is a set of generators of the distributive lattice of all cooperative TU games. Finally, we characterize zero-monotonic games using a strong max-convex decomposition.

4 - Optimal Feedbacks in Investment Games

Alexander Tarasyev, Dynamic Systems, Institute of Mathematics and Mechanics, ul. S. Kovalevskoi 16, Ekaterinburg 620219, Russia, 620219, Ekaterinburg, Russian Federation, tam@imm.uran.ru

A dynamic game model of investment process for an innovator in a market environment is considered. The innovator dynamics is described by the system of exponential trajectories with quickly changeable growth parameters. Parameters of the market trajectories vary slowly and can be identified using probabilistic distribution functions. The model consists of three decision making levels for dynamic identification, optimization of the commercialization time and optimal control design. Dynamic optimality principles are used for finding optimal investment plans and designing optimal feedbacks.

■ MD-35

Monday, 14:00-15:30
DEC VR11 V-147

Integrating PSMs with MCDA approaches

Stream: Problem Structuring Methods / Soft OR
Invited session

Chair: *Gilberto Montibeller*, Dept. of Business Information Management, Kingston Business School, Kingston University, Kingston Hill Campus, Kingston upon Thames, KT2 7LB, London, United Kingdom, G.Montibeller@kingston.ac.uk

1 - A methodology for analysing measures to reduce the risk of oil pollution

Tony Kråkenes, Norwegian Defence Research Establishment, P O Box 25, NO-2027, Kjeller, Norway, tony.krakenes@ffi.no, *Stein Malerud*

A major concern for Norway is to ensure a sustainable development of natural resources in the Barents Sea region. There is an increased emphasis on security at sea and oil-spill preparedness, and different measures are being discussed in order to reduce the probability of accidents and the consequences of oil-spills. This paper presents a methodological framework for identifying and ranking the most promising measures, accounting for risks and uncertainties. Different OR methods, including problem structuring methods and MCDA, are assembled in a multi-methodology fitted for this problem.

2 - On the evaluation of options in the Strategic Choice Approach

L. Alberto Franco, Warwick Business School, University of Warwick, ORIS Group, Gibbet Hill Road, CV4 7AL,

Coventry, United Kingdom, alberto.franco@warwick.ac.uk, *Gilberto Montibeller*

The Strategic Choice Approach (SCA) is a widely applied problem structuring method which provides decision support to groups of actors confronted with interconnected areas of choice that are surrounded by uncertainty. The SCA has a phase of evaluation of such choices, in order to identify the nature and sources of uncertainty, and the most suitable course of action. In this paper we analyse SCA's prescriptions for this phase, comparing them with those of decision analysis, and identify the conditions under which a more rigorous evaluation of options could be conducted under the SCA framework.

3 - Multicriteria Framework for Problem Structuring in Fisheries Management

Theodor Stewart, Statistical Sciences, University of Cape Town, Upper Campus, 7701, Rondebosch, South Africa, tjstew@stats.uct.ac.za

We describe the structuring components of the development of a decision support for fisheries rights allocations in South Africa. Perceptions both of fishing communities and of government officials were represented initially as cognitive maps, then by value trees and finally as a spreadsheet DSS.

4 - Reasoning Maps: An Integrated Approach for Problem-Structuring and Multi-Criteria Evaluation

Gilberto Montibeller, Dept. of Business Information Management, Kingston Business School, Kingston University, Kingston Hill Campus, Kingston upon Thames, KT2 7LB, London, United Kingdom, G.Montibeller@kingston.ac.uk, *Valerie Belton*

Causal maps have been successfully employed in supporting problem structuring, as they are able to depict complex reasoning processes as a network of arguments; but they were not originally devised to evaluate decision options. In this paper we present a new decision method, called Reasoning Maps, which employ a causal map structure to support not only the process of problem structuring but also a (qualitative) multicriteria evaluation of decision options along multiple and complex paths of arguments.

■ MD-36

Monday, 14:00-15:30
DEC VR11 V-155

MCDA Methods

Stream: Multicriteria Decision Analysis
Invited session

Chair: *Yves De Smet*, SMG - CODE, Université Libre de Bruxelles, Boulevard du Triomphe CP 210-01, 1050, Bruxelles, Belgium, yves.de.smet@ulb.ac.be

1 - Missing values in MCDA

Bertrand Mareschal, SMG, Université Libre de Bruxelles, Boulevard du Triomphe CP 210-01, 1050, Brussels, Belgium, bmaresc@ulb.ac.be, *Mohamed El Hadouchi*

This paper analyses the problem of missing data in multicriteria decision aid. A typology of missing values is first proposed. Several approaches for the treatment of missing values are then proposed. They are classified according to whether they are applicable for certain types of missing values or to certain decision aid methods. Guidelines are given for the selection of an appropriate treatment of missing values and practical examples are provided using the PROMETHEE multicriteria decision aid method.

2 - A new minimalistic multicriteria method: AURORA.

Johan Springael, Faculty of Applied Economics, University of Antwerp, Prinsstraat 13, 2000, Antwerp, Belgium, johan.springael@ua.ac.be, *Wim De Keyser*

When discussing with decision makers in order to perform a multicriteria analysis several questions rise on the usability of the method. Many methods need a lot of information from the decision maker such as preferences, weights. It is often the case that decision makers have not the time to go through the procedure. Mostly, they do not trust the method(s) due to the cumbersome mathematical structure, which they do not understand. The method presented here called AURORA, standing for "Aggregating Unicriterion Rankings into One RANking", uses low level mathematics.

3 - Large group decisions modelling

Yves De Smet, SMG - CODE, Université Libre de Bruxelles, Boulevard du Triomphe CP 210-01, 1050, Bruxelles, Belgium, yves.de.smet@ulb.ac.be, Pierre Kunsch, Johan Springael

In this paper, we consider the modelling of simultaneous decisions taken by a large group of individuals. The proposed method is based on a Markov chain approach where the transition matrix is derived from the pair wise comparison of alternatives. At first, we consider the case where the individual decisions are taken on the basis of a basic weighted sum where the weights' distribution is uniform. Then other distributions and models are considered.

■ MD-37

Monday, 14:00-15:30

DEC VR7 V-156

AI and Neural Networks II

Stream: AI and Neural Networks

Invited session

Chair: *Camelia Ioana Ucenic*, Management of Industrial Systems, Technical University Cluj Napoca, Street Muncii, 3400, Cluj Napoca, Romania, cameliaucenic@yahoo.com

1 - The expert system for evaluating the fitness of the organizational structure to the strategy of the organization

Jovica Djurkovic, Faculty of Economics, Segedinski put 9-11, 24000, Subotica, Serbia and Montenegro, djovica@eccf.su.ac.yu

Adapting an organization to the strategy has three relevant aspects: specification of the necessary changes, evaluation of critical situations, and actions in carrying out the changes. The expert system of the organizational structure of the organization (OSO) - is developed and intended to: diagnosing the type of the organizational structure; evaluating the dimension of uncertainty evaluating the level of coordination of the type of the organizational structure of an organization with the dimension of uncertainty of its environment.

2 - A Collaborative Reputation-aware Autonomous Agent Negotiation Framework for Electronic Marketplace Environments

Lambros Pechlivanos, Athens University of Economics and Business, Greece, lpech@aueb.gr, Ioanna Roussaki, Malamati Louta

We propose an agent-based negotiation framework for e-marketplaces, with a dynamic multi-issue multi-party negotiation model and negotiation strategies that employ a flexible ranking mechanism, instead of the complicated counter offer scheme. A collaborative Seller reputation mechanism enables Buyers to exchange information on Sellers' reliability and considers the Sellers' past performance in meeting the Buyers' requirements. The reputation management system distinguishes between truthful and deceiving responses and enforces a penalty policy for malicious parties endangering its integrity.

3 - Hydroelectric Multireservoir System Control Applying Reinforcement Learning: Theoretical Framework and Early Results

Alaa Abdalla, Integrated Operation Risk Management, BCHYDRO, 6911 Southpoint Drive (E15), V3N 4X8, Burnaby, British Columbia, Canada, Alaa.Abdalla@bchydro.bc.ca, Ziad Shawwash, Denis Russell, Tom Siu

This paper introduces the main concepts and computational aspects of using an artificial intelligence approach called Reinforcement Learning (RL) for the multi-reservoir problem. We present a methodology for establishing optimal operating policies and computing the marginal value of water in storage in the various reservoirs of a multi-reservoir system. The proposed RL reservoir optimization model is applied to a case study of a system that includes B.C. Hydro's two main river systems. The RL model presented considers stochastic inflows and market prices.

■ MD-38

Monday, 14:00-15:30

DEC VR7 V-157

Applications of Data Envelopment Analysis

Stream: DEA and Performance Measurement

Invited session

Chair: *Lawrence Seiford*, Industrial and Operations Engineering, University of Michigan, 1205 Beal Avenue, IOE, Room 1877, 48109-2117, Ann Arbor, MI, United States, seiford@umich.edu

1 - Combining SSM and DEA: Evaluating the Performance of the Chinese Academy of Science

John Mingers, Kent Business School, Kent University, CT2 7PE, Canterbury, Kent, United Kingdom, j.mingers@kent.ac.uk, Wenbin Liu, Wei Meng

The largest research institution in China is the state controlled Chinese Academy of Sciences (CAS). It encompasses 116 science and technology enterprises including 89 research institutes, three universities and five libraries. An attempt was made to apply DEA to evaluating the Institutes of the CAS but it proved very difficult to determine an agreed and objective set of measures. This led to the innovative use of soft systems methodology (SSM) as a way of structuring this complex situation in order to be able to employ DEA.

2 - Developing a Decomposable Measure of Profit Efficiency Using DEA

Emmanuel Thanassoulis, Aston Business School, Aston University, Operations and Information Management, B4 7ET, Birmingham, United Kingdom, e.thanassoulis@aston.ac.uk, Maria Portela

In this paper we highlight problems with existing approaches to measuring profit efficiency and propose a new measure based on a geometric distance function. Overall profit efficiency is then decomposed into its technical and allocative components. We also define a measure of profitability efficiency which complements profit efficiency in that it makes it possible to retrieve the scale efficiency of a unit as a component of its profitability efficiency. The connections between profit and profitability efficiency are also discussed.

3 - Recovering from Delays: A DEA Study of United States Airport Efficiency

Lawrence Seiford, Industrial and Operations Engineering, University of Michigan, 1205 Beal Avenue, IOE, Room 1877, 48109-2117, Ann Arbor, MI, United States, seiford@umich.edu, Warren Sutton

The operational efficiency of airlines has been analyzed through numerous studies. Most of these studies focus on the individual airlines and how airline operations are organized. This study takes a different approach to measuring operational efficiency by analyzing the efficiency of the airport instead of the airline. The airport and airlines are, in fact, dependent entities that rely heavily upon each other to succeed in daily operations. With these issues in mind, one primary objective of this study is to find out if a hub airport is more likely to be efficient than a non-hub airport.

■ MD-39

Monday, 14:00-15:30

DEC VR7 V-158

MCA/AHP case studies in planning and the built environment

Stream: Decisions for a Sustainable Built Environment

Invited session

Chair: *Patrizia Lombardi*, Casa-Città Department, Polytechnic of Turin, V.le Mattioli 39, 10125, Turin, Italy, patrizia.lombardi@polito.it

1 - The valuation of urban renewal programmes feasibility: a multiple criteria approach

Chiara d'Alpaos, Università degli Studi di Padova, Padova, Italy, chiara.dalpaos@unipd.it, Paolo Rosato, Giuseppe Stellin

The issue of urban renewal programmes emerged since the late Seventies, but its potential in terms of induced economic development was fully recognised only during the mid Nineties, when new institutional and economic instruments were introduced for promoting and accelerating investments. In this context public-private partnership as defined by the Italian legislation (L. 127/97, D.Lgs. 267/00) plays a pivotal role. Given the lack of public financial resources, a multicriteria model is proposed to evaluate by a ranking procedure which programmes are to be financed according to L. 21/01.

2 - Analytic Hierarchy Process and Environmental Assessment

Marta Bottero, diget, Politecnico di Torino, Corso Duca Degli Abruzzi 24, 10129, Turin, Italy, marta.bottero@polito.it, Giulio Mondini

Environmental problems and the principle of sustainable development in projects and planning processes have become increasingly important over the last years. This means that the feasibility studies should involve not only the technical elements and the social-economic aspects but also the factors related to the interferences of the operation with the environmental components. The work, through the use of the AHP, compares different sites in order to choose the most compatible location for a waste incinerator, with particular reference to the impacts on the environmental system

3 - Integrated Spatial Assessment: A Multicriteria Approach to Sustainable Development of Cultural and Environmental Heritage in San Marco dei Cavoti, Italy

Pasquale De Toro, Conservation of Architectural and Environmental Assets, University of Naples 'Federico II', Via Roma, 402, I-80132, Naples, Italy, detoro@unina.it, Luigi Fusco Girard

Starting from the concept of 'territory' and from the definition of integrated conservation', the papers defines the operative dimensions of Spatial Integrated Assessment, applying it to the territorial context of San Marco dei Cavoti (a rural village in Southern Italy). In particular, the paper - using the Analytic Hierarchy Process method - tries to construct integration between environmental approaches in the process of strategies definition and of planning choices, recognizing the relevant role of the environmental aspects in the decision-making process and alternatives selection.

4 - How to define the criteria to support decisions for sustainable development

Patrizia Lombardi, Casa-Città Department, Polytechnic of Turin, V.le Mattioli 39, 10125, Turin, Italy, patrizia.lombardi@polito.it

Multicriteria analysis is often used in planning for evaluating alternative development options against a set of evaluation criteria. In the context of sustainable development, the definition of these criteria is quite controversial because of the complex and fuzzy nature of this emerging topic. The paper suggests a framework which can help decision makers to handle the multiplicity of the issues embodied in the concept of sustainability. This is based on the holistic approach developed by the Multimodal System Thinking Theory of the Dutch philosopher Herman Dooyeweerd.

■ MD-40

Monday, 14:00-15:30

SOC VR11 V-257

Reverse Logistics

Stream: Environmental Planning

Invited session

Chair: Stavros Daniel, Industrial Management, University of Piraeus, Karaoli & Dimitriou 80, 18534, Piraeus, Greece, stdanielgr@yahoo.com

1 - Applying Life Cycle Impact Assessment to Reverse Supply Chains: a case study

Stavros Daniel, Industrial Management, University of Piraeus, Karaoli & Dimitriou 80, 18534, Piraeus, Greece, stdanielgr@yahoo.com, Costas Pappis

The methodology of Impact Assessment and the main environmental impact categories, according to which these impacts are assessed, are described. The EDIP method, adapted to the SETAC LCIA method, is used in order to assess the environmental implications in the case of disposal and recovery of used lead acid batteries. A comparison is made between two alternative waste management policies of disposal and recovery of used battery channels in terms of their environmental impact. From this comparison, conclusions are drawn in order to produce an environmental profile of the examined channels

2 - Assessing alternative reverse logistics policies for the recovery of used mobile phones

Costas Pappis, Industrial Management, University of Piraeus, 80 Karaoli & Dimitriou str., 18534, Piraeus, Attica, Greece, pappis@unipi.gr, Giannis Tsoufias, Tom Dasaklis

In this paper, we present the current situation regarding recovery of used mobile phones globally, with a reference to the special case of Greece, and we identify, assess, and compare, in terms of environmental performance, alternative reverse logistics policies for the recovery and utilization of used mobile phones by means of Life Cycle Assessment. We particularly focus on the Interpretation phase of LCA and analyze and discuss the arising methodological problems related to decision making in the presence of other criteria, in addition to the environmental ones.

3 - Environmental assessment of re-assembling policies: The case of personal computers

Nikolaos Rachaniotis, University of Piraeus, 80 Karaoli&Dimitriou str., 18534, Piraeus, Greece, nraxan@unipi.gr, Tom Dasaklis, Costas Pappis, Giannis Tsoufias

Re-assembling deteriorating subsystems of a complex system from used and new parts represents a special case of closed loop supply chains management. Environmental gains may be incurred from re-assembly, since the life cycle of used components may be extended instead of ending by entering the waste stream. The assessment of these environmental benefits is examined using an example in the case of personal computers and a decision-making model with the objective to find the proper re-assembly policies in a period of time so as to maximize the system's overall performance value is presented.

■ MD-41

Monday, 14:00-15:30

SOC VR11 V-258

Behavioural Economics

Stream: Behavioural and Experimental Economics

Invited session

Chair: Bernd Brandl, Department of Government, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, bernd.brandl@univie.ac.at

1 - Incentives and Norms: Do Input-Norms Outperform Output-Norms?

Barbara Mayer, Dept. of Business Studies, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, barbara.mayer@univie.ac.at

Evidence suggests that people exhibiting social preferences may have a profound impact on incentive provision, contract formation, ... We study a principal-agent situation and analyze norms concerning the outcome of the relationship or the exerted level of effort. Generally, norms result in intrinsic motivation. However, the correlation between outcome and performance measure plays a crucial role in determining whether input norms outperform output norms and the relationship between the uncertainty of the performance measure and the intensity of incentives can be either negative or positive.

2 - Team Decisions

Rakesh Sarin, Anderson Graduate School of Management, UCLA, 110 Westwood Plaza, Box 951481, 90095-1481, Los Angeles, CA, United States, rakesh.sarin@anderson.ucla.edu

Economic theory predicts that teams will fail because of free rider problem. We provide some experimental results on team performance. The key result is that under some conditions teams fail but in others cooperation is induced and teams succeed. Application to Production Management is discussed.

3 - Social Optimality and Duopoly Competition with Real Options

Guillermo Gallego, Industrial Engineering and Operations Research, Columbia University, 500 West 120th Street, 10027, New York, NY, United States, gmg2@columbia.edu, *Ozge Sahin*

We consider a two period model with a finite number of homogeneous customers who know the distribution of their valuations in period one and see the actual realizations in period two. Our previous work for finite capacity providers shows that selling call options on capacity leads to larger revenues than low-to-high pricing. We extend our analysis and show that options are socially optimal and provide a range of consumer surplus over which options strictly dominate low-to-high pricing. We also consider a duopoly game between providers with finite capacity that compete by offering call options.

4 - Interaction dynamics and reinforcement learning in collective wage bargaining

Bernd Brandl, Department of Government, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, bernd.brandl@univie.ac.at, *Walter Gutjahr*

Collective bargaining plays a key role for entrepreneurial activity and for economic. If negotiations over wages are an important part of economic reality, it is essential to understand the dynamics of the bargaining process. The aim of this paper is to study the interaction between bargainers. Different to other literature we describe a more realistic model in which bargaining follows an interactive pattern with alternating-move structure. We will argue that the dynamics of alternating moves in the bargaining process can be described by a reinforcement learning process.

■ MD-42

Monday, 14:00-15:30
SOC VR71 V-261

Modeling Social Systems II

Stream: Modeling Social Systems
Invited session

Chair: *David Lane*, Interdisciplinary Institute of Management, London School of Economics and Political Science, Houghton Street, WC2A 2AE, London, United Kingdom, d.c.lane@lse.ac.uk

1 - Formal Theory Building For The Avalanche' Game: Explaining counter-intuitive behaviour of a complex system by examining geometrical and human behavioural effects

David Lane, Interdisciplinary Institute of Management, London School of Economics and Political Science, Houghton Street, WC2A 2AE, London, United Kingdom, d.c.lane@lse.ac.uk

In the group exercise *Avalanche'* a rod is lowered to the ground. Normally the task is easily accomplished; increasing group size causes problems. We present a formal theory for the causal mechanisms in operation. The interaction of effects is needed for a plausible account. This is a geometric source of the behaviour. Other effects concern human behaviour and balancing loops. In combination these create a reinforcing loop which explains upwards movement. Stability analysis indicates: The balancing loops only dominate in a narrow region. This explains the counter-intuitive rising' behaviour.

2 - No Longer Born Wild? Implications of the Cohort Effect on the Motorcycle Industry

Kristjan Ambroz, Institute of Management, University of St. Gallen, Dufourstrasse 50A, 9000, St. Gallen, Switzerland, kristjan.ambroz@gmail.com, *Camilo Olaya*

The aim of this paper is to examine the implications of the cohort nature of motorcycle riders on the industry. The age structure of "bikers" in Europe shows a creeping superannuation and might lead to a pool of riders too old to incite younger riders to join and too small to sustain the motorcycle industry. A simulation model is constructed, which generates insights and suggests possible remedies. The cohort effect is examined more widely with other potential risky cases identified. The use of simulation tools for the early identification and tackling of the cohort effect is also discussed.

3 - Self-Organization and Money in a Marketplace: An Agent-Based Computational Approach

Felipe Mota, Universidad de Los Andes, 57, Bogota, Colombia, f-motta@uniandes.edu.co, *Roberto Zarama*

A decentralized pre-capitalist economy is simulated with agents that produce a given commodity and demand the commodities that other agents produce. Trade takes place on the marketplace where agents sell their respective commodity at the price they set. All prices are nominal and transactions are made with fiat money. The main objective of this paper is to present an example of how market self-organization emerges from the decentralized interaction of self-interested agents. The impact of different monetary rules and supply shocks on the macroeconomic stability is also addressed.

■ MD-43

Monday, 14:00-15:30
FIN Endur Room 1

Stochastic programs with continuous distributions

Stream: Stochastic Programming
Invited session

Chair: *Teemu Pennanen*, Business Technology, Helsinki School of Economics, PI 1210, 00101, Helsinki, Finland, pennanen@hse.fi

1 - DotSMod - Modeling Multi-stage Stochastic Programming Problems

Ronald Hochreiter, Dept. of Statistics and Decision Support Systems, University of Vienna, Universitaetsstrasse 5, A-1010, Vienna, Austria, ronald.hochreiter@univie.ac.at

Modeling multi-stage stochastic programming problems in a unified and simplified modeling environment is an important task to gain a wider acceptance of optimization under uncertainty. By now, different solutions have been proposed, which are commonly bound to specific modeling strategies or scenario optimization techniques. The DotSMod framework will be presented, whose core is an extension of the AMPL modeling language. It will be shown, how different scenario optimization methodologies and workflows can be integrated easily. An integration into the Open Office suite guarantees usability.

2 - Numerical analysis of discretizations of multistage stochastic programs

Petri Hilli, Management Science, Helsinki School of Economics, Runeberginkatu 22-24, 00100, Helsinki, Finland, petri.hilli@hse.fi

This talk reports computational experience on numerical solution of multistage stochastic programs where uncertainty is described by multivariate time series models. Numerically computed statistical bounds indicate that one can obtain near optimal solutions for practically relevant problems with quadrature based discretizations and interior point methods on a modern PC.

3 - On complexity of stochastic programming

Teemu Pennanen, Business Technology, Helsinki School of Economics, PI 1210, 00101, Helsinki, Finland, pennanen@hse.fi

This talk presents a complexity result for a class of stochastic programming problems where uncertainty is described by continuous probability distributions.

■ MD-44

Monday, 14:00-15:30

FIN Endur Room 2

Investment Strategies and Timing

Stream: Long Term Financial Decisions

Invited session

Chair: *Andreas Loeffler*, Banking and Finance, Universität Hannover, Königsworther Platz 1, 30167, Hannover, Germany, al@wacc.de

1 - Large Global European portfolio construction: Does a changing volatility structure matter?

Wolfgang Polasek, Economics and Finance, IHS Wien, Stumpergasse 56, 1060, Vienna, Austria, polasek@ihs.ac.at

We propose a multivariate time series model to forecast the returns and volatilities of 15 European financial markets. Using the approach of mean-variance portfolios we develop several strategies which are based on the predictions of high-dimensional VAR-GARCH models for future volatilities. We explore the value of volatility timing strategies by simplifying the forecasting model. One approach for information blocking is based on factor analysis for the returns. Finally we discuss if multivariate volatility timing strategies are successful for beating the benchmark index (MSCI Europe index).

2 - Optimal investment strategies under risk constraints

Ralf Wunderlich, Group of Mathematics, University of Applied Sciences, Psf 201037, 08056, Zwickau, Germany, ralf.wunderlich@fh-zwickau.de

We address the dynamic portfolio optimization problem where the expected utility from terminal wealth has to be maximized. The special features of this paper are an additional constraint on the portfolio strategy modeling bounded shortfall risks and a model of the financial market with partial information. Stock prices are assumed to satisfy a stochastic differential equation with a drift parameter modeled as an unobservable continuous-time, finite state Markov chain (HMM). Numerical examples illustrate the analytical results.

3 - The role of longevity bonds in optimal portfolios

Francesco Menoncin, Economics, Brescia University, Via S. Faustino, 74/B, 25122, Brescia, Italy, menoncin@eco.unibs.it

A longevity bond pays coupons proportional to the (stochastic) survival rate of a population. Thus the longevity risk becomes hedgeable on the financial market. In our model there are: (i) a longevity bond as a derivative on the survival rate, (ii) a bond as a derivative on the riskless interest rate, and (iii) a stock. The investor maximizes the expected utility of his intertemporal consumption. We demonstrate that the amount of wealth invested in the longevity bond reduces the portfolio weight of the bond without affecting the weights of the other assets.

■ MD-45

Monday, 14:00-15:30

FIN Endur Room 3

Portfolio Optimization

Stream: Optimization in Financial Mathematics

Invited session

Chair: *Mustafa Pinar*, mustafap@bilkent.edu.tr

Chair: *Francisco J. Nogales*, Statistics, Universidad Carlos III de Madrid, Avda. de la Universidad, 30, Leganes, 28916, Madrid, Spain, FcoJavier.Nogales@uc3m.es

1 - Optimal Capital Structure with a Jump-Diffusion Process

Sarp Kaya Acar, Financial Mathematics, Fraunhofer ITWM, Fraunhofer Platz 1, 67663, Kaiserslautern, Germany, sarp.kaya.acar@itwm.fraunhofer.de

We extend the Leland's endogenous optimal capital structure model based on the diffusion process by adding double exponentially distributed jumps to the underlying. The proposed model shows that the jump risk has significant effects on the optimal leverage ratio and the credit spreads of the firm.

2 - Accounting for estimation risk in dynamic optimal portfolio selection

Eranda Dragoti-Cela, FSC-Financial Soft Computing, Siemens Austria AG, Gudrunstrasse 11, 1100, Vienna, Austria, eranda.dragoti-cela@siemens.com, *Peter Haumer*, *Raimund Kovacevic*

Practical portfolio selection models take as inputs estimations of expected returns and expected risk matrices. We discuss three approaches to account for the inaccuracy of estimations at the portfolio selection level and present some related numerical results: 1. Adapting the risk matrix so that it takes into account the estimation risk besides the market risk. 2. Robust optimization techniques where confidence intervals are considered instead of point forecasts. 3. Bayesian techniques where expected return distributions are considered instead of point forecasts.

3 - Robust Portfolio Estimation and Optimization

Francisco J. Nogales, Statistics, Universidad Carlos III de Madrid, Avda. de la Universidad, 30, Leganes, 28916, Madrid, Spain, FcoJavier.Nogales@uc3m.es, *Victor DeMiguel*

Markowitz portfolios constructed using maximum-likelihood estimators perform poorly out-of-sample due to estimation error. A robust estimator is one that provides meaningful information even when the sample distribution deviates from normality or has outliers. We show how to compute a portfolio that minimizes a robust estimate of risk. We give a bound on the sensitivity of the resulting portfolio to changes on the distribution of asset returns. Finally, out-of-sample results show that the proposed robust portfolios outperform classical portfolios on simulated and empirical datasets.

■ MD-46

Monday, 14:00-15:30

FIN Endur Room 4

Risk Theory

Stream: Applied Probability

Invited session

Chair: *David Stanford*, Dept. of Statistical & Actuarial Sciences, The University of Western Ontario, Wsc 262, 1151 Richmond Street N., N6A 5B7, London, Ontario, Canada, stanford@stats.uwo.ca

1 - On the discounted penalty function in the renewal risk model with general interclaim times

Gordon Willmot, Dept. of Statistics and Actuarial Science, University of Waterloo, 200 University Avenue West, N2L 3G1, Waterloo, Ontario, Canada, gewillmo@math.uwaterloo.ca

The defective renewal equation satisfied by the Gerber-Shiu discounted penalty function in the renewal risk model with arbitrary interclaim times is analyzed. The ladder height distribution is shown to be of mixture form, resulting in an invariance property satisfied by a large class of claim amount models. In particular, for the exponential model, simple results follow for a penalty function of the deficit only, and the Laplace transform of the (defective) density of the surplus prior to ruin is obtained. A general expression for moments of the discounted deficit are also obtained.

2 - Portfolio Optimization under a Conditional Value-at-Risk Constraint

Ulrich Rieder, Abteilung Mathematik VII, Universitaet Ulm, Helmholtzstrasse 18, 89069, Ulm, Germany, rieder@mathematik.uni-ulm.de

This paper analyzes optimal portfolio choice of utility maximizing investors in the presence of risk constraints which are given in terms of a class of coherent risk measures. We investigate when the risk constraint is binding and provide a closed-form expression of the optimal terminal wealth. Using the Black-Scholes model and applying martingale methods, analytic expressions for the solution of the terminal wealth problem under a conditional value-at-risk constraint are presented. In particular, we study the behaviour of the optimal portfolio strategies w.r.t. interesting parameters.

3 - The compound Poisson risk model with multiple thresholds

Kristina Sendova, Statistics and Actuarial Sciences, University of Western Ontario, 1151 Richmond Street North, Western Science Centre, Room 223, N6A 5B7, London, Ontario, Canada, ksendova@stats.uwo.ca, *Sheldon Lin*

In this paper we consider a multi-threshold compound Poisson risk model. We further solve a general integro-differential equation with potential applications to ruin theory problems. Consequently, an important particular case is discussed. Namely, the Gerber-Shiu discounted penalty function under the compound Poisson model with multiple thresholds. Finally, examples are considered to illustrate the applicability of the main result.

■ MD-47

Monday, 14:00-15:30

FIN Endur Room 5

Commodity Pricing and Risk Management I

Stream: Financial Modelling

Invited session

Chair: *Rita D'Ecclesia*, Teoria Economica e Metodi Quantitativi per le Scelte politiche, Università di Roma, Piazza Aldo Moro 5, 00185, Roma, Italy, rita.decclesia@uniroma1.it

1 - Exchange Rates and Switching Dynamics

Rosella Castellano, DIEF, University of Macerata, Via Crescimbeni, 20, 62100, Macerata, Italy, castellano@unimc.it, *Luisa Scaccia*

Since the beginning of the floating exchange rate system, there have been continuous attempts to describe the behaviour of the exchange rates. Among the recent efforts, the Markov Switching Models (MSM), allowing exchange rates to alternate between regimes, seem to return encouraging results. This paper presents an empirical study to re-evaluate the presence of the switching dynamics in the exchange rates. Assuming the number of regimes is unknown and subject to inference, we adopt a Bayesian approach based on the posterior distribution of the parameters which describe the model.

2 - Exchange Rates Modeling: an Utility-Based Stochastic Control Approach

Rosella Castellano, DIEF, University of Macerata, Via Crescimbeni, 20, 62100, Macerata, Italy, castellano@unimc.it, *Roy Cerqueti*, *Rita D'Ecclesia*

The aim of this paper is to derive a regime switching model for the exchange rate dynamics as solution of a stochastic control problem. We assume that the dynamics of the exchange rates are driven by a Brownian Motion with state-dependent drift and volatility. The state variable is assumed to be represented by the fundamental. We assume exchange rates behavior can be described as the solution of expected utility maximization which represent Monetary Authority policies.

3 - A forward contract to manage market power in the electricity market

Rita D'Ecclesia, Teoria Economica e Metodi Quantitativi per le Scelte politiche, Università di Roma, Piazza Aldo Moro 5, 00185, Roma, Italy, rita.decclesia@uniroma1.it

The aim of the paper is to verify if the introduction of a derivative electricity contract may stimulate and control the underlying spot market. Following Dong and Liu (03) we assume the input commodity is nonstorable; the supplier and the manufacturer have significant market power; negotiation of the forward contract can be described by a Nash bargaining process. We find a unique equilibrium forward contract in closed form. We suggest a specific contract and simulate the possible effect of this contract on the Italian market.

4 - Efficient strategies of an electricity producer

Silvana Stefani, Metodi quantitativi, Università Milano Bicocca, Piazza Ateneo Nuovo 1 U6, I-20100, Milano, Italy, silvana.stefani@unimib.it, *Paolo Falbo*, *Daniele Felletti*

In the electricity market a price taker producer may offer capacity in the spot market or bind it (partially or totally) through a forward contract. Since we assume that the producer needs an input (gas or oil) to produce the output, both spot and forward strategies are risky (given that the input itself is risky). In a one period time horizon we analyze the producer profit function and consider his risk-return trade-off. If the producer chooses only efficient allocations, some restrictions arise in possible shapes of individual supply curve both in the spot and in the forward market.

■ MD-48

Monday, 14:00-15:30

EWG Logberg 102

EWG: Decision Support Systems (DSS)

Stream: EWG Meetings

Invited session

Chair: *Pascale Zaraté*, Institut de Recherche en Informatique de Toulouse, 118 route de Narbonne, 31062, Toulouse, France, zarate@irit.fr

1 - Meeting of EURO WG "DSS"

Pascale Zaraté, Institut de Recherche en Informatique de Toulouse, 118 route de Narbonne, 31062, Toulouse, France, zarate@irit.fr

EURO Working Group on DSS Meeting, will take place in the afternoon of Monday, July 3, 2006, presumably, at 14-15.30h. All members and friends are cordially welcome.

Monday, 16:00-17:30

■ ME-01

Monday, 16:00-17:30

KEY Askja N-132

TUTORIAL: Financial Mathematics and Industry Applications

Stream: Optimization in Financial Mathematics

Invited session

Chair: *Ralf Korn*, Dept. Mathematics, University of Kaiserslautern, 67653, Kaiserslautern, Germany, korn@mathematik.uni-kl.de

1 - TUTORIAL: Optimal Dynamic Investment Strategies: Theoretical Aspects and Practical Problems

Ralf Korn, Dept. Mathematics, University of Kaiserslautern, 67653, Kaiserslautern, Germany, korn@mathematik.uni-kl.de

The continuous-time approach to portfolio optimization is much more flexible than the usual one-period Markowitz approach. However, while from a theoretical side it is well-understood, there remain various problems with applying it in theory. In this talk the basic continuous-time methods, recent results (transaction costs, crashes, derivatives, inflation, ...) and their transformation to real-world applications are considered.

2 - Longevity Bonds - Pricing, Modelling and Aspects for German Data.

Kalina Natcheva, Financial Mathematics, Fraunhofer ITWM, Fraunhofer-Platz 1, 67663, Kaiserslautern, Germany, natcheva@itwm.fhg.de, *Ralf Korn*

Besides the interest rate risk, the longevity risk is the second major risk factor faced by life offices and pension plans. This is emphasized by the trend of increasing life expectancy. To allow the hedge of at least a big portion of the longevity risk, capital markets offer and trade the so called "Longevity Bonds" whose coupons depend on the development of the survival function of a given cohort. In this paper, we present a simplified but flexible (in respect to the applied model) approach for pricing longevity bonds which compounds ideas from Cairns et al. (2005) and Korn et al. (2006).

■ ME-02

Monday, 16:00-17:30

APP Askja N-131

Primary and Ambulatory Care

Stream: OR in Health Care

Invited session

Chair: *Leonid Churilov*, Department of Accounting and Finance, Monash University, Caulfield East, PO Box 197, 3145, Melbourne, Victoria, Australia, Leonid.Churilov@buseco.monash.edu.au

1 - Intelligent decision support for pathology ordering by general practitioners in Australia

Leonid Churilov, Department of Accounting and Finance, Monash University, Caulfield East, PO Box 197, 3145, Melbourne, Victoria, Australia, Leonid.Churilov@buseco.monash.edu.au

Pathology ordering by General Practitioners (GPs) is a significant contributor to rising health care costs both in Australia and worldwide. This presentation describes how Kohonen's Self-Organizing Maps are used to discover the most typical patterns in pathology orderings for different patient groups. Test ordering data from a pathology company in Australia is analyzed; homogenous clusters of patients with similar ordering patterns are discovered and investigated, and possible management implications are discussed.

2 - Predicting Health Care Costs, a Data Mining Approach

Margret Bjarnadottir, Operations Research Center, Massachusetts Institute of Technology, 77 Mass Ave, Mit E40-149, 02139, Cambridge, MA, United States, margret@mit.edu, *Dimitris Bertsimas*, *Chris Kryder*, *Michael Kane*, *Rudra Pandey*, *Santosh Vempala*, *Grant Wang*

Rising health care costs are of increasing concern in the US. One way to address this concern is through better health care management with timely interventions for patients at risk for high future costs. A key aspect of health care intervention is the ability to predict which members will carry those high future health care costs. We use claims data and utilize state of the art data mining models, classification trees and clustering to provide readily interpretable models. Our results significantly improve forecasting accuracy, beyond commercially available software in the market today.

3 - Patient flow simulation modelling in a regional health authority

William Blackburn, School of Computing Mathematics, University of Ulster, Shore Road, BT37 0QB, Newtownabbey, Antrim, United Kingdom, wt.blackburn@ulster.ac.uk, *Patrick Lundy*

In relation to patient flow activity within a regional health authority, primary systems and operational characteristics are identifiable. Interactions between different services and facilities create complexities. The nature, quality and cost of service are affected by resources and their administration. Clinical and operational perspectives may differ. Macro- or micro-level views may be desirable, with hierarchical linkage. A user-definable simulation modelling phase one development tool is proposed, demonstrated and evaluated. Soft issues are reviewed, in the context of future phases.

■ ME-03

Monday, 16:00-17:30

APP Askja N-130

Combinatorial Auctions and Multi-Item Auctions

Stream: Auctions

Invited session

Chair: *Karla Hoffman*, Department of Systems Engineering and Operations Research, George Mason University, Mail Stop 4A6, 4400 University Drive, 22030, Fairfax, Virginia, United States, khoffman@gmu.edu

1 - Delayed Item Augmentation in Iterative Combinatorial Auctions

Roy Kwon, Mechanical and Industrial Engineering, University of Toronto, 5 Kings College Road, M5S 3G8, Toronto, Ontario, Canada, rkwon@mie.utoronto.ca

Maximizing revenue in combinatorial auctions is a difficult task. We present an iterative CA mechanism that introduces items in a delayed manner. We show that the mechanism can achieve higher revenue for the auctioneer without sacrificing economic efficiency. We illustrate the mechanism on a telecommunications network design problem.

2 - Core Payments in Combinatorial Auctions

Robert Day, School of Business, University of Connecticut, 2100 Hillside Road, U-1041, 06269-1041, Storrs, CT, United States, Bob.Day@business.uconn.edu

In this talk I will summarize recent results on "Core" payment mechanisms for combinatorial auctions and their merits relative to the VCG and other mechanisms. Equilibrium bidding behavior will be characterized and general principles for the selection of a particular core solution will be discussed. The computation of core payments is shown to be NP-hard, and recent solution techniques will be presented. The set of core payments is also shown to be identical to the set of payments for which shill bidding is unprofitable, providing possible alternative computational techniques.

3 - Auction theory in OR settings

Sasa Pekec, Fuqua School of Business, Duke University, 1 Towerview Road, 27708-0120, Durham, NC, United States, pekec@duke.edu

I will discuss ramifications of extending classical auction theory models by incorporating assumptions that are important for management science and operations research applications. In particular, the focus is (1) on allowing for uncertainty in supply and demand and implications on equilibrium existence and revenue rankings of uniform and discriminatory multi-item auctions, (2) comparing different information policies during the course of an auction, (3) choosing an auction model and optimizing supply accordingly.

4 - Implementing Ascending Vickrey Auctions

Rudolf Müller, Department of Quantitative Economics, Maastricht University, P.O. Box 616, 6200 MD, Maastricht, Netherlands, r.muller@ke.unimaas.nl

In their paper "On Ascending Vickrey Auctions" de Vries, Schummer and Vohra propose an ascending price combinatorial auction that results in an efficient allocation and, for substitute valuations, the Vickrey payments. Bidders submit in each round their most preferred sets, given current non-anonymous bundle prices. In each round, the center updates these prices, until at current prices demand of all bidders can be satisfied by a revenue maximizing allocation. In this presentation we report about our experiments with implementing this auction.

ME-04

Monday, 16:00-17:30

APP Askja N-129

Energy/Electricity

Stream: Energy/Electricity

Invited session

Chair: *Emmanuel Canon*, Strategy RD, Electrabel, New Tech Center Av. Einstein, 2 A, 1348, Louvain-la-Neuve, Belgium, emmanuel.canon@electrabel.com

1 - Risk Management in Hydro-based Power Generation: Advanced Use of Optimization to cut back on Execution Time

Emmanuel Canon, Strategy RD, Electrabel, New Tech Center Av. Einstein, 2 A, 1348, Louvain-la-Neuve, Belgium, emmanuel.canon@electrabel.com, *Catherine Van Houte*

Hydro-based power generations incur inherent volume and price risks. Both risks induce volatility on revenues. In order to manage these risks, a simulation tool was created that coupled optimisation and Monte Carlo approaches. The tool consists of solving a series of optimization profit maximization models on successive small periods. Successful real world implementation requires fast execution times, we discuss the efficient development of the tool using MPL/Optimax using its advanced functionalities (matrix changes, advance basis, data manipulation) combined with appropriate runs ordering.

2 - Variational formulation of Electromagnetism dedicated to Energy Efficiency

Vincent Mazaauric, Corporate Research Division, Schneider Electric, 38TEC/T3 Building, 37 Quai Paul-Louis Merlin, 38050, Grenoble, France, vincent.mazaauric@schneider-electric.com, *Nadia Maïzi*, *Philippe Wendling*

To bring a vision of electrical engineering for future energy challenges, the laws of electromagnetism are derived from variational principles deduced from thermostatics. While flux density divergence-free is obtained everywhere from the stationary condition on the Gibbs free energy, the Faraday law and the Ohm law with motion are obtained, in conductors, by assuming a trend for a reversible evolution of the electromagnetic field. The approach is consistent with Finite Element Method, multi-scale optimization (from scratch to the Life Cycle Assessment of the network) and finance allocation.

3 - Optimization approach for managing the restructured electricity market

Maria Teresa Vespucci, Dept. of Management Engineering, University of Bergamo, via Marconi, 5a, 24044, Dalmine (BG), Italy, mtvespucci@tin.it, *Elisabetta Allevi*, *Adriana Gnudi*, *Igor Konnov*, *Evelina Kourbanova*

We consider a restructured electricity market divided in zones, where sell bids and purchase bids are presented by generating companies and customers respectively. The Market Operator has to fix the zonal prices as well as to decide the energy quantity to be accepted for each bid, in order to maximize the social surplus. We propose several formulations of the optimal managing problem for the distributed market with respect to the social surplus function. According to each class of optimization problems, we develop special algorithms for computing their local and global solutions.

ME-05

Monday, 16:00-17:30

APP Askja N-128

Sequential Optimisation in Agriculture and Forestry II

Stream: OR in Agriculture and Forest Management

Invited session

Chair: *Anders Kristensen*, Department of Large Animal Sciences, Royal Veterinary and Agricultural University, Groennegaardsvej 2, Frederiksberg C, DK-1870, Copenhagen, Denmark, ark@dina.kvl.dk

1 - Optimal continuous cover forest management in an uneven-aged forest in the north of Iran

Soleiman Mohammadi Limaei, Forest Economics, Swedish University of Agricultural Sciences, 901 83, Umea, Sweden, soleiman.mohammadi@sekon.slu.se, *Peter Lohmander*

In this paper a growth function was estimated for an Iranian uneven-aged forest. Then the optimal harvest decisions were calculated via stochastic dynamic programming. The harvest decisions which maximize the expected present value of all profits over time are made adaptively, conditional on the latest available price and stock level information. It is possible to determine the optimal harvesting level under different price and stock level states. The results show that you may increase the expected present value by more than 26% via optimal adaptive decisions.

2 - A graph markov decision process model for harvest planning under risk of windthrow

Nicklas Forsell, Dept, of Forest Resource Management and Geomatics, Sveriges lantbruksuniversitet, Inst. skoglig resurshushållning och geomatik, 901 83, Umeå, Sweden, nicklas.forsell@resgeom.slu.se, *Frederick Garcia*, *Ljusk Ola Eriksson*, *Regis Sabbadin*, *Peder Wikström*

An approach is presented for taking the risk of windthrow into account when optimizing the management policy of a forest. The ensuing problem is a spatial problem and we assume that the risk of a stand being windthrown is dependent on the state of the stand itself, as well as the states of the neighboring stands. The problem is modeled as a Graph-Based Markov Decision Process and solved with an approximate linear programming algorithm. The approach is demonstrated on a sample problem, consisting of about 5000 stands.

3 - Substitution between clearcutting and thinning decisions in private forestry

Jussi Uusivuori, Finnish Forest Research Institute Metla, Unioninkatu 40 A, FIN-00170, Helsinki, Finland, jussi.uusivuori@metla.fi, *Jani Laturi*

A two-period intertemporal model describing the behavior of a nonindustrial private forest owner facing a dual management problem of clearcut harvesting and thinning of an even-aged forest is rigorously solved. The two decisions are interdependent and solved simultaneously. A sequential solution is also demonstrated. Under general conditions, saving for more old-growth forest and reducing the thinning intensity are shown to be substitutes. Comparative statics methodology and numerical examples are used to show that a timber price change may affect the two harvesting decisions in opposite ways.

4 - Fuzzy multicriteria approval method and its application to forest planning

Annika Kangas, Department of Forest Resources Management, University of Helsinki, P.o. Box 27, 00014, Helsinki, Finland, annika.kangas@helsinki.fi, *Jyrki Kangas*, *Sanna Laukkanen*

One MCDA method used in forest planning is Multicriteria Approval (MA). It is based on approval voting, where the voters have been replaced by criteria. Alternatives are approved or rejected with respect to each criterion, using a crisp approval threshold defined by the system. The importance order is provided by the DM, and it is accounted for using the concept of ordinal dominance. We present a new version of MA method using a concept of fuzzy approval. It can also be extended to group decision making problems. Its application to forest planning is presented.

■ ME-06

Monday, 16:00-17:30

APP Askja N-121

PANEL: OR in the public private sectors

Stream: OR in the Public Sector

Invited session

Chair: *Michael Pidd*, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, m.pidd@lancaster.ac.uk

1 - Panel paper: OR in the public & private sectors

Linda Green, Graduate School of Business, Columbia University, Uris Hall, 3022 Broadway, 10027, New York, United States, lvg1@columbia.edu

Abstract to follow.

2 - Panel paper: OR in the public & private sectors

Luk Van Wassenhove, Technology and Operations Management Area, INSEAD, Boulevard de Constance, 77305, Fontainebleau cedex, France, luk.van-wassenhove@insead.edu

Abstract to follow.

3 - Panel paper: OR in the public & private sectors

Jonathan Caulkins, H. John Heinz III School of Public Policy Management, Carnegie Mellon University, 5032 Forbes Avenue, 15289, Pittsburgh, United States, caulkins@andrew.cmu.edu

To follow.

4 - PANEL Discussion

Michael Pidd, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, m.pidd@lancaster.ac.uk

Well-known contributors will each present their experience and views on differences between OR in the public and private sectors and then open the discussion to the audience.

■ ME-07

Monday, 16:00-17:30

APP Askja N-120

Excellence in Practice Award II

Stream: Excellence in Practice Award

Invited session

Chair: *Gautam Mitra*, CARISMA, Brunel University, Department of Mathematical Sciences, Kingston Lane, UB8 3PH, Uxbridge, Middlesex, United Kingdom, gautam.mitra@brunel.ac.uk

Chair: *Stefan Voss*, Wirtschaftsinformatik/Information Systems, University of Hamburg, Von-Melle-Park 5, 20146, Hamburg, Germany, stefan.voss@uni-hamburg.de

Chair: *Jitka Dupacova*, Probability and Math. Statistics, Charles Univ, Faculty of Math. and Physics, Sokolovska 83, CZ-18675, Prague, Czech Republic, dupacova@karlin.mff.cuni.cz

Chair: *Paolo Toth*, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, ptoth@deis.unibo.it

Chair: *Catherine Roucairol*, PRISM lab. - CNRS, Univ. of Versailles Saint Quentin en Yvelines, 45, avenue des Etats-Unis, 78035, Versailles Cedex, France, Catherine.Roucairol@prism.uvsq.fr

1 - www.Personal.Asset.Allocation

Stavros Zenios, Professor of Finance and Management Science, University of Cyprus, 75 Kallipoleos street, 1678, Nicosia, Greece, zenios.stavros@ucy.ac.cy

Today consumers are demanding anytime-anywhere delivery of financial services. At the same time the World Wide Web provides a rich channel for the distribution of customized services. The system we developed for Prometeia provides consumers and financial advisors support for personal financial planning. Scenario optimization models develop plans that are consistent with the client's goals, aptitude towards risk, and prevailing views on market performance. The system had a profound impact on the business of Prometeia and is in use by major Banks.

2 - Planning the analog to digital migration in terrestrial broadcasting networks

Carlo Mannino, Informatica e Sistemistica, Universita' La Sapienza, Via Buonarroti 12., 00185, Rome, Italy, mannino@dis.uniroma1.it, *Fabrizio Rossi*, *Stefano Smriglio*

The introduction of Digital Broadcasting in Europe requires a challenging re-planning of in-place analog systems. An abrupt migration of resources (frequencies and transmitters) cannot be accomplished, since the analog service must be preserved temporarily. Hence, a multi-objective problem arises in which several networks sharing common resources have to be designed. We present our experience in developing models and solution methods at RAI, the major Italian broadcaster. The resulting software tool is used at RAI to select high-quality alternatives for the deployment of digital equipment.

■ ME-08

Monday, 16:00-17:30

EDU Oddi 101

Real-world projects in OR courses

Stream: OR Education

Invited session

Chair: *Daniel Haight*, Management Science, University of Alberta, 11027 - 87 Ave, #705, T6G2P9, Edmonton, Alberta, Canada, dan.haight@ualberta.ca

1 - Application of fuzzy logic for the evaluation process of interns' performance

Jorge Escobar, Productive Processes, Javeriana University, Calle 40 #5-50, 1234, Bogota, Colombia, escodonic@gmail.com, *Ana Halabi*

This paper evaluates the applications of expert systems implemented in the academic evaluation process of industrial internship. This necessity arose from the need to create equal and unified concepts based on the observations of the companies in order to assess the practicing through the same criteria. This system of evaluation is based on fuzzy logic. There are four main criteria, each one of these are compounded by three or two parameters of observation, and are expressed by fuzzy sets. The qualification attained by a student reflected his entire academic and practical performance.

2 - Teaching analytical management consulting to business students

Erhan Erkut, Faculty of Business Administration, Bilkent University, Bilkent, 06800, Ankara, Turkey, erkut@bilkent.edu.tr

I will describe a two-course sequence on analytical management consulting offered at the University of Alberta School of Business. In the first course, students learn about the consulting industry and work on several analytically oriented case studies. The second course involves a real consulting engagement, and involves preparation of bids, working on a project, and presentation of results both to the client and at a regional student conference.

3 - Student Projects in Management Science - from Prostate Cancer to Professional Sports Yield Management

Daniel Haight, Management Science, University of Alberta, 11027 - 87 Ave, #705, T6G2P9, Edmonton, Alberta, Canada, dan.haight@ualberta.ca

In this presentation, we talk about the Centre for Excellence in Operations - a research centre devoted to improving management science knowledge transfer between students, academics, and industry. We give a brief background on how the centre has grown and evolved and then talk about two projects in particular: Prostate Cancer Treatment Access, and Attendance Modeling for a Professional Sports Team. We talk about our approach to these projects, the modeling required, and the outcomes achieved.

ME-09

Monday, 16:00-17:30

IT Oddi 106

Bioinformatics III

Stream: Computational Biology and Bioinformatics

Invited session

Chair: *Jonathan Garibaldi*, Computer Science IT, University of Nottingham, Jubilee Campus, Wollaton Road, NG8 1BB, Nottingham, United Kingdom, jmg@cs.nott.ac.uk

1 - Transparent Holographic Regularities in the Protein domain

Itziar Frades, Computer Sciences and IT, University of Nottingham, Jubilee Campus, Wollaton Rd., NG8 1BB, Nottingham, United Kingdom, iaf@cs.nott.ac.uk, *Natalio Krasnogor*, *Jonathan Garibaldi*

I. Frades, P. van der Helm, N. Krasnogor, J. Garibaldi Pisa is an algorithm that computes specific regularities in strings known as transparent holographic regularities. This is a formal property that singles out specific kinds of regularity, while transparency is a code property that allows separating regularities to be hierarchically combined. These properties can be extrapolated to molecular biology as these regularities might have functional transcendence. We aim to explore these and apply any finding into the proteins structure ab initio prediction and optimization problem

2 - Soft Computing in Bioinformatics

Juan Ramón González, University of Granada, Granada, Spain, jrgonzalez@decsai.ugr.es, *David Pelta*

The comparison of protein structures is an important problem in bioinformatics. Structure comparison is useful in a variety of situations like inferring biological functionality of a new structure or assessing the quality of tertiary structure predictors. We focus on the problem from the point of view of fuzzy contact maps and the universal similarity metric, thus extending our previous work. The results show that the simplest generalization of the standard contact map, can produce similarity values that in turn, allowed to recover the class structure presented in the datasets used.

3 - Mining microarray data using multicriteria association rules

Clarisse Dhaenens, LIFL, University of Lille I, 59655, Villeneuve d'Ascq cedex, France, Clarisse.Dhaenens@lifl.fr

Microarray data are a great challenge for biologists in order to understand genetic factor that may explain some diseases, for example. In order to find relationships between expression level of genes, we propose to look for association rules. As optimization criteria for association rules are very numerous, we adopt a multicriteria strategy in order to evaluate those rules according to several aspects. Therefore a multicriteria model for association rules is proposed and an approach using an optimization method, based on an adaptive parallel genetic algorithm, is developed.

ME-10

Monday, 16:00-17:30

OR Oddi 201

70th Anniversary Session I

Stream: OR - The Profession: 70th Anniversary

Invited session

Chair: *Heiner Müller-Merbach*, Wirtschaftswissenschaften, Universität Kaiserslautern, Postfach 3049, 67653, Kaiserslautern, Germany, hmm@bior.de

1 - Simultaneous Optimization of Work and Buffer Space in Unpaced Production Lines with Random Processing Times

Fred Hillier, Management Science Engineering, Stanford University, Stanford University, 94305-1057, Stanford, California, United States, fhillier@stanford.edu

We focus on the simultaneous optimization of the workload allocation and the buffer allocation in unpaced production lines with exponential or Erlang processing times. Using a basic cost model that includes both revenue per unit of throughput and cost per unit of buffer space, exact numerical results are obtained for the underlying Markov chain with even millions of states. We investigate how the bowl phenomenon for workload allocation and the storage bowl phenomenon for buffer allocation interact when performing both allocations simultaneously.

2 - The making of EJOR

Bernhard Tilanus, Management Science, Eindhoven University of Technology, Haarboersweg 5, 7645 AD, Hoge Hexel, Netherlands, tilanus@planet.nl

EJOR is with 9000 pages annually the fastest grown and youngest of the prominent OR journals. But why is EJOR as it is? We will try to find its deepest roots and also try to explain its development since 1977. How EJOR developed totally different from what the editors intended in three respects: contents, size and circulation.

3 - Five Levels of Model Building

Heiner Müller-Merbach, Wirtschaftswissenschaften, Universität Kaiserslautern, Postfach 3049, 67653, Kaiserslautern, Germany, hmm@bior.de

Mathematical modelling for planning and decision purposes, i.e. modelling in OR/MS, has to deal with five different levels of reality, such as: (i) re-modelling of man-made structures, (ii) per-modelling of scientific detection, (iii) fore-modelling of empirical evidence, (iv) trans-modelling of hypothetical conjectures, and (v) pre-modelling of presumes objectives. The five levels will be arranged as a horseshoe. They require different skills and are subject to different threats. Most OR/MS models cover all five levels.

ME-11

Monday, 16:00-17:30

TRANS Oddi 202

Resources Location

Stream: Transportation

Invited session

Chair: *Francisco Saldanha-da-Gama*, CIO/DEIO, University of Lisbon, FCUL-DEIO, Bloco C6, Piso 4, 1749-016, Lisbon, Portugal, fsgama@fc.ul.pt

1 - An optimisation model for the coordination of the schedules at an interchange node

Giuseppe Bruno, Ingegneria Economico Gestionale, Università di Napoli, Piazzale Tecchio 80, 80126, Napoli, Italy, giuseppe.bruno@unina.it, *Gennaro Improta*, *Antonino Sgalambro*

Intermodality is a transport system that allows different modes to be used in an integrated manner. Its efficient organisation would encourage the use of more environmentally friendly transport modes. In this context the correlation of the schedules at an interchange node can play a key role to improve the users perceived cost and the quality of transport chain. In this paper we propose a combinatorial optimisation model for the schedule coordination problem. The application to a real case study shows that the model could be effectively used to provide interesting practical solutions.

2 - Location of fixed and mobile units for route guidance in traffic network management and control

Antonio Sforza, Dipartimento di Informatica e Sistemistica, Università di Napoli, via Claudio 21, 80125, Napoli, Italy, sforza@unina.it

Variable message systems (VMS) location is a relevant optimisation problem for route guidance in traffic management. For its solution path covering models could be used, based on the knowledge of o-d path flows, where the objective function is aimed to maximize the flow intercepted from a fixed number of plants, or to minimize the number of plants necessary to intercept an assigned percent of the total flow. Constraint formulation has to be adapted to the specific role that VMS's play in the network. Computational tests on medium networks are reported and a real application is described.

3 - Discretized formulations for discrete location models with modular costs

Luis Gouveia, DEIO, University of Lisbon, Campo Grande, Bloco C6, 1749-016, Lisbon, Portugal, legouveia@fc.ul.pt, *Isabel Correia*, *Francisco Saldanha-da-Gama*

We present a formulation with allocation variables explicitly indicating the quantity shipped from each location to each demand point. We compare this formulation with other classical models. Using the new allocation variables we propose new valid inequalities for improving the linear programming relaxation bound. We present the results computational tests showing that the valid inequalities proposed not only enhance the linear programming relaxation bound but may also be extremely helpful when using a commercial package for solving the problem optimality.

■ ME-12

Monday, 16:00-17:30

TRANS Oddi 205

Heuristic Algorithms for Routing (SADERYL3)

Stream: Transportation

Invited session

Chair: *Enrique Mota*, Statistics Operations Research, University of Valencia, Fac. of Mathematics, Dr. Moliner, 50, 46100, Burjassot (Valencia), Spain, Enrique.Mota@uv.es

Chair: *Juan José Salazar González*, Estadística e Investigación Operativa, Universidad de La Laguna (Tenerife), Av. Astrofísico Francisco Sánchez, s/n, 38271, La Laguna, Tenerife, Spain, jjsalaza@ull.es

1 - A Scatter Search algorithm for the vehicle routing problem with time windows

Clara Simon de Blas, Statistics Operations Research, Rey Juan Carlos University, Departamental II, Desp. 251, C/Tulipan s/n, 28933, Mostoles, Madrid, Spain, clara.simon@urjc.es, *Francisco José Cano-sevilla*, *Cano Alsua*, *Angel Felipe*

We propose a two phase algorithm to solve the VRPTW. The first stage is a construction algorithm to generate a set of feasible solutions. The idea is to construct p initial routes based on a lower bound. The initial city on each route is computed using a weighted random function. An insertion cost function is proposed to add the remaining non routed clients. On the second stage of the procedure an improvement algorithm in the total travelled distance is proposed based on the combination of different feasible solutions. The algorithm has been applied on Solomon 56 instances for VRPTW.

2 - Optimising Safety and Environmental Routes in Road Transportation using ALGACEA procedures

Javier Faulin, Department of Statistics and OR, Public University of Navarra, Los Magnolios Building, 1st Floor, Campus Arrosadía., 31006, Pamplona, Navarra, Spain, javier.faulin@unavarra.es, *Sergio Ubeda*, *David Monje*, *Fernando Lera-Lopez*, *Jorge San Miguel*, *Jesus M Pintor*

This paper introduces the concepts of safety measures cost and environmental costs in the Capacitated Vehicle Routing Problem (CVRP). ALGACEA-3 tries to minimise delivery distances taking into account the increase of the cost due to safety measures and the externality cost due to pollution and noise. Finally, we solve the problem with the ALGACEA-3 procedure and compare the results with some classic heuristics. The ALGACEA-3 procedure makes use of the Monte Carlo techniques, the Entropy concept and the Clarke and Wright's savings function to solve the CVRP.

3 - A Scatter Search Procedure for the Split-Delivery Vehicle Routing Problem

Enrique Mota, Statistics Operations Research, University of Valencia, Fac. of Mathematics, Dr. Moliner, 50, 46100, Burjassot (Valencia), Spain, Enrique.Mota@uv.es, *Vicente Campos*, *Angel Corberan*

We present a heuristic procedure that provides feasible solutions for the Capacitated and Distance Constrained Vehicle Routing Problem, in the case in which the demand of any client can be serviced by more than one vehicle. In this case, it is possible sometimes to reduce the optimal solution cost, using the minimum number of vehicles needed. We construct a population of feasible solutions using standard heuristic methods, adapted for the split-delivery case, and devise procedures to combine them. Preliminary computational results are also provided.

■ ME-13

Monday, 16:00-17:30

TRANS Oddi 206

Optimization in liner shipping

Stream: Maritime Transportation

Invited session

Chair: *Kjetil Fagerholt*, Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred Getz vei 3, 7491, Trondheim, Norway, kjetil.fagerholt@iot.ntnu.no

1 - Revenue management for container liner shipping

Brian Kallehauge, Centre for Traffic and Transport, Technical University of Denmark, Building 115, 2800, Kgs. Lyngby, Denmark, bk@ctt.dtu.dk

In this talk we discuss the potential of using revenue management (RM) in container liner shipping. The structure of the RM problem in liner shipping is similar to airline network problems however there are also significant differences to airline RM. We give a review of the literature on RM for liner shipping which is somewhat limited, and present an overview of the models and solution methods applied to liner shipping RM problems. We conclude by discussing possible future lines of research in the area.

2 - Empty container repositioning in liner shipping

Frank Hennig, Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred getz veg 3, NO-7491, Trondheim, Norway, Frank.Hennig@iot.ntnu.no, *Bjørn Nygreen*, *Kjetil Fagerholt*, *Anette Bjerke*

Container liner shipping faces the challenges of liner shipping and container transport. An imbalance in cargo in- and outflow in many ports creates the need for empty container repositioning. Empty containers, unlike loaded ones, have no specific origin/destination pair. Thus they add more flexibility to the planning problem for loaded containers. Characteristics in shipping, e.g. in handling and transshipment, form the background for the problem. The presentation outlines the characteristics of container liner shipping and introduces an industrial case together with solution approaches.

3 - Mechanism Design for Sustainable Alliances among Sea Carriers

Richa Agarwal, Industrial And Systems Engineering, Georgia Institute of Technology, 1542 Woodlake Dr NE, Apt F, 30329, Atlanta, GA, United States, agaricha@gmail.com, *Ozlem Ergun*

Increasing pressure to provide better customer service and expanding markets are forcing different sea carriers to work in close liaisons and provide collaborative schedules on especially deep sea routes such as Asia-North America. Though working in collaboration these carriers follow their own self-interests. For example on collaborative routes the "resource", e.g. capacity on a ship, belongs to some carrier who does not allow other carriers to freely obtain "benefits" from it. We present membership mechanisms that allocate resources and benefits to carriers for forming sustainable alliances.

ME-14

Monday, 16:00-17:30

PROD Arnag 101

Call centers II

Stream: Operations Management / Revenue Management

Invited session

Chair: *Zeynep Aksin Karaesmen*, Graduate School of Business, Koc University, Rumeli Feneri Yolu, Sariyer, 34450, Istanbul, Turkey, zaksin@ku.edu.tr

1 - Efficiency Improvement in the Simulation of Call Centers

Pierre L'Écuyer, DIRO, Université de Montréal, C.P. 6123, Succ. Centre-Ville, H3C 3J7, Montreal, QC, Canada, lecuyer@IRO.UMontreal.CA, *Eric Buist*

Realistic models of call centers are too complicated to be solved by analytic formulas or numerical algorithms, leaving us with simulation as the only viable approach. But then, the stochastic noise in the estimator vanishes very slowly, asymptotically at speed $A^{-1/2}$ for a constant $A > 0$, as a function of the computing effort n . Good simulation strategies can reduce the value of A by reducing the variance. We examine variance reduction methods relevant to the simulation of call centers, discuss their implementation and combination, and provide empirical results.

2 - Improving the Hayward approximation for overflow models in call centers

Jean-Christophe Van den Schrieck, Louvain School of Management, Université catholique de Louvain, Place des doyens, 1, 1348, Louvain-la-Neuve, Belgium, vandenschrieck@poms.ucl.ac.be, *Philippe Chevalier*, *Jean-François Macq*

The Hayward approximation is well known and widely used to compute blocking probabilities in loss systems. There are nevertheless circumstances in which the approximation is not very precise. In this talk we examine the performance of the Hayward approximation for the computation of loss probabilities in call centers. We propose improvements that increase the accuracy of the computed loss probabilities.

3 - A New Modelling Paradigm for Bilingual Call Centres

David Stanford, Dept. of Statistical Actuarial Sciences, The University of Western Ontario, Wsc 262, 1151 Richmond Street N., N6A 5B7, London, Ontario, Canada, stanford@stats.uwo.ca, *Wayne Horn*

Bilingual call centre models considered by Stanford and Grassmann (1993, 2000) and Stanford, Horn and Latouche (2006) employ a system state that tracks the number of customers of each language group. The matrix-geometric solution requires an agent-allocation rule that is independent of the current level of the process (the number of waiting customers of a given language group). Ideally, one would want to allocate bilingual servers on the basis of the difference in these queue lengths. We present a new paradigm for the level and sub-level of the process in this paper allowing such allocations.

4 - Joint Flexibility and Capacity Design in Service Systems

Zeynep Aksin Karaesmen, Graduate School of Business, Koc University, Rumeli Feneri Yolu, Sariyer, 34450, Istanbul, Turkey, zaksin@ku.edu.tr, *Fikri Karaesmen*, *E. Lerzan Ormeci*, *Nesrin Cakan*

Multi-class call centers can be seen as service systems with flexibility. For systems with flexibility, the capacity optimization problem under uncertain demand is formulated as a two-stage stochastic optimization problem. The paper proposes a simulation-based optimization procedure for this problem using sample-path gradient estimation. The procedure is tested against a set of benchmark cases, and is used to explore the relationship between capacity and flexibility structure via numerical examples.

ME-15

Monday, 16:00-17:30

PROD Arnag 201

IT enabled supply-chain management

Stream: Supply Chain Management

Invited session

Chair: *Katerina Pramatarı*, Department of Management Science Technology, Athens University of Economics Business, 47A Evelpidon & 33 Lefkados Str., 11362, Athens, Greece, k.pramatari@aueb.gr

1 - Measuring Success of Supply Chain Information Systems Collaboration Practices in Retail

Cleopatra Bardaki, Management Science and Technology, Athens University of Economics and Business, 47A Evelpidon Str., 11362, Athens, Greece, cleobar@aueb.gr, *Lefteris Kioses*, *Dimitris Papakiriakopoulos*, *Katerina Pramatarı*, *Georgios Doukidis*

The paper discusses different aspects of employing information systems to support supply chain collaboration practices in retail and the measurement of their success. The first aspect deals with the evaluation of electronic marketplace services supporting supply chain collaboration. The second aspect discusses a case of extended supplier-retailer collaboration enabled by an e-business platform and its business impact. The third aspect examines the employment of artificial intelligence techniques in a collaborative information system identifying "out-of-shelf" situations.

2 - RFID Technology: Simulating the Impact on Supply Chain and Demand in Retail Industry

Cleopatra Bardaki, Management Science and Technology, Athens University of Economics and Business, 47A Evelpidon Str., 11362, Athens, Greece, cleobar@aueb.gr, *Aggeliki Karagiannaki*, *Katerina Pramatarı*, *Ioannis Mourtos*

This paper demonstrates the results of a simulation study evaluating the impact of RFID technology on overall supply chain measures. More specifically, the distribution centre (DC) operations of a 3PL company are simulated and the AS-IS scenario is compared with the TO-BE scenario after deployment of the RFID technology. The measures used in the evaluation include: the throughput, the time spent on "pick, pack & ship" match, DC labour productivity, level of claims and deductions for both retailers and manufacturers, and efficient product allocation in the backroom.

3 - Web Based Fleet Management DSS: A Case Study from Waste Recycling Industry

Panagiotis Repoussis, Management Science and Technology, Athens University of Economics and Business, 47A Evelpidon Street and 33 Lefkados Street, 113 62, Athens, Greece, panagiotis.repoussis@pathfinder.gr, *Christos Tarantilis*, *George Ioannou*

An internet based fleet management Decision Support System (DSS) that coordinates and disseminates tasks related to Waste Lube Oils collection and regeneration processes. The proposed DSS incorporates intra-city vehicle routing with real-life operational constraints utilizing sophisticated metaheuristic methodologies, while it encompasses strategic planning tools to control inventory and model service urgency. The application of the DSS to an actual industrial environment showed improved productivity and competitiveness, indicating its applicability on realistic reverse logistical problems.

4 - Dynamic Vehicle Dispatching with Time-Dependent Travel Times in Urban Settings

Vasileios Zeimpekis, Management Science Technology, Athens University of Economics Business, Patission 76, Athens, 10434, Athens, Greece, vzeimp@aueb.gr, *George Giaglis*, *Ioannis Minis*

This paper proposes a real-time fleet management system for dynamic incident handling in urban freight deliveries. The system monitors distribution vehicles in real-time and recommends intelligent re-routing interventions in case of vehicle delay or vehicle breakdown so that two objectives are met: minimization of delivery delays and maximization of number of served clients. The system was tested within real-life operations of two freight carriers in Greece and the results demonstrated reductions in time window violations and increases in the total number of served clients.

■ ME-16

Monday, 16:00-17:30

PROD Arnag 301

Scheduling: Novel Approaches

Stream: Scheduling

Invited session

Chair: *Johann Hurink*, Department of Mathematical Sciences, University of Twente, P.O. Box 217, 7500 AE, Enschede, Netherlands, j.l.hurink@utwente.nl

1 - Inverse Optimization in Scheduling

Natalia Shakhlevich, School of Computing, University of Leeds, LS2 9JT, Leeds, United Kingdom, ns@comp.leeds.ac.uk

A forward optimization problem consists in finding an optimal solution that minimizes a given objective function under an assumption that all input data are precisely known and fixed. In an inverse optimization problem, some typical parameters and a target solution are given. The objective is to modify the parameters as little as possible so that the target solution becomes optimal. In this presentation, we consider various types of inverse problems that arise in the scheduling context, establish the links with other optimization problems and suggest efficient algorithms for their solution.

2 - A Cyclic Approach to Large-Scale Short-Term Planning of Multipurpose Batch Plants

Christoph Schwindt, Institute of Management and Economics, Clausthal University of Technology, Julius-Albert-Str. 2, 38678, Clausthal-Zellerfeld, Germany, christoph.schwindt@tu-clausthal.de, *Norbert Trautmann*

The short-term planning problem of multipurpose batch plants can be decomposed into a batching and a batch-scheduling problem. The basic idea of the cyclic approach consists in reducing the size of the batch-scheduling problem by computing a cyclic sub-schedule, which is executed several times. The set of batches of one cycle is determined by solving a MINLP, which also provides the number of cycles needed to satisfy the primary requirements. The sub-schedule is then obtained by scheduling the batches on the processing units subject to material-availability and storage-capacity constraints.

3 - Efficiency of Local Search for some Scheduling Problems

Johann Hurink, Department of Mathematical Sciences, University of Twente, P.O. Box 217, 7500 AE, Enschede, Netherlands, j.l.hurink@utwente.nl, *Tobias Brueggemann*

Local Search methods are nowadays very popular solution methods for solving scheduling problems. In this talk we present some theoretical results on the worst case quality of solutions resulting from applying local search to some specific scheduling problems. Furthermore, we present for one scheduling problem some large scale neighborhoods and discuss their efficiency.

■ ME-17

Monday, 16:00-17:30

PROD Arnag 303

Production and Inventory III

Stream: Production and Inventory (c)

Invited session

Chair: *Thomas Archibald*, School of Management, University of Edinburgh, 50 George Square, EH8 9JY, Edinburgh, United Kingdom, T.Archibald@ed.ac.uk

1 - The optimum frequency of inventory plan updates to minimize growth of surplus inventory for low-demand, high-cost service parts in a multi-echelon network.

Deepak Bhatia, Service Parts Management, Applied Materials, 965 E El Camino Real, Apt 211, 94087, Sunnyvale, CA, United States, deepak_bhatia@amat.com, *Ted Noble*

We examine the effect of periodic inventory plan updates on the growth of surplus inventory for low-demand, high cost service parts. This is achieved by an iterative process of running discrete event simulation, capturing simulated demand and generating a new optimized inventory plan at a pre-specified frequency of inventory plan updates. The surplus inventory at the end of the (simulated) year is analyzed at different frequencies of plan changes. We conclude an optimum frequency of inventory plan updates to minimize the growth of surplus inventory for these parts.

2 - On The Attractiveness Of Sorting Before Disassembly In A Remanufacturing Facility

George Tagaras, Mechanical Engineering, Aristotle University of Thessaloniki, P.O. Box 461, 54124, Thessaloniki, Greece, tagaras@auth.gr, *Christos Zikopoulos*

We examine the attractiveness of simple but inaccurate sorting procedures just before disassembly and remanufacturing of used items. That type of quick sorting is often made possible through electronic devices implanted in products, which record usage data and provide information about the remanufacturability of the product without the need to dismantle it. We study a two-level reverse supply chain with remanufacturing in a single-period context with uncertainty about the remanufacturability of used products and we derive the conditions under which quick sorting is economically justifiable.

3 - Probabilistic Analysis Of A Robot System With Redundant Safety Units And Critical Failures

Balbir Dhillon, Mechanical Engineering, University of Ottawa, 770 King Edward Avenue, K1N 6N5, Ottawa, Ontario, Canada, dhillion@genie.uottawa.ca

This paper presents reliability and availability analyses of a model representing a system having one robot and n-redundant safety units with critical failures (common-cause failures). At least k safety units must function successfully for the robot system success. Markov and supplementary variable methods were used to perform mathematical analysis of this model. Generalized expressions for state probabilities, system availabilities, reliability, mean time to failure, and variance of time to failure are developed. Plots of some resulting expressions are shown.

4 - Index heuristics for transshipment decisions in multilocation inventory systems

Thomas Archibald, School of Management, University of Edinburgh, 50 George Square, EH8 9JY, Edinburgh, United Kingdom, T.Archibald@ed.ac.uk, Dan Black, Kevin Glazebrook

The use of transshipments is an important issue for the management of inventory systems in the retail sector. Many existing models restrict the timing of transshipments to simplify analysis. We propose a Markov decision process model that allows transshipments to occur at any time in response to stockouts. We develop solution methods for this model using dimensionality reduction techniques. We use simulation to demonstrate that, compared to simple transshipment policies commonly applied in practice, our approach can deliver significant savings in the cost of managing large systems.

ME-18

Monday, 16:00-17:30

PROD Arnag 304

Network Location Design

Stream: Locational Analysis

Invited session

Chair: *Mihiro Sasaki*, Dept. of Information Systems and Mathematical Sciences, Nanzan University, 27 Seirei, 489-0863, Seto, Aichi, Japan, mihiro@nanzan-u.ac.jp

1 - A Voronoi heuristic approach for hierarchical facility location problems on a network

Takehiro Furuta, Graduate School of Mathematical Sciences and Information Engineering, Nanzan University, 27 Seirei, 4890863, Seto, Aichi, Japan, takef@fw.ipsj.or.jp, *Mihiro Sasaki, Atsuo Suzuki*

FTPLP (the Facility and Transfer Points Location Problem) is one of the hierarchical facility location problems. In this study, we propose a heuristic algorithm based on a network Voronoi diagram to solve the minimax version as well as the minisum version of FTPLP. The network Voronoi diagram is a network version of the Voronoi diagram, which plays important roles in solving various network problems. Computational results using the benchmark data set for p-median problems provided by Beasley's OR-Library show that our algorithm efficiently solves FTPLP and its variations on a network.

2 - Reducing Travel Distance and Traffic Flow by Introducing Diagonal Roads into a Rectangular Lattice City

Tsutomu Suzuki, Faculty of Systems and Information Engineering, University of Tsukuba, 1-1-1 Tennodai, 305 8573, Tsukuba, Ibaraki, Japan, tsutomu@risk.tsukuba.ac.jp

We deal with the effect on travel distance reduction by diagonal roads introduced into a city that has a rectangular lattice road network. Diagonal roads can reduce mean travel distance by more than 10 percent, and also contribute to traffic relaxation by absorbing almost one third of whole traffic flow.

3 - Locating median paths of unbounded length on connected outerplanar graphs

Federica Ricca, University of Rome, P.le Aldo Moro, 5, 00185, Rome, Italy, federica.ricca@uniroma1.it, *Andrea Scozzari, Isabella Lari, Ronald I. Becker*

During the last two decades, there has been a growing interest in locating extensive facilities, such as paths, on networks. In this paper we study the median path problem of unbounded length on the class of connected outerplanar graphs with equal weights assigned to the edges and nonnegative weights associated to the vertices. We provide a $O(kn)$ time algorithm, where n is the number of vertices of the graph G and k is the number of blocks in G . As a byproduct, we provide a linear time algorithm to find a median path of any length between two fixed vertices in a biconnected outerplanar graph.

4 - Exact optimal solutions for hierarchical facility location problems on a network

Mihiro Sasaki, Dept. of Information Systems and Mathematical Sciences, Nanzan University, 27 Seirei, 489-0863, Seto, Aichi, Japan, mihiro@nanzan-u.ac.jp, *Takehiro Furuta, Atsuo Suzuki*

We consider hierarchical location problems called MLTP and FTPLP, where q facilities and p transfer points are located on a network and each customer goes to one of the facilities directly or via one of the transfer points. In FTPLP, the location of both facilities and transfer points should be optimized while the location of facilities is given in MLTP. Although good heuristics have been proposed for the minisum MLTP and FTPLP, no exact optimal solution has been computed due to the size of the problems. We present new formulations to solve the minisum version of the problems exactly.

ME-19

Monday, 16:00-17:30

PROD Arnag 311

Queueing Theory with Applications II

Stream: Queueing Theory with Applications

Invited session

Chair: *Douglas Down*, Computing and Software, McMaster University, 1280 Main Street West, L8S 4L7, Hamilton, Ontario, Canada, downd@mcmaster.ca

Chair: *Sunil Kumar*, Graduate School of Business, Stanford University, 518 Memorial Way, 94305, Stanford, California, United States, skumar@stanford.edu

1 - M/G/1/MLPS queue: mean delay analysis

Samuli Aalto, Networking Laboratory, Helsinki University of Technology, P.O.Box 3000, FIN-02015, Tkk, Finland, samuli.aalto@tkk.fi

We consider M/G/1 queues provided with MLPS scheduling disciplines. MLPS disciplines were originally introduced by L. Kleinrock, but they were forgotten for years. However, due to an application related to the service differentiation in the Internet, they have recently gained new interest. Many new results concerning the mean delay for such disciplines have been found, in particular within service time distribution classes DHR and IMRL. In this presentation we give an overview of these results and highlight the methods behind them.

2 - Heuristics for Allocation of Reconfigurable Resources in a Serial Line with Reliability Considerations

Mark Lewis, School of Operations Research and Industrial Engineering, Cornell University, 226 Rhodes Hall, 14853, Ithaca, NY, United States, mel47@cornell.edu, *Douglas Down*

We consider the allocation of reconfigurable resources in a serial line with machine failures. Each station is equipped with non-idling dedicated servers while the whole system is equipped with a finite number of reconfigurable servers that are available to be assigned to any station. We provide conditions for a policy to achieve throughput optimality and discuss heuristics based on the two-server model that reduce average holding costs significantly.

3 - Exploiting user flexibility in queueing systems

Douglas Down, Computing and Software, McMaster University, 1280 Main Street West, L8S 4L7, Hamilton, Ontario, Canada, downd@mcmaster.ca

We examine how if one accommodates user flexibility, then in many cases even if servers have limited flexibility, one can approach the performance of a system with completely flexible servers. We exploit and extend various extant results in heavy traffic limits for queues to support our observations.

■ ME-20

Monday, 16:00-17:30

HEUR Arnag 422

Applications of Variable Neighbourhood Search

Stream: Metaheuristics

Invited session

Chair: *Belen Melian Batista*, Estadística, I.O. y Computación, University of La Laguna, Astrofísico Sanchez s/n, Campus de Anchieta, 38271, La Laguna, Spain, mbmelian@ull.es

1 - Variable neighborhood search for the teacher/class timetabling problem

Yuri Kochetov, Operations Research Department, Sobolev Institute of Mathematics, pr. Akademika Koptyuga, 4, 630090, Novosibirsk, Russian Federation, jkochet@math.nsc.ru, *Polina Obuhovskaya*, *Mikhail Pashchenko*

We consider the well known NP-hard teacher/class timetabling problem. Variable neighborhood search and tabu search heuristics are developed to find near optimal solutions of this problem. The heuristics are based on two types of solution representation. For each of them we consider two families of neighborhoods. The first family applies swapping of time periods for one teacher (class) timetable. The second family uses the idea of large Lin-Kernighan neighborhoods. Computational results for difficult random test instances show high efficiency of the proposed approach.

2 - VNS heuristics for scheduling of patients in hospitals

Silvija Vlah, Faculty of Economics, Dept. of Mathematics, University of Zagreb, Trg J.F.Kennedy 6, 10000, Zagreb, Croatia, svlah@efzg.hr, *Zrinka Lukac*

We address the real world problem of scheduling resident patients in hospitals to certain treatments on a given day. Each treatment consists of different number of procedures performed in a prescribed sequence on a certain medical machine capacitated in terms of number of patients. Treatments have different levels of priority. Also, there are labor constraints in terms of doctors who perform the treatments. Exactly one doctor has to be assigned to each machine. Each doctor is skilled to perform treatments on several kinds of machines. We suggest VNS based heuristics to solve the problem.

3 - Stochastic model for locating health resources

Joaquín Pacheco, Applied Economy, University of Burgos, Olaza Infanta Elena s/n, 09001, Burgos, Spain, jpacheco@ubu.es, *Ada Alvarez*, *Silvia Casado*, *Jesús Alegre*

This work is aimed at finding the best locations in which to place health resources where patients with a diabetic coma can be attended. The main contributions are: to model the more realistic problem to minimize the expected value of the number of patients who suffer permanent damage, and to solve it for the specific situation of Burgos (Spain). We introduce the probability of a patient suffering a diabetic coma and the probability of a patient getting permanent damage. We compare three algorithms based in Scatter Search, Tabu Search and Variable Neighborhood Search.

■ ME-21

Monday, 16:00-17:30

HEUR Arnag 423

RAMP Algorithms for Hard Combinatorial Problems

Stream: Adaptive Memory Programming (AMP)

Invited session

Chair: *Cesar Rego*, School of Business Administration, University of Mississippi, University, 38677, Oxford, MS, United States, crego@bus.olemiss.edu

1 - RAMP for Very Large Multi-Resource Generalized Assignment Problems

Lutfu Sagbansua, Finance Banking Department, International Ataturk Alatau University, Tunguch Microregion, Gorky Street, 720048, Bishkek, Kyrgyzstan, lutfusagbansua@hotmail.com, *Cesar Rego*, *Fred Glover*

The Multi-Resource Generalized Assignment Problem (MRGAP) is an important and recognizably difficult problem in combinatorial optimization with a broad range of applications. It is a generalization of the classical GAP when more than one type of resources are used. A RAMP algorithm is proposed for the solution of the MRGAP. Computational experiments on a standard testbed show that RAMP yields results dominating the performance of the previously best methods. For larger and more difficult problems, RAMP is also extremely efficient in finding optimal and near-optimal solutions.

2 - Advances on Primal-Dual RAMP for Linear Ordering Problems

Dorabela Gamboa, Instituto Politecnico do Porto (ESTGF/IPP), Casa do Curral, Rua do Curral, Apt. 205, 4610-156, Felgueiras, Portugal, dgamboa@estgf.ipp.pt, *Cesar Rego*, *Fred Glover*

This paper concerns the Linear Ordering Problem (LOP) and proposes a RAMP algorithm to solve this problem efficiently and effectively. The algorithm explores primal-dual relationships by appropriately combining "restricted" with "relaxation" procedures under the RAMP framework. The quality of the results carried out on a standard testbed shows that the RAMP approach clearly outperforms all state-of-the-art algorithms for the LOP. In addition, the algorithm discloses 58 new best solutions for the 175 instances in the tested for which the optimal solution is not known.

3 - A Primal-Dual RAMP Algorithm for Very Large Set Covering Problems

Jose Humberto Ablanado Rosas, University of Mississippi, School of Business Administration, 8 County Road 3077, 38655, Oxford, MS, United States, jablanedo@bus.olemiss.edu, *Cesar Rego*, *Fred Glover*

The Set Covering Problem (SCP) is a classical combinatorial problem used to model a wide range of applications such as airline and railway crew scheduling, political districting, and truck routing. We present a Primal-Dual RAMP algorithm based on scatter search and surrogate constraint relaxations yielding exceedingly good results for very large SCPs.

■ ME-22

Monday, 16:00-17:30

OPT Adal 050

Multiobjective Combinatorial Optimization II

Stream: Multiple Objective Optimization

Invited session

Chair: *Matthias Ehrgott*, Engineering Science, University of Auckland, Private Bag 92019, 1001, Auckland, New Zealand, m.ehrgott@auckland.ac.nz

1 - Combinatorial optimization problems with random costs

Subhash Narula, School of Business, Virginia Commonwealth University, 1015 Floyd Avenue., Box 844000, 23284-4000, Richmond, Virginia, United States, snarula@vcu.edu, *Paolo Serafini*

We consider the extension of the previous definition when costs are represented by random variables. The problem is inherently bi-objective because we want to minimize the cost and the risk simultaneously. The risk is modeled on the variance of the random variable and we need to find solutions with minimum mean and variance. The problem of computing efficient solutions is difficult in general. However, if the costs are normally distributed, it is not harder to compute efficient solutions than computing optima with fixed costs.

2 - Multiobjective Mixed-integer Stackelberg Games

Ted Ralphs, Industrial and Systems Engineering, Lehigh University, 200 West Packer Avenue, 18015, Bethlehem, PA, United States, tkralphs@lehigh.edu, *Scott DeNegre*

We consider a mixed-integer, zero-sum, static Stackelberg game. Using a multiobjective version of this game, we examine resource tradeoffs for the leader. We describe methods for generating the set of Pareto solutions to a biobjective game by solving a sequence of mixed-integer bilevel programs with weighted Chebyshev objective function.

3 - MEMOTS: a Memetic Algorithm Integrating Tabu Search for Multiobjective Combinatorial Optimization

Jacques Teghem, Service de Mathématique et recherche opérationnelle, Faculté Polytechnique de Mons, Rue de Houdain, 9, B-7000, Mons, Belgium, Jacques.Teghem@fpms.ac.be, *Thibaut Lust*

MEMOTS is a memetic method to approximate the set of efficient solutions of MOCO problems. At each offspring MEMOTS applies an original multiobjective Tabu Search to intensify the research. There is no use of any aggregation function. Applied on the multidimensional Knapsack problem, MEMOTS outperforms the MOGLS method.

4 - Column Generation in Multiobjective Integer Programming

Matthias Ehrgott, Engineering Science, University of Auckland, Private Bag 92019, 1001, Auckland, New Zealand, m.ehrgott@auckland.ac.nz, *Jørgen Tind*

In multiobjective integer programming it is of importance to limit the number of columns introduced in the integer programming problem, because usually multiple alternative efficient solutions are required. This paper presents a column generation scheme for integer programming, incorporating the two major algorithmic approaches in integer programming, branch and bound as well as cutting planes. The suggested scheme gives additional dual information that limits the work required to move among the alternatives to be generated.

ME-23

Monday, 16:00-17:30

OPT Adal 051

Approximating Connectivity Problems

Stream: Approximation Algorithms

Invited session

Chair: *Marek Karpinski*, Department of Computer Science, University of Bonn, Roemerstr. 164, 53117, Bonn, Germany, marek@cs.uni-bonn.de

1 - Delegate and Conquer: An LP-based approximation algorithm for Minimum Degree MST

R Ravi, Tepper School of Business, Carnegie Mellon University, 5000 Forbes Avenue, 15217, Pittsburgh, PA, United States, ravi@andrew.cmu.edu

In this paper, we study the minimum degree minimum spanning tree problem: Given an undirected graph and a non-negative cost function c on the edges, the objective is to find a minimum cost spanning tree under the given cost function (MST) such that the maximum degree of any node in the tree is minimized.

We obtain an algorithm which returns a MST of maximum degree at most $\text{OPT} + k$, where OPT is the minimum maximum degree of any MST and k is the distinct number of costs in any MST of the graph. We use a lower bound given by a linear programming relaxation to the problem and strengthen known graph-theoretic results on minimum degree subgraphs to prove our result. Previous results for the problem used a combinatorial lower bound which is weaker than the LP bound we use.

2 - The k-Path Tree Matroid and its Applications to Survivable Network Design

Refael Hassin, Statistics, Tel Aviv University, Ramat Aviv, 69978, Tel Aviv, Israel, hassin@post.tau.ac.il, *Esther Arkin*

We define the k -path tree matroid, and use it to solve network design problems in which the required connectivity is arbitrary for a given pair of nodes, and 1 for the other pairs. We solve the problems for undirected and directed graphs. We then use these exact algorithms to give improved approximation algorithms for problems in which the weights satisfy the triangle inequality and the connectivity requirement is either 2 among at most five nodes and 1 for the other nodes, or it is 3 among a set of three nodes and 1 for all other nodes.

3 - Min Power and Min-Cost Vertex Connectivity Problems

Guy Kortsarz, Department of Computer Science, Rutgers University, 322 BSB, 227 Penn Street, 08102, Camden, NJ, United States, guyk@crab.rutgers.edu

Graph connectivity optimization problems have costs on edges and it is required to find a minimum cost subgraph G' subject to some connectivity constraints among vertex pairs. The cost of G' is the sum of the costs of its edges.

A different model is the min-power model. The power of a vertex v in G' is the cost of the heaviest edge touching v in G' . The power of the graph G' is the sum of powers of the vertices in G' .

We compare the two costs measures on several vertex connectivity problems.

The talk is a survey talk in nature and presents results from various papers

4 - Simple reductions for approximate vertex cover on random graphs

Eyolfur Asgeirsson, Dept. of IEOR, Columbia University, 500 West 120th Street, Rm. 313 S.W. Mudd Building, 10027, New York, NY, United States, eyjo@leppur.net, *Clifford Stein*

The vertex cover problem is a classic NP-complete problem for which the best worst-case approximation ratio is roughly 2. We use a collection of simple reductions, each of which guarantees an approximation ratio of $3/2$, to find approximate vertex cover on randomly generated graphs. These reductions are extremely fast and even though they, by themselves are not guaranteed to find a vertex cover, we have managed to find a $3/2$ -approximate vertex cover for every single random graph that we have tested.

ME-24

Monday, 16:00-17:30

OPT Adal 052

Modeling and Simulation of Dynamical and Anticipatory Systems

Stream: Dynamical and Anticipatory Systems

Invited session

Chair: *Antonio Mascia*, Industry, Euro View Services, 273 Chaussee de Lodelinsart, 6060, Gilly, Hainout, Belgium, management@euro-view.com

Chair: *Stig C Holmberg*, Information Technology and Media, Mid Sweden University, Mid Sweden University, Itm - Q351, 83125, Östersund, Sweden, shbg@ieee.org

1 - M2-STAR Software for the Simulation of Management Models with Anticipation and Retardation

Daniel M. Dubois, UER Operations, HEC Management School - University of Liege, Office: Institute of Mathematics, B37, Grande Traverse 12., B-4000, Liège, Belgium, daniel.dubois@ulg.ac.be, *Stig C Holmberg*

A software, Multi-Level Management Support Simulation Tool with Anticipation and Retardation (M2-STAR), was designed to simulate dynamical and anticipatory models of management. M2-STAR is open source so everyone will be able to change and improve the models. M2-STAR is continuously developed and run with free and commonly available development and run-time environments. M2-STAR is a web-application based on an Apache 3 web server and with PHP 4 as programming language. An experimental version can be accessed at <http://www.c8systems.com/mad/start.html>, with an example of model.

2 - Using invariants to change detection in dynamical system with chaos

Mateusz Tykierko, The Institute of Computer Engineering, Control and Robotics, Wrocław University of Technology, ul. Wybrzeże Wyspińskiego 27, 50-372, Wrocław, Poland, mateusz.tykierko@pwr.wroc.pl

There are good established methods for linear and nonlinear systems, but there is a lack of methods considering chaos. The paper presents change detection techniques for dynamical systems with chaos. We consider dynamical system described by time series originated from ODE and real phenomena such as computer networks. The process of change detection is based on chaos characteristic parameters such as fractional dimension. Changes in value of this invariants is the indicator of change. Methods are checked against small data set and stream data. Fast estimation algorithms are presented.

3 - Design of a Generator and Simulator of Sequential Operations in Discrete Dynamical Systems

Antonio Mascia, Industry, Euro View Services, 273 Chaussee de Lodelinsart, 6060, Gilly, Hainout, Belgium, management@euro-view.com, *Daniel M. Dubois*

This paper deals with a general method for the analysis and the logical generation of discrete systems. The Boolean operators are implemented with a generic and unique algebraic model as event-dependent discrete equations which can be executed in a sequential order. With this method, a generator of sequential logical tables can be designed, simulated and executed for implementing discrete dynamical systems. The purpose of this research is to design a universal generator of sequential operations which automatically checks the logic of the implemented discrete dynamical systems.

■ ME-25

Monday, 16:00-17:30

OPT Adal I-111

Reformulations and Relaxation Techniques

Stream: Mathematical Programming

Invited session

Chair: *Leo Liberti*, Lix, Ecole Polytechnique, LIX, Ecole Polytechnique, F-91128, Palaiseau, France, leoliberti@yahoo.com

Chair: *Nenad Mladenovic*, School of Mathematics, Brunel University, Kingston Lane, UB8 3PH, Uxbridge, Middlesex, United Kingdom, Nenad.Mladenovic@brunel.ac.uk

1 - Convex Quadratic Reformulation for Exact Solution of 0-1 Quadratic Programs

Marie-Christine Plateau, CEDRIC, CNAM, 292 rue Saint Martin, 75003, Paris, France, mc.plateau@cnam.fr, *Sourour Elloumi*, *Alain Billionnet*

We recall our general exact solution method (QCR) for linearly-constrained 0-1 quadratic programs. It uses the equality constraints in order to reformulate the objective function by an equivalent quadratic convex function. The best reformulation from the LP-relaxation point of view lies on semidefinite programming. In this communication, we present an application of this method to the densest k -subgraph problem and we give a comparison with other reformulations method. Experimental results show that, for this problem, the approach outperforms existing methods.

2 - Canonicalizing disciplined convex programs

Michael Grant, Electrical Engineering, Stanford University, 1025 Windsor Drive, 94025, Menlo Park, CA, United States, mcgrant@stanford.edu, *Stephen Boyd*

Disciplined Convex Programming is a methodology for convex optimization that provides considerable opportunity for automation. In this talk we explore the process of converting disciplined convex programs to a solvable canonical form, including the handling of nondifferentiable functions, and the exploitation of structure for improved performance.

3 - Automatic construction of tight convex relaxations for quadratic MINLPs

Leo Liberti, LIX, Ecole Polytechnique, LIX, Ecole Polytechnique, F-91128, Palaiseau, France, leoliberti@yahoo.com

We present an algorithmic procedure for constructing tight convex relaxations of mixed-integer nonlinear programming problems involving quadratic terms and linear equation constraints, which we then use within a Branch-and-Bound framework. The main merit of this method is that it is completely automatic and applicable to a very general class of mathematical programming formulations. Our comparative computational results, obtained on several classes of problems show that our method improves the Branch-and-Bound performance dramatically.

4 - Stochastic formulation space search methods

Nenad Mladenovic, School of Mathematics, Brunel University, Kingston Lane, UB8 3PH, Uxbridge, Middlesex, United Kingdom, Nenad.Mladenovic@brunel.ac.uk

The basic idea of a recent new approach for solving optimization problems, called Formulation Space Search (FSS), is to search for a better solution not only through solution space but also through formulation space. Systematic search is performed for a formulation-solution pair (f,x) in (F,S) either by changing formulation or by changing solution; F is supplied with some distance function and associated neighborhoods. Different variants of such approach are possible. In this paper we develop a basic stochastic variants of FSS: Monte-Carlo and Random walk heuristics for searching through F .

■ ME-26

Monday, 16:00-17:30

OPT Adal III=231

Advances in Integer Programming

Stream: Combinatorial Optimization

Invited session

Chair: *Andrea Lodi*, D.e.i.s., University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, alodi@deis.unibo.it

Chair: *Silvano Martello*, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, smartello@deis.unibo.it

1 - On the integrality gap for a survivable network design problem

Sylvia Boyd, S.I.T.E., University of Ottawa, 800 King Edward Ave., K1N 6N5, Ottawa, Ontario, Canada, sylvia@site.uottawa.ca, *Tony Alexander*, *Paul Elliott-Magwood*

In this paper we study the problem of designing a minimum cost communication network for n centers which can withstand single-link failures, also known as the 2-edge connected subgraph problem (2EC). One direction which seems promising for finding improved solutions for 2EC is the study of its LP relaxation. We examine the integrality gap (i.e. worst-case ratio) k between 2EC and its LP relaxation. Finding the exact value for k is difficult even for small values of n due to the exponential size of the data involved. We describe how we were able obtain k for all n up to 10.

2 - Elementary Closures and the Integer Hull

Egon Balas, Tepper School of Business, Carnegie Mellon University, 15213, Pittsburgh, PA, United States, eb17@andrew.cmu.edu, *Anureet Saxena*

A number of different cutting plane procedures, if applied recursively to the linear programming relaxation P of a mixed integer program, yields the integer hull in a finite number of iterations. The first iteration of such a procedure is known as the elementary closure of P with respect to the given family of cuts. We compare the strength of several elementary closures and find that some of them, on some important problem classes, come surprisingly close to describing the integer hull.

3 - Exploiting Planarity in Separation Routines for the TSP

Adam Letchford, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX,

Lancaster, Lancashire, United Kingdom,
a.n.letchford@lancaster.ac.uk, *Nicholas Pearson*

The main reason for the success of branch-and-cut at solving the TSP is the availability of effective separation procedures; that is, routines for identifying violated linear constraints. For the comb and domino-parity constraints, it has been shown that separation becomes easier when the underlying graph is planar. We continue this line of research by showing how to exploit planarity in the separation of three other classes of constraints: subtour elimination, 2-matching and simple domino-parity constraints. The resulting separation routines are remarkably fast in both theory and practice.

■ ME-27

Monday, 16:00-17:30

OPT Adal V=229

Optimization Software Systems

Stream: Software for OR/MS

Invited session

Chair: *Robert Fourer*, Industrial Engineering and Management Sciences, Northwestern University, 2145 Sheridan Road, 60208-3119, Evanston, IL, United States, 4er@iems.northwestern.edu

1 - Model Views - A Concept for OR Model Visualization

Matthias Buchs, Departement of Informatics, University of Fribourg, Boulevard de Pérolles 90, 1700, Fribourg, Switzerland, matthias.buchs@unifr.ch, *Pius Haettenschwiler*

Although mathematical modeling systems have become powerful for model creation, solving, debugging and data visualization, visual analysis and navigation of models is still not very developed. Graphical representation of the modeled knowledge should support better communication between domain experts, modelers and model users. This paper introduces a formal concept for visualizing OR models. Braking down model views into filters, sorts and layouts will simplify implementations of powerful model browsers. Additionally, restoring and exchange of specified views will be eased.

2 - Production campaign planning by OM Partners

Arie Quist, OM Partners N.V., Koralenhoeve 23, B-2160, Wommelgem, Belgium, aquist@ompartners.com

After a short general introduction to OM Partners we give a description of production campaign planning, and the associated planning issues. Insight is provided in the practical experience we have gained in solving these planning problems using our supply chain planning and optimization software.

3 - Generating Optimization Applications Automatically from Model Structure

Greger Ottosson, ILOG, 1681 Route de Dolines, Les Taissounieres HB2, 06560, Valbonne, France, gottosson@ilog.com, *Gregory Glockner*

The connector between ILOG OPL and ODM allows push-button generation of a customizable ODM application from the structure of an OPL model. The OPL model is not embedded as a black box. On the contrary, the model's structure (data, constraints, objective functions) results in interactive displays of ODM input data, solution views, business goals and relaxable constraints. We discuss how these business concepts are mapped to the underlying mathematical elements, during development and at runtime.

■ ME-28

Monday, 16:00-17:30

OPT Adal VI=207

Optimization and Data Mining I

Stream: Linear Optimization

Invited session

Chair: *Marcello Sanguineti*, DIST, University of Genoa, Via Opera Pia, 13, 16145, Genova, Italy, marcello@dist.unige.it

1 - Generalized kernel principal component analysis

Carlos Alzate, Departement Elektrotechniek - ESAT-SCD-SISTA, Katholieke Universiteit Leuven, Kasteelpark Arenberg 10, 3001, Leuven, Belgium, carlos.alzate@esat.kuleuven.ac.be, *Johan Suykens*

Starting from the Least Squares Support Vector Machine formulation to KPCA, we extend it to a generalized form in which the underlying loss function, regularization, and primal/dual aspects are explicit in an optimization context. In this generalized form, one can use different loss functions to achieve desirable properties such as robustness and sparseness. These two properties are missing in classical KPCA. A robust sparse loss function was used; simulation results show significant improvements compared with classical KPCA in the sense of robustness together with a sparse representation.

2 - Learning from multidimensional data

Mikhail Belkin, Computer Science and Engineering, The Ohio State University, 395 Drees Laboratories, 2015 Neil Avenue, 43210-1277, Columbus, Ohio, United States, mbelkin@cse.ohio-state.edu

I will discuss a framework for learning from data sampled from a probability distribution in high-dimensional space, using penalty functionals defined intrinsically in terms of these distributions. In particular, I will discuss algorithms for semi-supervised learning and clustering, and some theoretical guarantees for these methods.

3 - Spectral methods for regularization in learning theory

Alessandro Verri, DISI, University of Genoa, Via Dodecaneso 35, 16146, Genova, Italy, verri@disi.unige.it

We show that a large class of regularization methods for ill-posed inverse problems originates consistent learning algorithms. The intuition is that looking at regularization from a filter function perspective, filtering out undesired components of the target function ensures stability with respect to random sampling, inducing generalization properties. We present a derivation of the methods by recalling that learning can be written as inversion of a linear embedding equation given a stochastic discretization. Consistency and finite sample bounds are derived for regression and classification.

■ ME-29

Monday, 16:00-17:30

OPT Adal VII=225

Applications of Optimization

Stream: Global Optimization: Deterministic and Stochastic Methods

Invited session

Chair: *Graham Wood*, Department of Statistics, Macquarie University, North Ryde, 2109, Sydney, NSW, Australia, gwood@efs.mq.edu.au

1 - Optimisation, the EM algorithm and a problem in genetics.

Sigurbjorg Gudlaugsdottir, Department of Statistics, Macquarie University, North Ryde, 2109, Sydney, NSW, Australia, sgudlaug@efs.mq.edu.au

The EM (Expectation-Maximization) algorithm is a local optimisation procedure that is widely used to estimate the parameters of a statistical mixture model. We outline the application of a "one step late" version of the algorithm to genetic data. For this problem the density functions of the underlying mixture are completely specified and the loglikelihood function is four-dimensional.

We use slices through the loglikelihood surface to check that the EM algorithm has converged to the global maximum. Geometric insight into the operation of the EM algorithm will be given.

2 - Global optimisation in the quantum future

David Bulger, Department of Statistics, Macquarie University, North Ryde, 2109, Sydney, NSW, Australia, dbulger@efs.mq.edu.au

Quantum information theory studies how the counter-intuitive laws of quantum physics could be used to process data in ways fundamentally different to today's computers. This talk gives an overview of quantum computation, looking specifically at implications for optimisation. In particular, recent work by the speaker shows how a quantum computational variant of the Newton-Raphson minimisation method can be implemented much more efficiently than on a modern computer, while largely circumventing the method's stability problems.

3 - Optimal animal nutrition

Graham Wood, Department of Statistics, Macquarie University, North Ryde, 2109, Sydney, NSW, Australia, gwood@efs.mq.edu.au, *Patrick Morel*, *Duangdaw Sirisatien*

Linear programming has long been used to find minimum cost animal diets, typically in chicken and pig production. A bigger problem is the finding of feeding schedules which maximise profitability at market, simultaneously minimising feed cost and maximising gross return. The development in recent years of accurate animal growth models and nonlinear optimisation techniques makes this soluble. The problem is described, a solution presented and the nature of the objective function explored. Recent work on the development of an efficient optimisation method for this problem will be discussed.

ME-30

Monday, 16:00-17:30

NONL Adal X=220

Linear Semi-Infinite Optimization III

Stream: Linear Semi-Infinite Optimization

Invited session

Chair: *Maxim Todorov*, Dpto. de Física y Matemáticas, Universidad de las Américas, Sta. Catarina Martir, 72820, Cholula, Puebla, Mexico, maxim.todorov@udlap.mx

1 - Linear Inequality Systems with Smooth Coefficients

Lidia-Aurora Hernandez-Rebollar, Facultad de Ciencias Fisico Matematicas, Universidad Autonoma de Puebla, Av. San Claudio y Rio Verde, C. U. Col. San Manuel, 72570, Puebla, Mexico, lidiahr06@hotmail.com, *Miguel Goberna*, *Maxim Todorov*

A linear inequality system with infinitely many constraints is polynomial (analytical) if its index set is a compact interval of the real line and all its coefficients are polynomial (analytical) functions of the index on this interval. This work provides sufficient conditions for a given closed convex set to be the solution set of a certain polynomial or at least analytical system and an example of analytical system whose solution set cannot be the solution set of any polynomial system.

2 - On Explicit Optimality Conditions for Convex Semi Infinite Programming Problems

Olga Kostyukova, Institute of Mathematics, Belarusian National Academy of Sciences, Surganov str. 11, 220072, Minsk, Belarus, kostyukova@im.bas-net.by, *Tatiana Tchemisova*

We consider a Convex SIP problem with continuum of constraints. On the base of new concepts of immobile points of the constraint's index set and the correspondent immobility orders the Implicit Optimality Criterion was introduced in (Kost-Tchem, 2005). We show how this Criterion can be used to obtain the new explicit optimality conditions for convex SIP problems that, in general, do not satisfy any regularity condition.

3 - Accurate approximation of linear semi-infinite programs

Sven-Ake Gustafson, Mathematics and Science, University of Stavanger, Ullandhaug, 4036, Stavanger, Norway, sven-aake.gustafson@uis.no

We consider linear semi-infinite programs where the index-set is a closed and bounded real interval. Discretisation means that the index set is replaced by a finite grid. The resulting error may be represented as the result of linear interpolation at the grid-points. We propose to use interpolation by means of piecewise cubic polynomials giving a much smaller error in the situation when the semi-infinite program is defined by functions having at least four continuous derivatives.

ME-31

Monday, 16:00-17:30

NONL Adal XI=222

OD(A)E- and PD(A)E-Constrained Optimization II

Stream: Industrial Application of Nonlinear Programming Algorithms

Invited session

Chair: *Hans Josef Pesch*, Department of Mathematics, University of Bayreuth, Chair of Mathematics in Engineering Sciences, 95440, Bayreuth, Germany, hans-josef.pesch@uni-bayreuth.de

1 - Preventing Hot Cracking in Laser Beam Welding by Optimization

Verena Petzet, Department of Mathematics, University of Bayreuth, Universitätsstr. 30, D-95440, Bayreuth, Germany, verena.petzet@uni-bayreuth.de, *Hans Josef Pesch*

Hot cracks are one of the severe problems in laser beam welding. By the multi-beam technique hot cracking can be eliminated. In order to improve this technique a mechanical 1D and thermal 2D optimization model has been investigated. This model describes the process of hot crack initiation quite well. But to get more realistic results the optimization model is extended by the temperature dependence of the coefficient in the heat equation and a better approximation of the area-specific heat flux density. A future task will be to formulate the mechanical effects in more detail.

2 - Optimal Boundary Control of the Wave Equation

Martin Gugat, Institute of Applied Mathematics, University of Erlangen-Nuremberg, Martensstr. 3, 91058, Erlangen, Germany, gugat@am.uni-erlangen.de

We consider a system governed by the wave equation with controls acting through Dirichlet boundary conditions. The aim is to control the system exactly to rest in a given finite time. We address questions of controllability: How much time is needed to assure that all possible initial states can be controlled to rest in this time? For the corresponding optimal control problem where the control norm is minimized we construct optimal solutions with respect to various norms. See M. Gugat: Optimal boundary control of a string to rest in finite time with continuous state, ZAMM 86, 134-150, 2006.

3 - Optimal control of laser material treatments

Dietmar Hoemberg, Weierstrass Institute for Applied Analysis and Stochastics, Mohrenstrasse 39, 10117, Berlin, Germany, hoemberg@wias-berlin.de

In most structural components in mechanical engineering, there are surface parts, which are particularly stressed. The aim of surface hardening is to increase the hardness of the corresponding boundary layers by changing its microstructure through rapid heating and subsequent quenching.

In my talk I will discuss a mathematical model for laser and electron beam hardening. I will formulate the heat treatment task in terms of an optimal control problem, show some numerical results and demonstrate how the results can be used for a machine-based process control.

■ ME-32

Monday, 16:00-17:30

NONL Adal XIII=218

Geometrical Topics in Convex Optimization

Stream: Convex Optimization Methods

Invited session

Chair: *Jérôme Bolte*, 4 Place Jussieu, Case 189, UFR 929, Université Paris 6, Equipe Combinatoire et Optimisation, 75252, Paris (Cedex), France, bolte@math.jussieu.fr

1 - Legendre functions on affine subspaces

Felipe Alvarez, Departamento de Ingeniería Matemática, Universidad de Chile, Av. Blanco Encalada 2120, 8370459, Santiago, Chile, falvarez@dim.uchile.cl

The gradient of a Legendre convex function is a continuous one-to-one mapping on its domain, named the "Legendre transform coordinates mapping". The applications of Legendre functions theory range from Hamiltonian mechanics to mathematical programming. We discuss Legendre functions restricted to affine subspaces and show how to extend some basic properties of the classical theory. We also give some applications to a general class of penalty/barrier methods for polyhedral constraints. These results extend a work by Bayer and Lagarias about the logarithmic barrier in linear programming.

2 - On convex and polyconvex $SO(n) \times SO(n)$ - invariant functions

Pierre Maréchal, Mathématiques, Université Paul Sabatier, Toulouse, 118 route de Narbonne, 31 062, Toulouse, France, marechal@mip.ups-tlse.fr

We shall discuss the convexity and polyconvexity of functions which are $SO(n)*SO(n)$ -invariant. An $SO(n)*SO(n)$ -invariant function is lsc and convex iff its restriction to the subspace of diagonal matrices is lsc and convex. This was established by Dacorogna-Koshigoe in the case $n=2$ and by Vincent in the general case as a consequence of a theorem of Kostant. We prove that this result is a consequence of an extension of Von Neumann's trace inequality. Similar results are obtained for polyconvex functions, these results being motivated by their application to the calculus of variations.

3 - Geometrical interpretation of the predictor-corrector type algorithms in structured optimization problems

Aris Daniilidis, Mathematics, C1/320, Universitat Autònoma de Barcelona, Bellaterra, Campus UAB, 08193, Barcelona, Spain, adaniilidis@idea.uab.es

In many optimization problems nonsmooth objective functions often appear smooth on naturally arising manifolds. This led to the development of optimization algorithms which exploit this smoothness. Many of these algorithms follow the same two step pattern: first predict a direction of decrease, and second make a correction step to return to the manifold. We examine the theoretical components in such predictor-corrector methods when the function is both prox-regular and partly smooth. We develop sufficient conditions for quadratic convergence using a proximal point correction step.

■ ME-33

Monday, 16:00-17:30

NONL Adal A=313

PANEL: Nonlinear Systems Modeling and Optimization: State-of-Art and Perspectives

Stream: Global Optimization: Software and Applications

Invited session

Chair: *Janos D. Pinter*, PCS Inc. Dalhousie University, 129 Glenforest Drive, B3M 1J2, Halifax, NS, Canada, jdpinter@hfx.eastlink.ca

1 - PANEL: Nonlinear Systems Modeling and Optimization: State-of-Art and Perspectives

Kenneth Holmström, Mathematics and Physics, Mälardalen University, P.O. Box 883, SE-72123, Västerås, Sweden, kenneth.holmstrom@mdh.se, *Leon Lasdon*, *Janos D. Pinter*, *Klaus Schittkowski*, *Tamas Terlaky*

Nonlinearity is a key characteristic of a vast range of objects, formations and processes in nature and in society. Consequently, nonlinear descriptive models are relevant in many areas of the sciences and engineering. Managing nonlinear systems leads to nonlinear optimization - a subject that has been of great practical interest for a long time. This panel session offers an interactive discussion of the state-of-the-art, with an emphasis on the practice and perspectives of nonlinear systems modeling and optimization.

■ ME-34

Monday, 16:00-17:30

DEC VR11 V-138

Systems Theory

Stream: Systems and Game Theory

Invited session

Chair: *Alberto A. Pinto*, Pure Mathematics, Faculdade de Ciências da Universidade do Porto, Rua do Campo Alegre, 687, 4169-007, Porto, Portugal, aapinto@fc.up.pt

1 - Integration Of Biofuels In The Optimal Production Planning Of Energy Production Systems

Metin Turkyay, Department of Industrial Engineering, Koc University, Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey, mturkyay@ku.edu.tr, *Ahu Soyulu*

Energy sector is a high-cost and high-emission sector. The energy sector must find new solutions continuously to decrease emissions while satisfying the energy demand under demanding environmental regulations. We had shown in our previous studies that collaboration among energy systems can create synergy both in environmental and economical criteria. This paper presents an analysis of the expected gains in a collaborative setting with an environmentally friendly fuel alternative, biodiesel.

2 - Leadership and flexibility advantages on a Bayesian duopoly

Fernanda A. Ferreira, Mathematics, ESEIG - Instituto Politécnico do Porto, R. D. Sancho I, 981, 4480-876, Vila do Conde, Portugal, fernandaamelia@eseig.ipp.pt, *Flávio Ferreira*, *Alberto A. Pinto*

We consider a dynamic model of duopoly in which a leader firm moves first and a follower firm moves second, supposing that there is asymmetric demand information owned by first and second movers. When the leading firms makes its choice, it does not know the exact demand, but only its distribution. Furthermore, we let the firms produce a differentiated good. The firm that moves first has the leadership advantage, but the firm that moves second has an informational advantage. We compare the advantages of leadership and flexibility, that depend upon the degree of differentiability.

3 - Edgeworthian Economies

Bruno M.P.M. Oliveira, FCNAUP, R. Dr. Roberto Frias, 4200-465, Porto, Portugal, bmpmo@fcna.up.pt, *Alberto A. Pinto*, *Miguel Ferreira*

We present a modified model of an Edgeworthian exchange economy where two goods are traded in a market place. The novelty of our model is that we associate a greediness factor to each participant which brings up a game like the prisoner's dilemma into the usual Edgeworth exchange economy. We also consider two distinct evolution rules of the greediness of the participants along the trades: they become either more or less greedy if they trade more. We analyse the effect of the evolution rules in the individual greediness factors and in the values of the utilities. Joint with B.F. Finkenstadt.

4 - On the Semivalues and the Shapley value for cooperative TU games

Irinel Dragan, Mathematics, University of Texas, 411 S.Nedderman Dr., Pickard Hall, Arlington, Texas, United States, dragan@uta.edu

In the present paper, we prove that any Semivalue is the Shapley value of a game easily obtained from the given game. To do this we use our Average per capita formula for Semivalues, (I.Dragan, 1999), to derive an average per capita formula for the efficient normalization of a Semivalue, to be compared with the formula for the Shapley value, then the linearity of the Shapley value is used. Based upon the relationship between a Semivalue and the Shapley value of the derived game, one can compute the Semivalues by using any algorithm for computing the Shapley value.

■ ME-35

Monday, 16:00-17:30

DEC VR II V-147

Problem Structuring and Confrontation Management

Stream: Problem Structuring Methods / Soft OR
Invited session

Chair: *Jim Bryant*, Faculty of Organisation & Management, Sheffield Hallam University, City Campus, Sheffield, United Kingdom, J.W.Bryant@shu.ac.uk

1 - A Graph Model Analysis of the Burnt Church Conflict

Marc Kilgour, MATH / LCMSDS, Wilfrid Laurier University, 75 University Avenue, N2L 3C5, Waterloo, Ontario, Canada, mkilgour@wlu.ca

The Graph Model for Conflict Resolution facilitates the modeling and analysis of multiple participant-multiple objective decision problems. In this application, the government of Canada, the Mi'kmaq First Nation, and local commercial fishers are in dispute over fishing rights in New Brunswick, illustrating how decision makers and policy planners can severely disagree over resource exploitation limits. The Graph Model is a systematic technique that produces accurate predictions and valuable strategic insights, thereby helping parties to defuse confrontation and achieve consensus.

2 - Analysis of standards development process with Drama Theoretical Approach

Jun Oura, 2-9-5 Shinmachi, 2020023, Nishi Tokyo, Japan, j-oura@mbb.nifty.ne.jp

Standards becomes more important than ever in global business environment. In order to manage standards for the business, it is important to understand the characteristics of standards.

This paper treats standards as the result of negotiation and confrontation. From the result of Drama Theoretical approach, we found what affect setting standards itself. In addition to the power balance among stakeholders, the speed of technology evolution would change the contents of standards.

The author will apply the result to real business case for proofing this consideration.

3 - Formal Modeling of Subjective Confrontation Analysis

Pri Hermawan, Dept. of Value and Decision Science, Tokyo Institute of Technology, 2-12-1 Ookayama, Meguro-ku, 152-8552, Tokyo, Japan, pri@valdes.titech.ac.jp, *Kyoichi Kijima*

The purpose of this paper is to introduce Subjective Confrontation Analysis, a new framework for analyzing conflict in negotiation. First, we identify negotiation as reciprocal proposals of positions and threats by two characters. Next, we formally define the six types of dilemma that might arise in such negotiation and introduce subjectivity to the analysis, by assuming the characters can have different perceptions of the situation and use subjective frame to resolve the conflict. The concept of simple Hypergame is adopted to represent the subjective frame, so as to obtain insightful results.

4 - Dramatically different or playing the rules of the game?

Jim Bryant, Faculty of Organisation Management, Sheffield Hallam University, City Campus, Sheffield, United Kingdom, J.W.Bryant@shu.ac.uk

This paper explores and seeks to clarify the relationship between drama theory and game theory. Since the metaphor of drama was first advanced as a generative device for helping people think through their interactions, drama theory has been used to support individuals and groups in organisations who have been rethinking their relationships with others or who have wished more effectively to manage their collaborations (or conflicts). Some stories, in which drama theory was used to frame situations, will be told and emerging software tools used to augment this process will be introduced.

■ ME-36

Monday, 16:00-17:30

DEC VR II V-155

MCDAs Methods for Sorting and Clustering

Stream: Multicriteria Decision Analysis
Invited session

Chair: *Bertrand Mareschal*, SMG, Université Libre de Bruxelles, Boulevard du Triomphe CP 210-01, 1050, Brussels, Belgium, bmaresc@ulb.ac.be

1 - MCDAs Methods for Sorting and Clustering Problems: PROMETHEE TRI and PROMETHEE CLUSTER

Yves De Smet, SMG - CODE, Université Libre de Bruxelles, Boulevard du Triomphe CP 210-01, 1050, Bruxelles, Belgium, yves.de.smet@ulb.ac.be, *José Rui Figueira*, *Bertrand Mareschal*, *Jean-Pierre Brans*

Extensions of the PROMETHEE methodology are proposed to treat sorting and clustering problems. These procedures are using central or reference actions to characterize categories and clusters. Deviations between the profiles of the actions and the reference actions are considered to solve the problem. A numerical application is presented to illustrate PROMETHEE TRI and PROMETHEE CLUSTER and their results are confronted with those obtained by ELECTRE TRI as a benchmark. Emphasis is put on the complementary nature of the two procedures.

2 - A comparative analysis of the ELECTRE TRI and PROMETHEE TRI methods applied to the semi-conductor sector

Bertrand Mareschal, SMG, Université Libre de Bruxelles, Boulevard du Triomphe CP 210-01, 1050, Brussels, Belgium, bmaresc@ulb.ac.be, *Tanguy Poelman*

We develop a multicriteria model to assist a portfolio manager in the identification of the best assets in a given financial sector. The objective is to sort the available assets in several categories defined by the user, from very good ones to very bad ones. The semi-conductor sector is used as a practical example to illustrate the model. Two multicriteria sorting methods (PROMETHEE TRI and ELECTRE TRI) have been applied in order to compare their characteristics and the results that they provide.

3 - The sorting problem based on disjunctive categories: a first investigation

Philippe Nemery, SMG, Université Libre de Bruxelles, Boulevard du Triomphe CP 210-01, 1050, Brussels, Belgium, pnemeryd@ulb.ac.be, *Yves De Smet*

We consider MCDA sorting problems where the available information for the assignment of alternatives to categories may be imprecise. In this context, an action belongs to a set of categories defined by a lower and an upper bound (which can be eventually identical). This information is obtained, for instance, by the use of methods like Electre TRI or based on rough judgements. The proposed approach is based on the Transferable Belief Model adapted to the management of preference degrees. Validation is based on empirical tests and an illustrative example is treated.

■ ME-37

Monday, 16:00-17:30

DEC VR7 V-156

AI and Neural Networks III

Stream: AI and Neural Networks

Invited session

Chair: *David Martens*, Decision Sciences and Information Management, Katholieke Universiteit Leuven, Naamsestraat 69, 3000, Leuven, Belgium, David.Martens@econ.kuleuven.be

1 - University Timetabling and Minimal Perturbation Problem Solved by a Self-adaptive Genetic Algorithm

Radomir Perzina, Department of Mathematical Methods in Economy, Silesian University, University square 1934/3, 73340, Karvina, Czech Republic, perzina@opf.slu.cz

The most of methods for solving the university timetabling problem deal with the problem statically, which makes great difficulties when requirements are changed, because a new timetable is usually very different from the previous one. To overcome it the minimal perturbation problem is incorporated into the timetabling model. For solving the model a self-adaptive genetic algorithm was proposed. Comparing to previous approaches we designed the encoding for self-adaptation not only one parameter or several ones but for all possible parameters of genetic algorithms at the same time.

2 - A new perspective in competitiveness of nations

Fusun Ulengin, Industrial Engineering, Dogus University, Engineering Faculty Acibadem, Kadikoy, 34722, Istanbul, Turkey, fulengin@dogus.edu.tr, *Sule Onsel Sahin, Ilker Topcu, Emel Aktas, Özgür Kabak*

The aim of this research is to group the countries based on different factors underlying their competitiveness level. The indices developed by World Economic Forum (WEF) are summarized and their drawbacks are underlined. Artificial neural network, data mining and multivariate statistical techniques are used to group the countries and to reveal the factors that play the dominant role in the specification of their relative positions in competitiveness. The results are compared with those of WEF.

3 - Mining Manufacturing Databases for Revealing the Effect of Operations Sequence on the Quality

Oded Maimon, Industrial Engineering, Tel Aviv University, 69978, Tel Aviv, Israel, maimon@eng.tau.ac.il, *Lior Rokach, Roni Romano*

Data mining methods are used for discovering efficient operational patterns in manufacturing processes. A novel algorithm for revealing operation sequence in addition to the operations settings is suggested. This algorithm consists of three stages: a set of regular expression patterns which are induced by employing a longest common subsequence dynamic programming algorithm; Then the most relevant patterns are identified; finally the inter-patterns interactions are automatically modelled using an ensemble of decision trees. A case-study illustrates the capabilities and the improved quality.

4 - Building Acceptable Classifiers with Ants

David Martens, Decision Sciences and Information Management, Katholieke Universiteit Leuven, Naamsestraat 69, 3000, Leuven, Belgium, David.Martens@econ.kuleuven.be, *Bart Baesens, Christophe Mues, Hsin-Vonn Seow, Reza Shahi, Jan Vanthienen*

The performance of classification techniques is typically measured by the accuracy of the generated models. In many applications, however, the classifiers should not only be accurate, but also comprehensible and justifiable. A classifier fulfilling all three requirements is said to be acceptable. Justifiability requires that the extracted classifier is in line with prior knowledge, such as monotonicity constraints. The recently proposed classification technique, AntMiner+, is based on ant colony optimization and we will show that the generated classifiers are indeed acceptable.

■ ME-38

Monday, 16:00-17:30

DEC VR7 V-157

DEA Applications I

Stream: DEA and Performance Measurement

Invited session

Chair: *Joseph Coughlan*, Faculty of Business, Dublin Institute of Technology, Aungier Street, 000, Dublin, Ireland, Joseph.Coughlan@dit.ie

1 - Using Data Envelopment Analysis for formative evaluation in retailing

Carla Amado, Faculdade de Economia, Universidade do Algarve, Campus de Gambelas, 8005 139, Faro, Portugal, camado@ualg.pt, *Sérgio Santos, Graeme Doherty*

The comparative performance of retail outlets is of strategic importance, especially if performance assessment is followed by a post-evaluation exercise in order to understand why and how certain outlets perform better than others. In this paper, we explore the use of Data Envelopment Analysis (DEA) for formative evaluation of a set of retail outlets commencing with context of the study. This is followed by a presentation of the models developed to compare the performance of the outlets and by a discussion of the findings. We conclude by discussing some managerial implications of our study.

2 - Assignment of New EU Agricultural Subsidies According to DEA: Olive Growing farms in Andalusia

Antonio F. Amores, Departamento de Economía, Métodos Cuantitativos e Historia Económica - Área de Métodos Cuantitativos, Universidad Pablo de Olavide, Ctra. Utrera Km.1, Ed. 3, 2º, Despacho 16, 41013, Seville, Spain, afamoher@upo.es, *Ignacio Contreras*

This paper proposes a new modulation system for European agricultural subsidies, taking into account Agenda 2000 criteria, by means of the assignment of them according to efficiency indexes calculated with DEA, in a way of internalizing the positive and negative externalities of the agricultural economic activity. The paper analyzes the application of this new system to the Andalusian (southern Spanish region) olive-growing sector by using the proposed indexes over a sample of 3,000 real farms, taken from the administrative subsidies database.

3 - Effect of the Servicescape on Productivity: A case study in branch banking

Joseph Coughlan, Faculty of Business, Dublin Institute of Technology, Aungier Street, 000, Dublin, Ireland, Joseph.Coughlan@dit.ie

Organisations expend significant resources in maintaining and continually updating their physical assets, principally their customer facing ones. The servicescape, the physical landscape of a service, has long been posited by marketing academics to affect the cognitive and affective state of the customer (Bitner, 1992). This research considers the effect of servicescape elements on the productivity of a group of bank branches. These productivities are generated using a DEA methodology. It is demonstrated that the servicescape has a significant effect on the productivity scores of branches.

■ ME-39

Monday, 16:00-17:30

DEC VR7 V-158

DSS Applications

Stream: Decision Support Systems

Invited session

Chair: *Pascale Zaraté*, Institut de Recherche en Informatique de Toulouse, 118 route de Narbonne, 31062, Toulouse, France, zarate@irit.fr

1 - A decision support system for automatic forecasting of time series

José Vicente Segura, Estadística y Matemática Aplicada, Universidad Miguel Hernández, Avd del Ferrocarril s/n,

3202, Elche, Alicante, Spain, jvsh@umh.es, José D. Bermúdez, *Enriqueta Vercher*

We present a DSS which searches for model specifications that can replicate patterns of observed time series. Our alternative model selection strategy permits the specification of a broad class of forecasting methods using a number of modifications to the generalized Holt-Winters. The procedure first provides the smoothing and initial parameters which minimize one of the three measures of fit, after uses a multi-objective formulation which jointly minimizes the error measurements of fit while keeping the updating equations of the HW methods in a Soft Computing framework.

2 - An application of fractional programming in paper production industry

G.D.H. Frits Claassen, Operations Research and Logistics, Wageningen University, Hollandseweg 1, 6706 KN, Wageningen, Netherlands, frits.claassen@wur.nl, *Theo H.B. Hendriks*

The contribution discusses the continuous improvements of an OR-based decision support system in paper production industry. The first system was handed over to the R&D-department in 1990. After fifteen years the basic concepts of the initial system are still used on a regular basis. However, the constantly advancing technology and physical knowledge of large scale paper production did have a substantial influence on the potencies of the latest upgrade. We will discuss the characteristic improvements of the past fifteen years and the impact of the system on different levels within the company.

3 - Study on diffusion of Rumours through Epidemic models under non identical set up

Asis Kumar Chattopadhyay, Department of Statistics, Calcutta University, 35 Ballygunge Circular Road, Kolkata 19, 700019, Calcutta, West Bengal, India, akcstat@caluniv.ac.in

The present paper attempts to study diffusion of rumours through a simple epidemic model, taking into account two possible sources of rumour via primary and secondary. Since the behaviour of different persons involved under the process will be different, also the rate of spread will be time dependent the underlying variables will not be independent and identical. The process has been studied through simulation, the process average has been compared with the average obtained from an established theoretical result. A real life data set has been used to demonstrate the use of the proposed model.

4 - From Simulators to Simulation Environment for Supporting Process Engineering

Pascale Zaraté, Institut de Recherche en Informatique de Toulouse, 118 route de Narbonne, 31062, Toulouse, France, zaraté@irit.fr, *Florian Fabre*, *Gilles Hétreux*

Simulators are used in Process System Engineering to develop new process or retrofit plants considering economics and environmental impacts. However, developing new process models with simulators is not an easy task for process engineers without an expertise in modelling and programming. This paper presents the evolution in the aid provided to the user of simulators and then the current solutions proposed to support process engineers. The final objective of our works is the development of a computer-aided modelling environment for the dynamic hybrid simulation environment ProDHYS.

■ ME-40

Monday, 16:00-17:30

SOC VR11 V-257

Environmental Planning

Stream: Environmental Planning (c)

Invited session

Chair: *Claudia Cristina Rave Herrera*, Geociencias and Environment - Energy Institute, National University of Colombia, Aa 1027, crr 80 No 65 - 223, BL M2 of 112, 57, Medellín, Colombia, crisrave@yahoo.com

1 - Centralised reallocation of emission permits using Data Envelopment Analysis

Sebastián Lozano, Dept. of Industrial Management, University of Seville, Escuela Superior de Ingenieros,

Camino de los Descubrimientos, s/n, 41092, Seville, Spain, slozano@us.es, *Gabriel Villa*, *Runar Brannlund*

A new centralized DEA approach for emissions permits allocation is presented. Desirable (plant production) and undesirable (emissions of relevant pollutants) outputs are considered. The proposed approach has three lexicographic objectives: maximizing aggregated desirable production, minimizing undesirable total emissions and minimizing consumption of input resources. The priorities of these objectives may be defined by the user. The approach is units-invariant, does not require information on inputs and outputs prices and has been tested on data from the Swedish pulp and paper industry.

2 - Market-oriented Emission Allowance Trading versus Emission Standards

Karl-Werner Hansmann, Industrial Management, University of Hamburg, Corveystraße 7, 22529, Hamburg, Germany, prof.hansmann@t-online.de

According to the Kyoto protocol the European Union has established a Greenhouse Gas Emission Allowance Trading Scheme to substantially reduce the emission of carbon dioxide (CO₂) and other greenhouse gases in the near future. I have developed two mixed integer programming models for manufacturing companies considering economic and ecological objectives. Based on duality theory I will show numerical results suggesting that the market-oriented emission allowance trading is not superior to appropriate chosen emission standards put in force by state authorities.

3 - A model for sustainable energy policy: The case of Turkey

Nihan Karali, Industrial Engineering Department, Bogazici University, 34342, Istanbul, Turkey, nihan.karali@boun.edu.tr, *Gürkan Kumbaroglu*

In the research, a model of energy-economy-environment integrated policy analysis is developed and calibrated to study economically sustainable energy and environmental policies for Turkey. It describes production within a nested structure of neoclassical production where energy demands, capital, and labor are aggregated using a constant elasticity of substitution. Particular emphasis is given on renewable energy whose cost is related to a Willingness-to-pay (WTP) function defining the consumers wills to reduce CO₂ emissions. The WTP equation is based on a survey conducted on 79 individuals.

4 - Integrated Energy-Environment-Economy Evaluation of the Energy Sector for Sustainable Development in the Medellín Metropolitan Area (Colombia)

Claudia Cristina Rave Herrera, Geociencias and Environment - Energy Institute, National University of Colombia, Aa 1027, crr 80 No 65 - 223, BL M2 of 112, 57, Medellín, Colombia, crisrave@yahoo.com, *Ricardo Smith*, *Juan David Vasquez*, *Juan Manuel Alzate*, *Angela Ines Cadena*

The energy system of the Medellín Metropolitan Area, Colombia has been modeled, under the integrated Energy Environment Economy modeling scheme, based on Markal. An energy reference system was set up and consolidated in a local spatial data base, that included residential, commercial, industrial and transport sectors. The application allowed us to evaluate the system in an evolving scenario that parted from the present conditions and changes under different scenarios, defined according to the complex dynamic of regional development. The results obtained are useful to support planning processes

■ ME-41

Monday, 16:00-17:30

SOC VR11 V-258

(Experimental) Psychology in Business Administration

Stream: Behavioural and Experimental Economics

Invited session

Chair: *Astrid Reichel*, Department of Management, Vienna University of Economics and Business Administration, Althanstrasse 51, 1090, Vienna, Austria, astrid.reichel@wu-wien.ac.at

1 - Harmonic Communication: looking to the arts and nature

Reidunn Døving Heyerdahl, Art and design, Kunst Design College, Nordbyveien 7, 3038, Drammen, Norway, r.d.heyerdahl@kcollege.no

Fine artists and composers offer us superb examples for harmonic communication: socially, ecologically and politically. When contrasts in media are too strong we fall prey to our inherent curiosity, essential for survival but addictive in excess. Disharmonious contrasts desensitize our mind so that we require steadily stronger contrasts in order to react. Harmony can not exist without contrasts, and the principle seems constant: in some cultures where varieties of ideas are made obsolete by dictatorial brainwashing, frictions appear on a larger scale towards other cultures and religions.

2 - An agent-based simulation of intra-firm knowledge diffusion and its impact on innovativeness

Markus Günther, Dept. of Business Studies, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, markus.guenther@univie.ac.at, *Christian Stummer*, *Kurt Heidenberger*

Properly combining information and (explicit or tacit) knowledge from within an organisation has a positive influence on the development of successful new products and services. In exploiting these resources, formal and informal paths for knowledge diffusion (e.g. represented through communication patterns of employees) play an important role. In our talk we outline a framework for an agent-based simulation that can be used to investigate how various (additional) organisational measures may influence these paths and, thus, promote a firm's innovativeness.

3 - Creative Problem Solving with Creativity Support Systems: Taxonomy of Commercial Systems and Examination of their Benefit

Astrid Reichel, Department of Management, Vienna University of Economics and Business Administration, Althanstrasse 51, 1090, Vienna, Austria, astrid.reichel@wu-wien.ac.at, *Judith Glueck*

The author created a taxonomy of applications aimed at supporting the user to increase the creativity of his ideas. In an experimental study she showed that the use of CSS yields higher quantity, higher creative quality and higher occurrence of very creative solutions than the use of a word processor.

ME-42

Monday, 16:00-17:30

SOC VR11 V-261

Modeling Social Systems III

Stream: Modeling Social Systems

Invited session

Chair: *Viveca Asproth*, Information Technology and Media, Mid Sweden University, Östersund, Sweden, viveca.asproth@miun.se

1 - Modeling Perpetuated Violence

Juan Camilo Bohórquez, Universidad de Los Andes, Universidad de Los Andes, Calle 19 A #, 37 Este Edificio W Quinto Piso, 57-1, Bogota, Colombia, jua-boho@uniandes.edu.co, *Roberto Zarama*

We explore a dynamic of violent acts. Agents exchange wealth, with the possibility of forcing an outcome violently reducing the welfare of another agent. These violent actions increase of the probability of the victim acting violently. An agency of regulators acts upon violent agents removing them. Although they can act on violent agents the victim is not attended, perpetuating the possibility of violent action through the victim. This brings into our attention the importance of treating victims of violence. Violence persists as a possibility even if those who act violently are detained.

2 - Communication Structure, Information Flow, and Homeostasis

Nelson Lammoglia, Industrial Engineering, Universidad de Los Andes, Calle 18 1-37 Este, 57, Bogota, Colombia,

n-lammog@uniandes.edu.co, *Henry Bustos*, *Roberto Zarama*

This work studies experimentally the relation between the dynamical equilibrium of an organization, its communicational structure, and the information diffusion in a network. We show that the diameter is the parameter that better explains the performance of a process of diffusion in which the typology of flow process is a serial duplication. In accordance to this, the experimental results show that the parameters of the graph that explain the performance of each group are: diameter, activity and maximum degree.

3 - Average infection rate model on a household-organized network

Juan Pablo Calderón, Universidad de Los Andes, 57, Bogota, Colombia, ju-cald1@uniandes.edu.co, *Neil Johnson*, *Roberto Zarama*

We present a model for the average infection rate on a household-organized network. Each household has intra-class connectivity and connectivity with the remaining households. Its average infection rate depends on the percentage of susceptible, infected inside, infected outside, an infection probability and a recuperation rate. The model estimates the infection rate of a class within a school, town within a country, etc. We investigate the effect of perturbations and disconnecting infected individuals inside or outside the household as an epidemic control strategy.

4 - Management of Critical Situations Caused by Flooding

Anita Håkansson, ITM, Mid Sweden University, Akademigatan 1, 83125, Östersund, Sweden, Anita.Hakansson@miun.se, *Viveca Asproth*

Globally flooding is one of the most serious natural catastrophes. In case of flooding many authorities and organizations become involved and there is a problem to take in the whole situation and have a common picture when many incidents happen at the same time. Established models of organizational control are insufficient to cope with the management of such complex situations. In this paper we will discuss, from a systemic management perspective, model requirements for management of flooding situations where several independent organizations have to collaborate.

ME-43

Monday, 16:00-17:30

FIN Endur Room 1

Probabilistic and Randomized Methods for Robust Design

Stream: Stochastic Programming

Invited session

Chair: *Giuseppe Calafiore*, DAUIN, Politecnico di Torino, Corso Duca degli Abruzzi, 24, 10141, Torino, Italy, giuseppe.calafiore@polito.it

1 - Scenario-based optimization for decision making under uncertainty

Giuseppe Calafiore, DAUIN, Politecnico di Torino, Corso Duca degli Abruzzi, 24, 10141, Torino, Italy, giuseppe.calafiore@polito.it

We discuss an efficient methodology for solving uncertain convex programs, based on sampling a finite number of instances of the uncertainties (the scenarios). In particular, we show that the optimal scenario-based solution is, with arbitrarily high probability, feasible for all the original constraints, except for a set of uncertainties having probability smaller than a pre-specified epsilon. An explicit bound is derived for the number of scenarios that need to be considered in the optimization, in order to achieve the desired levels of reliability in the solution.

2 - On the Convexity of Probabilistically Constrained Linear Programs

Constantino Lagoa, Electrical Engineering Department, The Pennsylvania State University, 111 K Electrical Engineering

West, 16802, University Park, PA, United States,
lagoa@enr.psu.edu

In this talk, we study the convexity of probabilistically constrained linear programs (PCLP). The PCLP is a linear program where deterministic constraints are replaced by probabilistic ones. It is shown that for log-concave symmetric distributions the PCLP is a convex program. A "deterministic equivalent" of the PCLP is also presented.

3 - Boosting methods for chance constrained problems

Garud Iyengar, Industrial Eng. and Operations Research Dept., Columbia University, Rm. 314 S. W. Mudd Bldg., 500W 120th St., 10027, New York, NY, United States, garud@ieor.columbia.edu

In this talk we will use "boosting" to reduce the number of samples required to solve a chance constrained problem. Boosting is a sequential technique that iteratively solves an approximation of the chance constrained problem and uses the solution of the approximation to generate samples for the next approximation. This method was developed by Freund and Schapire for solving pattern recognition problems. Our contribution is to show that the technique extends to more general chance constrained problems.

4 - Multi-stage Stochastic Optimization for Pension Fund Management

Ronald Hochreiter, Dept. of Statistics and Decision Support Systems, University of Vienna, Universitaetsstrasse 5, A-1010, Vienna, Austria, ronald.hochreiter@univie.ac.at,
Georg Pflug

Optimal management of pension funds is important for handling the growing challenges in keeping stable nation-wide pension systems. In contrast to standard Asset Liability Management, the goal of managing a pension fund is not solely based on a maximization of profits, while ensuring the coverage of liabilities. In addition, the contradictory interests of both the active members and the retired members have to be considered. Furthermore, the set of regulatory constraints is huge, and constantly evolving. A multi-stage stochastic programming model for managing such funds will be presented.

ME-44

Monday, 16:00-17:30

FIN Endur Room 2

Empirical Finance

Stream: Long Term Financial Decisions

Invited session

Chair: *Gregor Dorfleitner*, Financial Engineering und Derivate, Wirtschaftsuniversität Wien, Nordbergstraße 15/B/6th floor, A-1090, Vienna, Austria, gregor.dorfleitner@wu-wien.ac.at

1 - Extrapolating interest rates in the long-term could be more hazardous than you think!

Sebastian Lobe, University of Regensburg, Universitaetsstr. 31, 93053, Regensburg, Germany, sebastian.lobe@wiwi.uni-regensburg.de, *Klaus Röder*

Long-term interest rates of government bonds play an important part in the valuation of very long maturity claims. But consols (apart from Great Britain) usually do not exist. Thus, valuing any cash flows beyond the maturity of traded bonds raises the question of how to forecast interest rates in the long run. Applying the prominent Svensson Method, we estimate German interest rates on a daily basis for the very long run and encounter most often arbitrage opportunities. These results suggest that specific bounds on the long-term behaviour of interest rates are called for.

2 - Annualization of return distribution parameters and estimation of performance measures

Gregor Dorfleitner, Financial Engineering und Derivate, Wirtschaftsuniversität Wien, Nordbergstraße 15/B/6th floor, A-1090, Vienna, Austria, gregor.dorfleitner@wu-wien.ac.at

To make return distribution parameters like the mean, the variance or performance measures referring to different time horizons comparable, one has to annualize them. We especially treat the case of long-term investments, i.e. a horizon of several years. We identify different frequently used estimation alternatives and analyze these with respect to their accuracy. Our analysis is carried out as a Monte Carlo simulation study since the analytical treatment of the involved estimators seems very hard. It is shown that most estimation procedures have a higher level of imprecision than suspected.

ME-46

Monday, 16:00-17:30

FIN Endur Room 4

Optimization problems in insurance

Stream: Applied Probability

Invited session

Chair: *Nicole Baeuerle*, Institute for Mathematical Stochastics, University of Karlsruhe, Englerstr. 2, 76128, Karlsruhe, Germany, baeuerle@stoch.uni-karlsruhe.de

1 - On optimal harvesting and dividend payouts under restrictions

Jostein Paulsen, Department of Mathematics, University of Bergen, Johs. Brunsgt. 12, 5008, Bergen, Norway, jostein@mi.uib.no

We consider a harvesting situation where resources (fish) follow a diffusion process. The objective is to maximize expected discounted value of the accumulated harvest until depletion, but with the side condition that no harvesting is allowed unless resources are at least $\$b_0$. Arguments from risk theory are used to determine this barrier $\$b_0$. Finally a discussion about the relevance of this problem for optimal dividend payouts for a financial institution, an insurance company subject to solvency restraints says, is given.

2 - Characteristics of the collective risk process in the presence of dividend payments and dependent risks

Hansjoerg Albrecher, Graz University of Technology, Steyregasse 30, 8010, Graz, Austria, albrecher@tugraz.at

In collective risk theory, the stochastic behavior of the free reserve of an insurance portfolio over time is studied. In this talk, some recent developments in the field will be discussed, in particular with respect to considering dependence among the involved risks and including dividend payments to shareholders. For the latter extension, some optimality issues will be discussed.

3 - Dynamic mean-variance problems

Nicole Baeuerle, Institute for Mathematical Stochastics, University of Karlsruhe, Englerstr. 2, 76128, Karlsruhe, Germany, baeuerle@stoch.uni-karlsruhe.de

For dynamic asset allocation problems the task of maximizing the expected utility is quite well investigated. In this talk we consider a mean-variance criterion which is well-known from the static Markowitz setting. The solution is particularly simple here even in the case of constraints on the control and jumps in the state process. As an application we consider the classical Cramér-Lundberg model for the risk reserve of an insurance company with dynamic proportional reinsurance and solve the problem of finding the optimal reinsurance strategy with respect to a mean-variance criterion.

ME-47

Monday, 16:00-17:30

FIN Endur Room 5

Commodity pricing and risk management II

Stream: Financial Modelling

Invited session

Chair: *Rita D'Ecclesia*, Teoria Economica e Metodi Quantitativi per le Scelte politiche, Università di Roma, Piazza Aldo Moro 5, 00185, Roma, Italy, rita.decclesia@uniroma1.it

1 - Dynamic Modelling of Cross-Commodity Prices: A Levy Copula Approach.

Andrea Roncoroni, Finance, ESSEC, Avenue Bernard Hirsch, BP 105, 95021, Cergy-Pontoise, France, roncoroni@essec.fr

Covariance is a standard measure for market risk affecting multi-asset positions. It is unable to disentangle independence between factors under the realistic assumption of non-Gaussian returns. We introduce a model driven by Levy processes linked each other through Levy copulae. Our goal is to analyze the extent this methodology is able to capture various aspects of dependence exhibited by energy commodities and provide a tool for simulating market scenarios for assessing the risk the cross-commodity positions.

2 - Multistage Stochastic Programming With Time and State Dependent Convex Objective Function

Giorgio Consigli, Mathematics, Statistics and Computer Sciences, University of Bergamo, Via dei Caniana 2, 24127, Bergamo, Italy, giorgio.consigli@unibg.it, *Vittorio Moriggia*

We present a multistage stochastic programming decision model formulated as a linearly constrained dynamic problem with an objective function explicitly taking into account a set of wealth targets and the dynamics of the decision process. The stochastic programming approach to asset-liability management has thus emerged as an effective and appropriate way to address and analyze the personal financial planning problem. The steps from the problem formulation to its solution as a multistage stochastic programming problem are analysed with respect to an individual financial planning case problem

Tuesday, 8:30-10:00

■ TA-01

Tuesday, 8:30-10:00

KEY Askja N-132

KEYNOTE: The Kelly Criterion

Stream: Long Term Financial Decisions

Invited session

Chair: *Thomas Burkhardt*, Campus Koblenz, IfM, Universität Koblenz-Landau, Universitätsstr. 1, 56070, Koblenz, Germany, tburkha@uni-koblenz.de

1 - KEYNOTE: The Kelly Criterion: Theory and Practice

William Ziemba, Sauder School of Business, University of British Columbia, 2053 Mail Mall, V6T 1Z2, Vancouver, BC, Canada, ziemba@interchange.ubc.ca, *Leonard MacLean*

This talk will be in two parts. The first part considers the theoretical properties whereas the second will discuss the practical use of the capital growth or Kelly criterion in a number of application areas. These include great investors such as Buffet, Keynes and Thorp in equity markets, Benter and Ziemba et al in horseracing, and Ziemba in lotto games and futures trading. The size of bets vary greatly by application as do the fractional Kelly strategies used.

■ TA-02

Tuesday, 8:30-10:00

APP Askja N-131

Prevention and Health Promotion

Stream: OR in Health Care

Invited session

Chair: *Ruth Davies*, Warwick Business School, University of Warwick, Gibbet Hill Road, CV4 7AL, Coventry, United Kingdom, Ruth.Davies@wbs.ac.uk

1 - Developing services to reduce the use of acute beds by older people: a strategy for decision support

Roger Beech, Centre for Health Planning and Management, University of Keele, Darwin Building, ST5 5BG, Keele, Staffordshire, United Kingdom, r.beech@hpm.keele.ac.uk

Health and Social Care Agencies are expanding services for older people such that acute events and admissions might be prevented and hospital discharges facilitated. However, limitations exist in how evidence is used to select service options and judge their likely effects. This study is collecting data at two levels: the individual service user and the "whole system". Discussions focus on "modelling" the links between these two levels of activity. Where links can be identified, monitoring frameworks can be developed: if not, gaps in services might be exposed.

2 - Errors in the pharmacy process

Steve Gallivan, Clinical OR Unit, Mathematics, University College London, Gower Street, WC1E 6BT, London, United Kingdom, s.gallivan@ucl.ac.uk, *Martin Utley*, *Christina Pagel*

Many errors occur in the pharmacy process. These include delays before a patient receives a drug, patients receiving the wrong drug, etc. Analysis will be discussed combining pharmacokinetics with a stochastic model reflecting errors that may occur in the process. This gives a way of deriving expressions for the mean and variance of drug concentration depending on the frequency of different forms of error. Comparing this with the therapeutic range that is intended gives a means of quantitative evaluation of the severity of the effects of different forms of error and error frequencies.

3 - Budget allocation for optimal health gains at the macro level

Geert-Jan Kommer, Dept for Public Health Forecasting, Dutch National Institute for Public Health and the Environment, PO Box 1, Ant. van Leeuwenhoeklaan 9, 3720 BA, Bilthoven, Netherlands, g.kommer@rivm.nl

Disease prevention is more beneficial for long term population's health than cure. This popular belief among public health scientists is studied quantitatively at a macro level. We developed a dynamic model in which the population's health depends on the amount of health care provided. Five interventions, varying from prevention to long term care, differ in effect and costs. LP-optimisation determines beneficial cost/benefit parameters for optimal population's health in the long term.

4 - The Effect of Social Mixing Controls on the Spread of Smallpox - A Two-Level Model

Moshe Kress, Operations Research, Naval Postgraduate School, 1411 Cunningham Rd, 93943, Monterey, CA, United States, mkress@nps.edu

We develop a social interaction model for evaluating alternative response policies to an outbreak of smallpox. We capture interactions within households, daily meeting sites (schools, offices etc.) and general meeting site such as mass transit system, and among these meeting places. Based on the model, we evaluate the effect of social mixing controls, situational awareness of the public health system and mass vaccination on the spread of the epidemic. Some policy recommendations are discussed.

■ TA-03

Tuesday, 8:30-10:00

APP Askja N-130

Combinatorial and Contract Auctions

Stream: Auctions

Invited session

Chair: *Kurt Nielsen*, Institute of Food and Resource Economics, The Royal Agricultural University, Copenhagen, Rolighedsvej 25C, 1958, Frederiksberg C, Denmark, kun@kvl.dk

1 - A branch-and-price algorithm for combinatorial auctions with ordered matrix bids

Dries Goossens, Applied Economics, Katholieke Universiteit Leuven, Naamsestraat 69, 3000, Leuven, Belgium, Dries.Goossens@econ.kuleuven.be, *Frits Spiessma*

A combinatorial auction, i.e. an auction allowing bidders to bid on combinations of items, can lead to an allocation with increased revenue for the auctioneer compared to a traditional auction. We study a combinatorial auction with ordered matrix bids, which limits the bidders in their valuation of the combinations of items (Day, 2004). We show how its winner determination problem can be solved using a branch-and-price algorithm for which the pricing problem is a shortest path problem. We discuss results from computational experiments involving auctions with up to 50 items and 100 bidders.

2 - Decision Support for Multi-Unit Combinatorial Bundle Auctions

Riikka-Leena Leskelä, Industrial Engineering and Management, Helsinki University of Technology, Otaniementie 17, 02150, Espoo, Finland, rleskela@cc.hut.fi, *Hannele Wallenius*, *Jyrki Wallenius*, *Jeffrey Teich*

We have developed a mechanism to support bidding in combinatorial reverse auctions. The so called quantity support mechanism provides a short list of bids (price-quantity combinations) that would bring the bidder among the current winners of the auction. The bidder can choose the most profitable one on the list and submit it. We have tested the quantity support mechanism in numerous simulations and results indicate that using the mechanism in progressive auctions leads on average to a lower total cost to the buyer.

3 - Coordinating Price and Quantities in a Walrasian Auction Without Disclosing Information - Reallocating Production Contracts

Kurt Nielsen, Institute of Food and Resource Economics, The Royal Agricultural University, Copenhagen, Rolighedsvej 25C, 1958, Frederiksberg C, Denmark, kun@kvl.dk

In this paper we consider the problem of constructing a secure Walrasian auction for redistributing two types of production contracts among a large number of sugar beet producers. To avoid any misuse of submitted bids and asks by the downstream monopsonist, the suggested auction is based on techniques from modern cryptography - so-called Secure Multiparty Computation. Results from a preliminary implementation of a single secure double auction is extended to a Walrasian auction with two interrelated double auctions.

■ TA-04

Tuesday, 8:30-10:00

APP Askja N-129

Market models I

Stream: Electricity Markets

Invited session

Chair: *Hung-po Chao*, ISO New England Inc, Holyoke, MA, United States, hchao@iso-ne.com

1 - Simulation models and merger control: the case of Gas Natural-Endesa

Julian Barquin, IIT, Pontificia Comillas University, C/ Alberto Aguilera 23, 28015, Madrid, Spain, julian.barquin@iit.upcomillas.es

In September 5th, 2005 Gas Natural, the major natural gas Spanish incumbent, launched a bid for Endesa, the major electricity incumbent. The National Competition Commission and the National Energy Commission issued recommendations to the Government. The bid arises complex issues, related to potential horizontal and vertical anti-competitive effects, as well as to the proposed remedies. In this paper, I address the role and shortcomings that simulation models have had in order to help to the Competition Authorities to quantify these effects.

2 - Electricity generation with looped transmission networks: Bidding to an ISO

Eric Ralph, EKconomics LLC, 2323 Audubon St, 70125-4117, New Orleans, LA, United States, kodjo@cox.net, *Xinmin Hu*, *Daniel Ralph*

Electricity ISOs maximize welfare based on generators' bid supply functions (SF), given transmission constraints. With looped congested networks, SF equilibria (SFE) cannot generally be found analytically. Novel optimization techniques are used to analyze SFE for generators & consumers with linear supply/demand. We show: A single Cournot price may be more efficient than nodal-priced SFE, as rivalry at a node increases; Generator vertical integration into transmission & buyer countervailing power can reduce efficiency. Thus without modeling congested loops, electricity SFE cannot be understood.

3 - Resource Adequacy via Option Contracts

Hung-po Chao, ISO New England Inc, Holyoke, MA, United States, hchao@iso-ne.com

We consider supply function equilibrium in the spot market and Cournot competition of capacity investment. Adequate supplies of energy and reserve capacity are ensured via long-term contracts, in particular, a portfolio of option contracts with a variety of strike prices. Long-term contracts transfer competition from spot markets to forward markets where the supply and demand are more responsive to prices. Moreover, option contracts mitigate quantity risks, price volatility and market power in spot markets. This approach is equally applicable to the reserve markets and demand response.

■ TA-05

Tuesday, 8:30-10:00

APP Askja N-128

Sequential Optimisation in Agriculture and Forestry III

Stream: OR in Agriculture and Forest Management

Invited session

Chair: *Roger Martin-Clouaire*, UBIA, INRA, Auzeville BP52627, 31326, Castanet Tolosan, France, rmc@toulouse.inra.fr

1 - Operations Research in Agroindustrial Supply Chains in Colombia

Edgar Gutierrez Franco, Facultad de Ingeniería, Centro de Investigación en Tecnologías Avanzadas de Decisión, Universidad de La Sabana, Autop Norte de Bogota Km 21 Campus Univesitario Puente del Comun., Cll 163 b No 48-68, 571, Bogota, Colombia, edgar.gutierrez@unisabana.edu.co, *Rafael Guillermo García Cáceres*, *Mario Ernesto Martinez*, *Maria Margarita Cervantes*

The project purpose is to deepen in the planning research and of the programming of operations in agroindustrial supply chains and to concrete that knowledge in mathematical models, which serve as support to chains of taking decisions that shall have to structure the enterprises of agroindustrial Colombian sector to increase its competitively. It shall be presented a study case of the Supply Chain of Palm Oil.

2 - A multiobjective simulation-based method for optimizing irrigation strategies

Frederick Garcia, Unite de Biometrie et Intelligence Artificielle, INRA, Castanet-Tolosan, France, fgarcia@toulouse.inra.fr, *Olivier Crespo*, *Jacques-Eric Bergez*

We consider the problem of designing new agricultural strategies by taking into account multicriteria evaluation under uncertainties. We propose an approach combining multiobjective optimization and simulation. This method is based on a stochastic simulation optimization algorithm that consists in a hierarchical decomposition of the parameter space. Partitioning is iterated on the promising regions that are selected through a multiobjective evaluation. We present first results obtained on an irrigation management problem by using the MODERATO simulation tool.

3 - Dynamic resource allocation in agricultural production systems

Roger Martin-Clouaire, UBIA, INRA, Auzeville BP52627, 31326, Castanet Tolosan, France, rmc@toulouse.inra.fr, *Jean-Pierre Rellier*

Typical agricultural production processes generally consist of a number of interrelated activities that are undertaken to achieve goals. Their successful completion depends on the availability of required resources such as labor, machinery or energy. The activities are scheduled flexibly to cope with uncertainty, and resources must be allocated dynamically. The paper presents an algorithm of dynamic resource allocation used in the simulation of a plan execution process. The focus is on the incremental search mechanism that operates on various kinds of resources.

4 - Efficiency evaluation of loading and transporting logs in Neka forest (northern Iran)

Ramin Naghdi, Dept. of Forestry, University of Guilan, College of Natural Resources, P.O.Box 1144,, 43619-96196, Sowmeasara, Iran, Islamic Republic Of, naghdir@yahoo.com, *Iraj Bagheri*

In this study the production and cost of Volvo BM loader, N12 trailer and N12 truck were determined for Neka forest in northern Iran. The mathematical model of loading and transporting time as a depended variable is a function of independent variables of volume. The results showed that the amount of production and costs when loading trailer and truck were 47.8m³/h and 35.1m³/h and 5.60\$/m³ and 7.63\$/m³ respectively. The amount of production cost when transporting logs by trailer and truck were 5.5m³/h and 2.9m³/h and 28.30\$/m³ and 48.43\$/m³ respectively.

■ TA-06

Tuesday, 8:30-10:00

APP Askja N-121

OR in the Public Sector IV

Stream: OR in the Public Sector

Invited session

Chair: *Martin Fischer*, Mitretek Systems, 3150 Fairview Park Drive, 22042, Falls Church, VA, United States, mfischer@mitretek.org

1 - Modelling Electoral Policy Reform

John Betts, Faculty of Information Technology, Monash University, Clayton, 3800, Melbourne, Victoria, Australia, john.betts@infotech.monash.edu.au

A problem commonly faced by political parties is that of limited available seats for new candidates to contest. One means of addressing this problem is to limit the time that elected members can serve. However, the advantage enjoyed by incumbent candidates is well known. Thus, the decision to routinely replace candidates must be viewed in terms of its effect on electoral success. This research presents a discrete-event simulation model of voting that includes the effect of incumbency as a variable. The model and decision problem are illustrated with historical data from Australian elections.

2 - Measuring Productivity of Portuguese Water and Sewerage Services by Non-parametric Methods

Rui Marques, CESUR-DECivil, IST-Technical University of Lisbon, Av. Rovisco Pais, 1049-001, Lisboa, Portugal, rcmr@sapo.pt, *Duarte Silva*

Productivity is defined as the ratio of the outputs that a firm produces to the inputs it consumes. The methods to compute productivity could be classified into frontier or non-frontier and into parametric or non-parametric (FARE et al., 1998). This document determines the productivity comparing several non-parametric methods, such as index numbers, the different approaches of Malmquist indexes and the Hicks-Moorsteen indexes. It intends to bring some insights to that discussion computing the productivity for a set of 45 Portuguese water and sewerage services over the period 1994-2001.

3 - Computing and Operations Research: A Practical View of Mutual Growth

Martin Fischer, Mitretek Systems, 3150 Fairview Park Drive, 22042, Falls Church, VA, United States, mfischer@mitretek.org

In this paper we present a practical view of the mutual growth of Operations Research and computing. We trace this growth and relate it to how Operations Research professionals conduct their business on a day-to-day basis. We follow this growth via my own professional experience as an Operations Research Professional working at the Defense Information Systems Agency for 24 years, and at Mitretek Systems (MTS) for 11 years.

■ TA-07

Tuesday, 8:30-10:00

APP Askja N-120

OR in Developing Countries

Stream: OR in Developing Countries

Invited session

Chair: *Leroy White*, Management, University of Bristol, Willes Memorial building, Queens Rd, BS8 1RN, Bristol, United Kingdom, leroy.white@bris.ac.uk

1 - An OR approach to planning sustainable community health schemes in rural areas of developing countries.

Honora Smith, School of Mathematics, University of Southampton, Highfield, SO17 1BJ, Southampton,

Hampshire, United Kingdom, hs@maths.soton.ac.uk, *Paul Harper, Chris Potts*

We are attempting to bridge the gap between planning based on summarising statistics alone and the alternative of a purely soft' approach based on local conditions. Amongst other OR methods, simulation of social influence networks is planned alongside hierarchical location modelling. Difficulties abound but with open-mindedness and the benefits of collaboration with those experienced in the healthcare field, we hope to contribute to a vital arena in the search for sustainable development to benefit those marginalised in society.

2 - Second order preferences in group decision making

Laura Plazola Zamora, Metodos Cuantitativos, Universidad de Guadalajara, Periferico Norte 799 Modulo M 2do. nivel, 45100, Zapopan, Jalisco, Mexico, azucenadelrey@yahoo.com.mx, *Servio Tulio Guillén*

We propose a method for group decision making based on second order preferences concept. It consists in all individuals have the same influence on group ordering ranking all possible orderings of the set of alternatives. This method come out from the fact that if the preference strength of each one in the group can be modeled by an additive difference value function, then each individual's influence in group decision is approximately proportional to the difference of value among the best and the worst alternative.

3 - Humanitarian Logistics - assistance to an NGO responsible for HIV/AIDS orphans

Hans.W. Ittmann, Logistics and Quantitative Methods, CSIR, P O Box 395, 0001, Pretoria, South Africa, hittmann@csir.co.za

The HIV/AIDS pandemic has left many young kids orphaned. A number of organisations(NGO's) have been established with the sole purpose of taking care of these widely dispersed kids. Needs that require attention include the provision of food, clothing, etc. and this involves logistics and supply chain management. The NGO's do not have the required expertise, or budgets, to apply proper supply chain management principles. This paper will provide background and progress on a project that has been initiated to support such a NGO.

4 - Right approach, perfect timing - OR solutions to idiosyncratic South African issues

Gregory Lee, School of Economic Business Sciences, University of the Witwatersrand, New Commerce Building, Private Bag 3 Wits, 2050, Johannesburg, Gauteng, South Africa, leeg@sebs.wits.ac.za

OR will expand in South Africa (SA) if it can be shown to have unique relevance to specific issues of the economy. This is indeed the case. SA faces particular issues to do with sustainable development, AIDS, skills, tourism, black economic empowerment and various economic shifts. New solutions are required, with various criteria determined by the problems themselves and other factors. In light of these, the SA issues are 'matched' to potential contributions that can best be provided by OR. SA adoption of OR is a key to African adoption. Implications and paradigmatic issues are discussed.

■ TA-08

Tuesday, 8:30-10:00

EDU Oddi 101

Cases and Interactive Games for OR Education

Stream: OR Education

Invited session

Chair: *James Cochran*, Department of Marketing and Analysis, Louisiana Tech University, PO Box 10318, 71272, Ruston, LA, United States, jcochran@cab.latech.edu

1 - Interactive Simulation: A New Perception of Uncertainty

Sam Savage, Department of Management Science and Engineering, Stanford University, 326 Terman Engineering, 94305, Stanford, CA, United States, savage@stanford.edu

In the late 1990's I started experimenting with interactive histograms (<http://ite.pubs.informs.org/Vol1No2/Savage/Savage.php>). A new generation of software performs Monte Carlo simulation instantaneously on arbitrary spreadsheet models. This does for probability distributions, what the spreadsheet did for numbers. Live demonstrations will display models useful to both students and managers. Examples will include the Flaw of Averages and a cut down version of an interactive portfolio model currently in use by Shell Exploration.

2 - The case method in teaching spreadsheet-based quantitative courses

Manel Baucells, Decision Sciences, IESE Business School, Avda. Pearson, 21, 08034, Barcelona, Spain, mbaucells@iese.edu

In this presentation, I will describe how the case method can be successfully employed to teach quantitative courses. Cases focus the class discussion in what is relevant: how to translate a verbally described problem into a model, and how to obtain insight and solutions from such model. Not all cases are created equal, and I will present few examples of cases that work particularly well in class. A second ingredient for teaching success is the use of spreadsheet-based software. I will also present a simple spreadsheet-based tool for (linear and logistic) regression analysis.

3 - Active Learning and Classroom Games for Quantitative Methods Courses

James Cochran, Department of Marketing and Analysis, Louisiana Tech University, PO Box 10318, 71272, Ruston, LA, United States, jcochran@cab.latech.edu

Keeping students focused and engaged can be challenging in an introductory quantitative course. The author has found that learning activities carefully designed around game and sports themes can effectively engage students and help them maintain their focus. In this presentation, a variety of active learning tools will be demonstrated. The use of mini-cases, the four-corner case method, Strat-O-Matic® board games with turn-to-your-neighbor exercises, boomerang quizzes, and a PowerPoint-based classroom version of Who Wants To Be A Millionaire® will be featured.

■ TA-09

Tuesday, 8:30-10:00

IT Oddi 106

Bioinformatics IV

Stream: Computational Biology and Bioinformatics

Invited session

Chair: *Metin Turkay*, Department of Industrial Engineering, Koc University, Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey, mturkay@ku.edu.tr

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, Odtü, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - A Set Covering Approach with Column-Generation for Parsimony Haplotyping

Paolo Serafini, Dept. of Mathematics and Computer Science, University of Udine, Via delle Scienze 206, 33100, Udine, Italy, serafini@dimi.uniud.it, *Giuseppe Lancia*

The haplotyping problem involves identification genotypes that are the result of a special sum of a pair of haplotypes. The problem is APX-hard, i.e., even finding an approximate solution is already NP-hard. Our approach is based on formulating PHP as a particular Set Covering problem, in which each possible haplotype corresponds to a set. The Set Covering is solved dynamically by adding variables and cuts when needed through special pricing and separation procedures. We are able to tackle instances that cannot even be input to the software based on the best previous formulations

2 - A Dynamical, Optimization and Algorithmic Approach to Analyze Gene-Environment Networks

Gerhard-Wilhelm Weber, Institute of Applied Mathematics, Middle East Technical University, Odtü, 06531, Ankara, Turkey, gweber@metu.edu.tr

An emerging area in computational biology is modeling and prediction of gene-expression patterns. Nonlinear ODEs allowing a generalized treatment of the absolute shift term representing environmental factors. The genetic process is investigated with a time-discretization by Runge-Kutta methods and a combinatorial algorithm to detect regions of (in)stability. The time-continuous and -discrete systems can be represented by matrices allowing biological implications (e.g., thresholds) and interpretation, and by the new gene-environment networks proposed.

3 - Re-structuring the PDB

Zoltan Szabadka, Computer Science, Eotvos University, Pazmany Peter setany, 1/C, H-1117, Budapest, Hungary, sinus@cs.elte.hu, *Vince Grolmusz*

We created a cleaned, well-structured, versatile database from the Protein Data Bank mmCIF format. We present the database and give examples of its application: a, for binding site description and b, for quickly retrieving the set of close atom-pairs from the whole PDB.

4 - Prediction of Folding Type and Secondary Structures of Proteins Using Mathematical Programming

Metin Turkyay, Department of Industrial Engineering, Koc University, Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey, mturkay@ku.edu.tr, *Ozlem Yilmaz*, *Fadime Uney Yuksektepe*

Protein structure determination and prediction has been a focal research subject in life sciences. A host of algorithms are developed for predicting the secondary structures using statistical and computational approaches. The prediction accuracies of these methods rarely exceeded 70%. A novel two-stage method to predict the location of secondary structure elements in a protein using the primary structure data is developed: prediction of the folding type, and assignment of secondary structure elements to amino acids. It is shown that the average accuracy of the predictions increased to 74.1%.

■ TA-10

Tuesday, 8:30-10:00

OR Oddi 201

70th Anniversary Session II

Stream: OR - The Profession: 70th Anniversary

Invited session

Chair: *Jakob Krarup*, Dept. of Computer Science, University of Copenhagen, Universitetsparken 1, DK-2100, Copenhagen, Denmark, krarup@diku.dk

1 - Sustainable Development in Danish Farming

Jon Krabbe, Frederiksdal Gods, Frederiksdalsvej 30, 4912, Harpelunde, Denmark, krabbe@c.dk

More than 60% of Danish land is cultivated. The land is farmed intensively with a large animal production. Large amounts of scientific resources are spent on sustainable development with weight on balanced nutrition, minimizing pesticide use, and organic production. The coming years the research effort will include use of domestic animal waste, organic waste, problems related to odours, animal welfare, bio fuel enzymes and nutrition research. In short, "back-to-nature farming" is sustainable farming, developed with a balanced consideration for budget and intensive production.

2 - Optimal structuring of Metabolic Flux Networks

John Villadsen, The Technical University of Denmark, Chem Engr. and BiC building 223 DTU, 2800, Lyngby, Denmark, jv@biocentrum.dtu.dk

To maximize the yield of a desired product by a microorganism the optimal flux of carbon in the metabolic network of the organism is calculated. Instead of using internal nodes with carbon-flux distribution at each node it is proposed to work with a graph that uniquely connects the carbon source(s) with individual, experimentally measured products. Now a set of linear algebraic equations is obtained that is much easier to solve than the usual, often non-linear model for the flux distribution.

3 - Visualizing duality: a tribute to Steven Vajda (1902-1995)

Jakob Krarup, Dept. of Computer Science, University of Copenhagen, Universitetsparken 1, DK-2100, Copenhagen, Denmark, krarup@diku.dk

A huge literature bears evidence of duality as a key concept within mathematical programming. For a given optimization problem, however, it is not always obvious what its dual actually represents. Instead of resorting to rather fuzzy terms like "shadow prices" or "valuations" in an explanation of the main idea and its potential, another approach is literally to visualize duality. Based on sketches of a joint paper with Steven Vajda, prepared shortly before he passed away in 1995, a series of examples spanning the period 1755 to date is provided.

■ TA-11

Tuesday, 8:30-10:00

TRANS Oddi 202

Transport Tolling

Stream: Transportation

Invited session

Chair: *Kathryn Stewart*, Napier University, 10 Colinton Road, EH10 5DT, Edinburgh, United Kingdom, k.stewart@napier.ac.uk

1 - Solving stochastic mathematical programs with complementarity constraints using simulation

S. Ilker Birbil, Manufacturing Systems/Industrial Engineering, Sabanci University, Orhanli, 34956, Tuzla, Istanbul, Turkey, sibirbil@sabanciuniv.edu, *Ovidiu Listes*, *Gul Gurkan*

We report some recent progress in broadening the applicability of the so-called sample-path optimization to include the solution of certain stochastic mathematical programs with equilibrium constraints. We provide sufficient conditions under which certain approximating problems have solutions that converge to a solution of the original problem. We illustrate an application to solving a toll pricing problem in transportation networks. We explain how uncertainty can be incorporated to such a problem and how the approximating problems can be modeled and solved using an off-the-shelf solver.

2 - An Optimization of Toll Charges in an Urban Expressway

Toshiharu Hasegawa, Dept. Information and Telecommunication Eng., Nanzan University, 27 Seirei-Cho, 489-0853, Seto, Aichi, Japan, thasegaw@it.nanzan-u.ac.jp, *Masanori Nomura*, *Takayasu Sugiyama*

Four public corporations related with toll expressways in Japan were privatized in October 2005 to have efficient utilization of vast investments. This paper propose a traffic demand management method to maximize total income of a section of a certain toll road by adjusting the pre-announced hourly toll charges to have maximum inflow traffic for one day. The analysis of the method depends on System Dynamics model which simulates decision making process of users of the toll road under the condition that estimated travel times of the section and its competing surface street are provided.

3 - NETWORK TOLLING: System Optimisation under Stochastic Assignment with Elastic Demand and Multiple User Classes.

Kathryn Stewart, Napier University, 10 Colinton Road, EH10 5DT, Edinburgh, United Kingdom, k.stewart@napier.ac.uk

The classical road tolling problem is to toll network links such that, under the principles of Wardropian User Equilibrium (UE) assignment, a System Optimising (SO) flow pattern is obtained. This paper examines the effect of tolling under Stochastic Assignment where two possible desired flow patterns are considered; true SO (where Total Network Travel Cost (TNTC) is minimised), and Stochastic System Optimum (where perceived TNTC is minimised). The extension to include elastic demand is demonstrated for both cases and the provision for differential tolling of Multiple User Classes is discussed.

■ TA-12

Tuesday, 8:30-10:00

TRANS Oddi 205

Vehicle Routing and Scheduling in Transport Services

Stream: Transportation/Transport Industry (c)

Invited session

Chair: *Marta Anna Krajewska*, Department of Economics, Chair of Logistics, University of Bremen, Wilhelm-Herbst-Strasse 5, 23359, Bremen, Germany, makr@logistik.uni-bremen.de

1 - Self-Adaptive Reactive Scheduling of Service Crews in Dynamic Environments

Joern Schoenberger, Chair of Logistics, University of Bremen, Wilhelm-Herbst-Straße 5, 28359, Bremen, Germany, sberger@logistik.uni-bremen.de, *Herbert Kopfer*

We consider the problem of determining schedules for service crews travelling in an operations area and healing technical failures reported by customer calls. These calls are coming in continuously and unpredictably over time so that the existing service crew schedules require a reactive update. We present an online-optimization model for this problem and propose a memetic algorithm schedule generator. A feedback feature allows the self-adaptation of the myopic decision rules to mid-term enterprise policies. Numerical experiments prove the applicability of our approach.

2 - On Anomalies in Distributed Branch-and-Cut Solving of the Capacitated Vehicle Routing Problem

Matko Botinčan, Department of Mathematics, University of Zagreb, Bijenicka cesta 30, 10000, Zagreb, Croatia, mabotinc@math.hr, *Goranka Nogo*

Increase in computing power directly influences execution speed of a sequential branch-and-bound algorithm. However, execution speed of its parallel counterpart may change irregularly with addition of new processors. This paper gives a theoretically supported analysis of anomalous behavior evidenced in distributed solving of the capacitated vehicle routing problem with a branch-and-cut algorithm. We hope that this analysis, based on existing results on anomalies in parallel branch-and-bound, will help to pursue development of a similar framework for parallel branch-and-cut algorithms.

3 - ARENA Logistics Modeling: Ensuring sustainable growth

Lynette Kotze, Operations Profitability Improvement, Sasol Technology, Po Box 872, Parklands, 2121, Johannesburg, Gauteng, South Africa, Lynette.Kotze@Sasol.com

Sasol is an integrated oil, gas and chemicals company. At the Secunda complex Sasol supports these operations by mining coal and converting it into Synthetic Fuels and chemicals. The plant's location is based on its close proximity to coal mines and so the factory relies on overland logistics to get products out. Sasol seen rapid growth in recent years while supply chain development lagged behind to a point where the logistics infrastructure hampered future growth. This paper deals with logistic challenges faced at Sasol and the role that stochastic modeling played in finding solutions.

4 - Modelling of the integrated operational transportation planning problem

Marta Anna Krajewska, Department of Economics, Chair of Logistics, University of Bremen, Wilhelm-Herbst-Strasse 5, 23359, Bremen, Germany, makr@logistik.uni-bremen.de, *Herbert Kopfer*

We present the integrated operational transportation planning problem as the extension of pick-up-and-delivery-problem with time windows. The extension consists in the possibility of forwarding the requests to subcontractors on different terms. Different types of metaheuristics, regarding different types of integration, have been applied to the problem. We present the comparison of existing approaches and the results that they generated. Furthermore, we introduce the practical aspects of the problem and present a model that couples those aspects with the theoretical assumptions.

■ TA-13

Tuesday, 8:30-10:00

TRANS Oddi 206

Optimization in Maritime Transportation

Stream: Maritime Transportation

Invited session

Chair: *Nina Linn Ulstein*, Department of Industrial Economics and Technology Management, NTNU, Alfred Getz vei 1, 7491, Trondheim, Norway, Nina.ulstein@iot.ntnu.no

1 - Non-Cooperative Games in Liner Shipping Strategic Alliances

Stefan Voss, Wirtschaftsinformatik/Information Systems, University of Hamburg, Von-Melle-Park 5, 20146, Hamburg, Germany, stefan.voss@uni-hamburg.de, *Xiaoning Shi*

This paper focuses on liner shipping's strategic alliances within the framework of non-cooperative game theory. We aim to 1) indicate the motivations of short-run cooperation among several liner carriers; 2) analyse pros and cons of being members in liner shipping strategic alliances; 3) explain the departure of a player when it faces turbulence and unpredictable shipping circumstances; 4) advise ways to contain long-run alliance's stability. Specific models are made based on non-cooperative games and repeated games to explain those differences.

2 - Strategic planning in maritime transportation

Kjetil Fagerholt, Department of Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred Getz vei 3, 7491, Trondheim, Norway, kjetil.fagerholt@iot.ntnu.no, *Marielle Christiansen*, *Trond A. V. Johnsen*, *Thor Jakob Vabø*

Many shipping companies engage in contracts specifying quantities of cargoes to be lifted between given ports within a time frame for an agreed payment per unit. Such contracts are usually combined with spot cargoes. Important strategic decisions for such companies are 1) acceptance/rejection of contracts, 2) the split between contracts and spot, and 3) optimal fleet size and mix for a given contract and spot portfolio. In this paper, we present a framework for a DSS that supports these decisions. The framework embeds a commercial heuristic-based DSS for short-term ship routing and scheduling.

3 - Designing a liner shipping service with visit separation requirements

Nina Linn Ulstein, Department of Industrial Economics and Technology Management, NTNU, Alfred Getz vei 1, 7491, Trondheim, Norway, Nina.ulstein@iot.ntnu.no, *Mikkel M. Sigurd*, *Bjørn Nygreen*, *David Ryan*

This talk considers a model for designing a liner shipping system with visit separation requirements. The model produces visit schedules, a fleet of ships and recurring routes for each ship. The visit schedules must adhere to customers' requirements for separation of visits and opening hours in the ports. The model is solved by Dantzig-Wolfe decomposition, with a set partitioning master problem and a pricing problem for delayed column (route) generation. The pricing problem is formulated as a resource constrained shortest path problem and solved with a heuristic two-phase algorithm.

■ TA-14

Tuesday, 8:30-10:00

PROD Arnag 101

Emergency Service Operations

Stream: Operations Management / Revenue Management

Invited session

Chair: *Armann Ingolfsson*, School of Business, University of Alberta, 3-40F Business Building, T6G 2R6, Edmonton, Alberta, Canada, Armann.Ingolfsson@UAlberta.Ca

1 - Extracting Ambulance Route Information from Sparse GPS Data - A Dynamic Program for Map Matching

Andrew J Mason, Dept Engineering Science, University of Auckland, Private Bag 92019, 1020, Auckland, New Zealand, a.mason@auckland.ac.nz, Shane Henderson

Many ambulance services now use automatic vehicle location (AVL) systems to record GPS position information from their vehicles. We outline a new dynamic programming approach for the 'map matching' problem of using this GPS data to determine a vehicle's route through a road network. Using Bayesian analysis, we compute the posterior density of likely routes given the observed GPS data. We then use dynamic programming to maximize this posterior, giving the most likely vehicle route. This new optimisation approach allows routes to be determined even if the GPS data is sparse.

2 - A DEA approach to the allocation of funding for regional ambulance service.

Susan Budge, School of Business, University of Alberta, 3-40F Business Building, T6G 2R6, Edmonton, Alberta, Canada, sbudge@ualberta.ca, Armann Ingolfsson, Tarja Joro

In March of 2004, the Government of Alberta made the decision to transfer the governance and funding of emergency medical services from municipalities to the regional health authorities. An important issue is how the funding will/should be allocated to the various health authorities and across their regions. An allocation based on population alone would miss many important factors in the costs and operations of such services. We take a DEA approach and examine the relevant inputs and outputs in order to construct an appropriate allocation of funding for a regional ambulance service.

3 - Optimal planning of public safety resources in Sweden

Tobias Andersson, Department of Science and Technology, Linköping University, Division of Communications and Transport Systems, SE-60174, Norrköping, Sweden, toban@itn.liu.se, Anders Axelsson

In this presentation, the similarities and differences between different public safety resources are discussed, concentrating on ambulance services and fire and rescue services. To provide some background for the discussion, two projects focusing on the construction of decision support tools for emergency services decision makers are described; OPAL - Optimized ambulance logistics and OPERA - Optimized and effective rescue resource allocation.

4 - The Impact of Ambulance System Status Management

Armann Ingolfsson, School of Business, University of Alberta, 3-40F Business Building, T6G 2R6, Edmonton, Alberta, Canada, Armann.Ingolfsson@UAlberta.ca

We use discrete event simulation to model an ambulance system that practices system status management (SSM), where ambulances are redeployed dynamically to maintain coverage. We use the model to estimate the impact of SSM on performance, compared to a situation where ambulances return to their home station at the conclusion of every call. Using data from a Canadian city, we estimate that the percentage of high priority calls reached in 9 minutes would drop from 85% to 77% if SSM were no longer used.

■ TA-15

Tuesday, 8:30-10:00

PROD Arnag 201

Sustainable Supply Chains

Stream: Supply Chain Management

Invited session

Chair: Luk Van Wassenhove, Technology and Operations Management Area, Insead, Boulevard de Constance, 77305, Fontainebleau cedex, France, luk.van-wassenhove@insead.edu

1 - Balancing sustainable supply chains

Jo van Nunen, Department Decision and Information Sciences, RSM Erasmus University, Burgemeester Oudlaan 50, 3062 PA, Rotterdam, Netherlands, jnunen@rsm.nl, Jacqueline Bloemhof

Sustainability in supply chains has been studied for different products in several market situations. The problem connected with finding the right balance between the Three P's of sustainability Profit, People and Planet has many interesting dimensions. In the paper we consider supply chains in the agricultural sector. We evaluate the possibilities offered by new information technology developments.

2 - Sustainable supply chains in the absence of a supply chain: the case of the Motion Picture and Television Industry

Charles Corbett, UCLA Anderson School of Management, 110 Westwood Plaza, Box 951481, 90095-1481, Los Angeles, CA, United States, charles.corbett@anderson.ucla.edu

The motion picture and television footprint of the industry are not usually thought of as polluting, but their sheer size in the Los Angeles area shows otherwise. We characterize the environmental footprint of the industry using a combination of life-cycle assessment and input-output analysis. We summarize findings from interviews with some 40+ individuals working in the industry, and present key learnings from about 5-10 examples of best environmental management practices in the industry, and relate those to the structure of the ever-evolving supply networks in this industry.

3 - Coal value chain optimisation for improved sustainability

Marthi Harmse, Operations Profitability Improvement, Sasol Technology, PO Box 2096, 1947, Sasolburg, South Africa, marthi.harmse@sasol.com

The world's energy demand will grow by 60% over the next 30 years to sustain economic and social development. The utilization of a diverse mix of energy sources must be optimized while maintaining environmental sustainability. Coal is an important role-player since it is readily available, affordable and provides a reliable power source. In South Africa (among the world's top five producers of coal) Sasol produces synfuels and petro-chemicals from coal. An integrated tool set was developed to facilitate the Coal Value Chain optimisation, including a planning, simulation and a scheduling model.

■ TA-16

Tuesday, 8:30-10:00

PROD Arnag 301

Scheduling and Planning

Stream: Scheduling

Invited session

Chair: Steef van de Velde, Technology Innovation, RSM Erasmus University, PO Box 1738, 3000 DR, Rotterdam, Netherlands, svelde@rsm.nl

1 - Combinatorial Optimisation approaches to Frequency Assignment

Celia Glass, Cass Business School, City University, 106 Bunhill Row, EC1Y 8TZ, London, United Kingdom, c.a.glass@city.ac.uk

The expansion in mobile telephony and telecommunications mass media has put an enormous premium on the electro-magnetic spectrum. The Combinatorial Optimisation problem associated with its efficient use is the Frequency Assignment Problem (FAP). In this paper we explore the connection between FAP and the Chromatic Number Problem. We consider the implications for combinatorial representations, and transferability of algorithms. In addition, we develop a Genetic Algorithm using our Directed Acyclic Graph representation of FAP, whose competitiveness we demonstrate.

2 - Due Date Quotation and Scheduling with Lead Time Sensitive Customer Orders

Ayhan Aydin, Faculty of Engineering and Natural Sciences - Industrial Engineering Masters Program, Sabanci University, Sehit Fethi Cad. No:31/9 Gozde Apt., Yenimahalle/Pendik, 34893, Istanbul, Turkey, aydin@su.sabanciuniv.edu, Kerem Bulbul

We consider a deterministic single-stage scheduling problem in which customers are quoted 100% reliable due dates upon arrival unless the order is rejected. The revenue from an accepted customer order is a non-increasing function of the quoted due date which cannot exceed a threshold. This threshold and the revenue function capture customers' sensitivity to lead times in a make-to-order setting in which customers may place orders with different manufacturers if necessary. Our objective is to maximize the revenue from accepted orders. We study this problem in both online and off-line settings.

3 - Capacity planning and scheduling by means of dispatching rules enhanced by dynamic programming

Steeff van de Velde, Technology Innovation, RSM Erasmus University, PO Box 1738, 3000 DR, Rotterdam, Netherlands, svelde@rsm.nl, Marcel van Assen, Paul Hentschke

We develop dispatching rules enhanced with a dynamic-programming based look-ahead feature for a generic capacity planning and scheduling problem that arises in make-to-order discrete parts manufacturing. Our computational results on randomly generated instances show that this added feature effectively and efficiently avoids the usually poor performance of dispatching rules. Furthermore, in a case study conducted at a leading Dutch second-tier supplier in the aerospace industry, we found that our algorithm significantly outperforms their MRP-based procedure in use.

■ TA-17

Tuesday, 8:30-10:00

PROD Arnag 303

Cutting and Packing I

Stream: Cutting and Packing

Invited session

Chair: Jose Fernando Oliveira, Feup / Inesc, Universidade do Porto, Rua Dr. Roberto Frias, 4200-465, Porto, Portugal, jfo@fe.up.pt

1 - A Genetic Algorithm Approach for the Constrained Two Dimensional Bin Packing Problem

Ahlem Bouziri, Computer Science, Institut Supérieur des Arts Multimédias, 19 rue ElAacha, 2083, Ghazela (Ariana), Tunisia, ahlembou@yahoo.com, Rym Mhallah

The constrained two dimensional bin packing problem consists of packing a given set of items into the smallest number of bins. Each item is a rectangle characterized by its width, length, and demand. All bins are rectangles of fixed width and maximal length. We solve this NP hard combinatorial problem using genetic algorithms. We adopt a matrix format for the solution configuration and design specific crossover and mutation operators. The extensive computational results on instances extracted from the literature show the good performance of the proposed approach.

2 - A Beam Search Implementation for Nesting Problems

Julia Bennell, School of Management, University of Southampton, Highfield, SO17 1BJ, Southampton, Hampshire, United Kingdom, jab2@soton.ac.uk, Xiang Song

The paper will present a constructive approach for nesting problems that utilises beam search to guide the generation of efficient layouts. In our implementation we base the placement rule on TOPOS. In order to determine the order in which the pieces should be placed a beam search approach is proposed.

3 - META TOPOS - Meta-heuristics approaches to the irregular strip packing problem

Jose Fernando Oliveira, FEUP / INESC, Universidade do Porto, Rua Dr. Roberto Frias, 4200-465, Porto, Portugal, jfo@fe.up.pt

TOPOS is a well-known constructive heuristics for the irregular strip packing problem. Based on several strategies to select the order by which the pieces are placed and their place and orientation on the board, TOPOS does not rely on any kind of bottom-left strategy to place the pieces. In META TOPOS meta-heuristics are used to endow TOPOS algorithm with a powerful search mechanism. Computational results over commonly used test problems will be presented.

4 - Solving nesting problems by lattice packing of clusters of irregular shapes

A. Miguel Gomes, Faculty of Engineering / INESC Porto, University of Porto, Rua Dr. Roberto Frias s/n, 4200-465, Porto, Portugal, agomes@fe.up.pt, M. Teresa Costa, Jose Fernando Oliveira

Nesting irregular shaped pieces is a 2D cutting and packing problem that arises in industrial production processes where raw material has to be cut from a given limited stock sheet, while minimizing the waste. The lattice packing problem is a variant of the general nesting problem, where congruent copies of a few small pieces are regularly placed. We propose a two stage approach to tackle nesting problems with a large number of pieces of relatively few different types: groups of small pieces are packed together in compact clusters, followed by a lattice packing algorithm to pack the clusters.

■ TA-18

Tuesday, 8:30-10:00

PROD Arnag 304

Competitive Location

Stream: Locational Analysis

Invited session

Chair: Blas Pelegrin, Statistics and Operations Research, University of Murcia, Spain, pelegrin@um.es

1 - Competitive location when demand is elastic

Dolores R. Santos-Peñate, Métodos Cuantitativos en Economía y Gestión, University of Las Palmas de Gran Canaria, Campus de Tafira. Edificio Dptal de Ciencias Económicas y Empresariales D-4-22, 35017, Las Palmas de Gran Canaria, Canarias, Spain, drsantos@dmc.ulpgc.es, Rafael Suarez Vega, Pablo Dorta-González

We study a competitive location problem where two firms make location decisions for their facilities in a market where the portion of buying power spent by a consumer depends on the distance between him and the facilities. The problem is formulated as a leader-follower model where each competitor takes a choice in order to optimize certain objective. Different objectives lead to distinct games. In contrast to inelastic demand for which some of these games are identical, for elastic demand the optimal strategies for these games may not be equal. We present some location results and examples.

2 - Clustering Customers in a von Stackelberg Model for Competitive Location

Lieslot Vanhaverbeke, MOSI, Vrije Universiteit Brussel, Pleinlaan 2, 1050, Brussels, Belgium, lieslot.vanhaverbeke@vub.ac.be, Frank Plastria

The MIP formulation of the von Stackelberg location model is used to optimize the final market share individually for the Leader and for the Follower after sequential location of their facilities. By grouping into one single cluster all customers, which may be guaranteed to always be assigned to the same facilities, one obtains an equivalent model with less customers. Finally, we report on computational experiments that show the extent of simplification in the von Stackelberg model for different consumer behavior approaches, and the effects on solution times.

3 - A multifacility location model for firm expansion under competitive delivered pricing

Blas Pelegrin, Statistics and Operations Research, University of Murcia, Spain, pelegrin@um.es, *Pascual Fernandez*, *Jose Fernandez*, *María D. García*

Under competitive delivered pricing, markets are captured by facilities with minimum marginal total cost (production + transportation). One positive effect of firm expansion is "profit increasing". However, a negative effect may occur: "cannibalization". We develop a model for locating a fix number of new facilities in which the two effects are captured. When the location space is a network, an optimal solution is found at the nodes. An integer linear programming formulation of the problem is presented, which is used to solve some test problems for different parameters configurations.

■ TA-19

Tuesday, 8:30-10:00

PROD Arnag 311

Applications of Resource-Constrained Project Scheduling

Stream: Project Management and Scheduling

Invited session

Chair: *Jürgen Zimmermann*, Business Administration, TU Clausthal, Julius-Albert Str. 2, 38678, Clausthal-Zellerfeld, Germany, juergen.zimmermann@tu-clausthal.de

1 - Dynamic order acceptance within a multi-project environment

Jade Herbots, Decision Sciences and Information Management, Katholieke Universiteit Leuven, Naamsestraat 69, 3000, Leuven, Belgium, jade.herbots@econ.kuleuven.be, *Willy Herroelen*, *Roel Leus*, *Erik Demeulemeester*

We study a dynamic order acceptance problem within a multi-project environment. When orders are presented dynamically to an over-demanded organization, quick accept/reject decisions have to be made based on rudimentary information. The company's available resources are assumed to be fixed, however, at additional per unit costs non-regular resources can be put on. The optimal solution can only be evaluated ex post; while branch-and-cut methods allow for a timely calculation. In addition, we develop solution procedures that aim at maximizing the expected profit of the organization.

2 - Optimizing Operating Room Processes: An Application of Stochastic Resource-Constrained Project Scheduling

Robert Heil, Department for Business Sciences, Technical University of Munich, Chair for Technical Services and Operations Management, Arcisstr. 21, 80333, Munich, Germany, robert.heil@wi.tum.de, *Rainer Kolisch*

We consider the problem of scheduling patients in operating rooms (OR) with the patients and their sequence given for each OR. The processing of a patient consists of 3 operations: induction of anesthesia, surgery and emergence from anesthesia. For each step a resource is required. If n ζ m resources are assigned to the m ORs, operations of different patients can be parallelized. We model the problem as stochastic RCPSP with minimal and maximal time lags and weighted completion time objective and propose a branch-and-bound procedure employing a forbidden set branching scheme.

3 - Scheduling prototyping activities in the automotive industry

Jürgen Zimmermann, Business Administration, TU Clausthal, Julius-Albert Str. 2, 38678, Clausthal-Zellerfeld, Germany, juergen.zimmermann@tu-clausthal.de

We present a multi-mode project scheduling model for optimizing testing processes in the automotive industry. The complex restrictions encountered in this application are formulated using renewable and cumulative resources as well as schedule dependent time windows. The objective considered is to minimize the overall number of required prototyping activities. Using a priority rule-based sampling heuristic and a genetic algorithm, we approximatively solve problem instances with up to 600 tests and 25 variants of prototyping vehicles.

■ TA-20

Tuesday, 8:30-10:00

HEUR Arnag 422

VNS-based Metaheuristics

Stream: Metaheuristics

Invited session

Chair: *Belen Melian Batista*, Estadística, I.O. y Computación, University of La Laguna, Astrofísico Sanchez s/n, Campus de Anchieta, 38271, La Laguna, Spain, mbmelian@ull.es

1 - VNS on artificial neural networks for classification

Ignacio García-del-Amo, D.E.I.O.C., University of La Laguna, Antigua Torre de Químicas, 2ª planta, 38271, La Laguna, Sta. Cruz de Tenerife, Spain, igdelamo@ull.es, *José A. Moreno-Pérez*, *Belen Melian Batista*

In this work we present a method for applying VNS to train artificial neural networks (ANN) for classification problems. The task of training ANN can be viewed as an optimization process, where the classification error is the value to be minimized, and the weights of the ANN are the parameters to be tuned. We propose a definition for the neighbourhood structures that considers the architecture of the ANN, assigning the same neighbourhood to weights that share their target neuron. Finally, we show some comparative results and present our conclusions.

2 - Integrating variable neighborhood search techniques into hybrid evolutionary algorithms for rich vehicle routing problems

Andreas Reinholz, Computer Science, University Dortmund, Otto-Hahn-Str. 14, 44227, Dortmund, Germany, andreas.reinholz@gmx.de

We present a methodology for designing Hybrid Evolutionary Algorithms for hierarchical nested rich Vehicle Routing Problems (VRP). This methodology starts with a quick and easy implementation that could be improved step by step by adding more complex elements. Problem specific neighborhood generating operators, working on different levels of the problem hierarchy, using specific coding, efficient data structures and accelerated function evaluations are introduced to develop competitive solvers. Experimental results with 101 new best solutions are given for benchmarks of several VRP.

3 - A variable neighbourhood search algorithm for the matrix bandwidth minimization

Nenad Mladenovic, School of Mathematics, Brunel University, Kingston Lane, UB8 3PH, Uxbridge, Middlesex, United Kingdom, Nenad.Mladenovic@brunel.ac.uk, *Dionisio Perez*, *Carlos García*

In this contribution, we consider the problem of reducing the bandwidth of a matrix, which consists of finding a permutation of the rows and columns of a given matrix which keeps the non-zero elements in a band that is as close as possible to the main diagonal. This NP-complete problem can also be formulated as a labeling of vertices on a graph, where edges are the non-zero elements of the corresponding symmetrical matrix. We propose a Variable Neighbourhood Search algorithm for this problem. Empirical results with a collection of reported instances indicate the effectiveness of this method.

■ TA-21

Tuesday, 8:30-10:00

HEUR Arnag 423

Logics for Prevision and Decision

Stream: Dynamical and Anticipatory Systems

Invited session

Chair: *Fábio Romeu de Carvalho*, Paulista University, Rua Dr Bacelar 1212, 04026-002, São Paulo, SP, Brazil, fabioromeu@unip.br

Chair: *Jair Minoro Abe*, Paulista University, Rua Dr Bacelar 1212, 04026-002, Sao Paulo, SP, Brazil, jairabe@uol.com.br

1 - Logistics: an application of the Para-analyzer

Israel Brunstein, Dept. of Production Engineering, University of Sao Paulo, Av Prof Almeida Prado 531 2ºa, 05508-900, Sao Paulo, SP, Brazil, brunstei@usp.br, *Jair Minoro Abe*, *Fábio Romeu de Carvalho*

In many of our publications we've studied a new class of Paraconsistent Logics, namely Annotated Logics, which allow to deal with uncertain, inconsistent and paracomplete concepts. Based on such logics, we've built a logical analyzer, the Para-analyzer, which has showed powerful for the implementation in control systems, very useful in decision-making in the presence of uncertain, inconsistent and paraconsistent data. We discuss in some detail in this work an application in Logistics, namely to increase machine availability through maintenance.

2 - Paracontrol: a logical controller based on paraconsistent annotated logics and its applications

Jair Minoro Abe, Paulista University, Rua Dr Bacelar 1212, 04026-002, Sao Paulo, SP, Brazil, jairabe@uol.com.br, *Joao Inacio da Silva Filho*, *Fábio Romeu de Carvalho*, *Israel Brunstein*

The contradictions or inconsistencies are common when we describe parts of the real world. The control systems used in Automation and Robotics and the expert systems used in AI perform this description, in general, with base in the conventional logic. The conventional logic makes this description considering only two states and these binary systems don't get to treat the contradictory situations appropriately. This work presents an algorithm elaborated and based on Paraconsistent Annotated Logic.

3 - Multiple criteria and multiple periods performance analysis: the comparison of North African Railways

Karim Sabri, HEC - Management School, University of Liège, Boulevard du Rectorat 7 (B31), 4000, Liege, Belgium, sabri.karim@caramail.com, *Gerard Colson*, *Mapapa Mbangala*

Differences of technical and financial performances are analysed by comparing North African railways (1990-2004). A first approach is based on the Malmquist DEA TFP index measuring the total factors productivity change. A multi-criteria analysis is also performed using the PROMETHEE II method and the software ARGOS, which provide complementary detailed information, especially by discriminating the technological and management progresses for Malmquist and the two dimensions of performance for Promethee: that are the service to the Community and the enterprises performances, often in conflict.

4 - A Decision-Making Theory for Uncertain Data

Fábio Romeu de Carvalho, Paulista University, Rua Dr Bacelar 1212, 04026-002, São Paulo, SP, Brazil, fabioromeu@unip.br, *Jair Minoro Abe*, *Israel Brunstein*

In this expository work we show how the Para-analyzer can be useful to a variety of applications involving decision making when facing mainly with uncertainty, inconsistent or paracomplete information. The Para-analyzer is based on Paraconsistent Annotated Logic Et which can deal with uncertain, inconsistent and paracomplete data without trivialization. It can be implemented electronically, originating the Para-control, very useful in applications in the area of Robotics and Automation.

■ TA-22

Tuesday, 8:30-10:00

OPT Adal 050

Scalarization Approaches in Multicriteria Optimization I

Stream: Multiple Objective Optimization

Invited session

Chair: *Kaisa Miettinen*, Helsinki School of Economics, P.O. Box 1210, FI-00101, Helsinki, Finland, miettine@hse.fi

1 - Smoothed Variants of the Scalarizing Functions in the Interactive NIMBUS Method

Jussi Hakanen, Mathematical Information Technology, University of Jyväskylä, P.O. Box 35 (Agora), FI-40014, Jyväskylä, Finland, jhaka@mit.jyu.fi

In this paper, we discuss smoothed variants of the scalarizing functions used in the interactive NIMBUS method and demonstrate their usefulness by solving challenging real-world multiobjective optimization problems. The scalarizing functions in the synchronous version of the NIMBUS method are of the min-max type and, thus, easy to smooth. By using smooth scalarizing functions, we can choose underlying optimizers from a wider class to meet the special requirements present especially in challenging real-world optimization problems arising, for example, in industry.

2 - Generalized Scalarizing Problem GENWS for Multi-criteria Optimization

Kaisa Miettinen, Helsinki School of Economics, P.O. Box 1210, FI-00101, Helsinki, Finland, miettine@hse.fi, *Mariana Vassileva*, *Vassil Vassilev*

We describe a generalized scalarizing problem, GENWS, that can be used for solving problems with multiple conflicting criteria. GENWS produces Pareto optimal solutions and can be adjusted to cover several existing scalarizing problems.

A general scalarizing problem is very convenient because many multicriteria optimization methods can easily be implemented with minor extra effort and the decision maker can conveniently switch over to another method if (s)he wishes to specify preference information in a different format and, thus, another type of a scalarizing function is to be used.

3 - An Additive Achievement Scalarizing Function For Interactive Multiobjective Methods.

Francisco Ruiz, Applied Economics (Mathematics), University of Málaga, Campus El Ejido s/n, School of Economics and Management, 29071, Málaga, Spain, rua@uma.es, *Mariano Luque*

The most commonly used achievement scalarizing functions in reference point type methods are based on the Tchebychev distance, where the maximum distance of each objective function from its corresponding reference level is minimized. But in some cases, it may be convenient to use a scalarizing function that allows an additive aggregation of the distances. In this communication, such a function is proposed, and a mixed binary model is developed. The efficiency of the solutions is studied, and some examples are shown to illustrate the model. An algorithm based on this function is proposed.

■ TA-23

Tuesday, 8:30-10:00

OPT Adal 051

Network Optimization

Stream: Combinatorial Optimization

Invited session

Chair: *Marta Pascoal*, Departamento de Matemática, Universidade de Coimbra, INESC-Coimbra, Largo D. Dinis - Apartado 3008, 3001-454, Coimbra, Portugal, marta@mat.uc.pt

1 - An Interactive Approach for Bicriteria Transportation Problems

Inês Marques, DEIO, Faculdade de Ciências da Universidade de Lisboa, Campo Grande - Ed. C6 - 4º Piso,

1749-016, Lisbon, Portugal, ines.marques@fc.ul.pt, *Maria Eugénia Captivo, João Clímaco*

An interactive approach for Bicriteria Transportation Problems, allowing for non-integer solutions, is presented. The decision-maker conducts the search by introducing upper bounds on the values of both criteria, adding two additional constraints to the original problem. So, usual algorithms for solving transportation problems cannot be used. Two extensions of the network simplex method were implemented. One to support two additional restrictions, and the other for one additional restriction. Both revealed to be less efficient than Cplex software, however, solving higher dimension problems.

2 - A study of the connectivity of the Internet

Linda Moonen, Katholieke Universiteit Leuven, Naamsestraat 69, 3000, Leuven, Belgium, linda.moonen@econ.kuleuven.be, *Frits Spijksma, Thomas Erlebach, Danica Vukadinovic Greetham*

Detailed information about the routing of data traffic over the Internet is not publicly available, so it is very hard to create an accurate model that can be used in the analysis of the Internet. In order to study connectivity issues of the Internet, we model it as a graph. A natural means for analyzing the connectivity of a graph, is to determine the maximum number of vertex-disjoint paths and the size of a minimum cut for any pair of nodes. Both problems are NP-hard in this specific setting. We will present several exact algorithms for solving both problems.

3 - An Algorithm for a Bicriterion - Minimum Cost/Minimum Label - Spanning Tree Problem

Marta Pascoal, Departamento de Matemática, Universidade de Coimbra, INESC-Coimbra, Largo D. Dinis - Apartado 3008, 3001-454, Coimbra, Portugal, marta@mat.uc.pt, *Maria Eugénia Captivo, João Clímaco*

We deal with a bicriteria spanning tree problem relevant in some application fields such as telecommunication networks or electric networks. Each arc is assigned with a cost value and a label (such as a color). The first criterion intends to minimize the total cost of the spanning tree (the summation of its arc costs), while the second intends to get the solution with a minimum number of different labels. As these criteria are generally conflicting we developed an algorithm to generate the set of non-dominated spanning trees. Computational experiments are presented and results discussed.

■ TA-24

Tuesday, 8:30-10:00

OPT Adal 052

Tools for Simulation of Dynamical and Anticipatory Systems

Stream: Dynamical and Anticipatory Systems

Invited session

Chair: *Ivan Krivy*, Dept. of Computer Science, University of Ostrava, 30. Dubna 22, 70103, Ostrava, Czech Republic, ivan.krivy@osu.cz

Chair: *Frantisek Hunka*, Computer Science, Ostrava University, Dvorakova 7, 70103, Ostrava, Czech Republic, Frantisek.Hunka@osu.cz

1 - Demographic studies using discrete simulation

Petr Bulava, Dept. of Mathematics, University of Ostrava, 30.dubna Street, 22, 70201, Ostrava, Czech Republic, peta.bulava@email.cz

In this paper, we will discuss the usage of discrete simulation in demography. Two accomplished projects and their results will be presented as well as some experience acquired "on the way". Their common attribute is that they predict the progress of some indicators of open human society (migration is also included). There are two steps in building a discrete model of human society; the origin society must be rebuilt first. In the second phase we need to model all main demographic processes.

2 - Stability postulate in complex systems dynamics

Lyudmila Kuzmina, Kazan Aviation Institute, Kazan State Technical University of A.N.Tupolev's name, Adamuck,

4-6, 420015, Kazan-15, Russian Federation, Lyudmila.Kuzmina@ksu.ru

The development of A.M.Lyapunov stability theory methods for qualitative analysis problems in complex systems dynamics is main aim of this work. Universal approach, based on N.G.Chetayev stability postulate, on methodology of P.A.Kuzmin parametric stability and singularity postulate, is constructed for complex multi-scale systems dynamics, with extending of reduction-decomposition principle for general qualitative investigation.

3 - Making BETA to System Simulation

Frantisek Hunka, Computer Science, Ostrava University, Dvorakova 7, 70103, Ostrava, Czech Republic, Frantisek.Hunka@osu.cz

This paper deals with the simulation class BetaSIMULATION that draws from powerful abstraction mechanisms for modeling and design that provides the BETA object oriented language. The concepts used in BetaSIMULATION are inherited from Simula. However BETA is a newer language that provides slightly different features from those of the Simula language. For this reason the simulation class BetaSIMULATION offers simulation means with the same interface and useful abstractions that can enrich system simulation and be used in this way for modeling of the anticipatory systems too.

4 - Computer Simulation of Anticipatory Artificial Systems

Ivan Krivy, Dept. of Computer Science, University of Ostrava, 30. Dubna 22, 70103, Ostrava, Czech Republic, ivan.krivy@osu.cz, *Eugene Kindler*

Many systems fabricated by human society are anticipatory, because it takes a certain intelligence applied in them. Traditional anticipation techniques can be replaced by more efficient ones, namely by using computer models. But the society designing such a system A represents also an anticipatory system S and should use a computer (simulation) model for recognizing the future possible behaviour of A. Thus the model M used by S should contain another model m applied inside A. Examples of such a "nesting" models in design of services, production and harbour logistics will be presented.

■ TA-25

Tuesday, 8:30-10:00

OPT Adal I-111

Nonlinear Optimization and Programming

Stream: Mathematical Programming

Invited session

Chair: *Hiroaki Ishii*, Osaka University, Japan, ishii@ist.osaka-u.ac.jp

1 - New developments on a methodology for the approximate solution of functional optimization problems

Riccardo Zoppoli, DIST, University of Genoa, 16145, Genova, Italy, rzop@dist.unige.it, *Marcello Sanguineti*

Most mathematical tools of nonlinear programming cannot be applied to functional optimization as admissible solutions belong to infinite-dimensional spaces of functions. It is known that some approximation schemes can approximate d-variable functions using a number of parameters growing polynomially with d. We conjectured that a similar property holds for the Extended Ritz Method (ERIM) for functional optimization. We present results confirming this conjecture: for sufficiently smooth functionals one can construct polynomially-complex minimizing sequences, so avoiding the curse of dimensionality.

2 - Second-order optimality conditions for general nonlinear optimization problems

Helmut Gfrerer, Institute for Computational Mathematics, Johannes Kepler University Linz, Altenbergerstr 69, A-4040, Linz, Austria, gfrerer@numa.uni-linz.ac.at

In this talk we present a very general and unified theory of second-order optimality conditions for general optimization problems subject to abstract constraints in Banach spaces. Our results apply both to the scalar and the multicriteria case. Our approach is based on the observation that near a local minimizer, a certain system composed of the objective and the constraints has a certain singular behaviour. We present also some variational results which show that, in a certain sense, our results are the best possible one can obtain by using second order analysis.

3 - Simultaneous application of multi-objective clustering and fuzzy c-means

Ryo Haruna, Graduate School of Information and Physical Science, Osaka University, 2-1 Yamadaoka, 5650871, Suita, Osaka, Japan, ryoharuna@ist.osaka-u.ac.jp, Hiroaki Ishii

Conventional clustering algorithms utilize a single criterion that may not conform to the diverse shapes of the underlying clusters. We offer a new clustering a new fuzzy c-means clustering that uses multiple objective functions simultaneously. Especially, flexibility has been introduced into belonging of the selection of the cluster and data in the cluster. It applies to clinical data intended for the diabetic by using the proposal method, and administering the medicine or the rule concerning the treatment method is extracted.

4 - Global optimization method about the nonlinear programming problem with estimated constraints

Takashi Hasuike, Graduate School of Information Science and Technology, Osaka University, 2-1 Yamadaoka Suita, 563-0102, Osaka, Japan, thasuike@ist.osaka-u.ac.jp, Hiroaki Ishii

When we formulate real problems as mathematical problems, they sometimes include estimated constraints. In this paper, we show the solution method for the nonlinear programming problem taking account of the confidence region of a linear constraint with unknown coefficients. This is transformed into a nonlinear programming problem with a reverse convex constraint. Though it is generally difficult to find a global optimal solution, we propose the solution method managing to find a global optimal solution about both linear programming and quadratic programming with a reverse convex constraint.

■ TA-26

Tuesday, 8:30-10:00

OPT Adal III=231

Discrete Nonlinear Optimization, Automatic Tuning and Traveling Salesman

Stream: Combinatorial Optimization

Invited session

Chair: Fred Glover, Leeds School of Business, University of Colorado, Ucb 419, 80309-0419, Boulder, Colorado, United States, Fred.Glover@Colorado.edu

1 - An Ejection Chain Algorithm for the Quadratic Assignment Problem

Cesar Rego, School of Business Administration, University of Mississippi, University, 38677, Oxford, MS, United States, crego@bus.olemiss.edu, Fred Glover, Tabitha James

For the quadratic assignment problem, a 2-exchange neighborhood is prevalent in most successful neighborhood search approaches as the exploration of larger neighborhoods for this problem is computationally expensive. We introduce an algorithm based upon the concept of ejection chains that allows larger exchanges to be strategically built and considered. We present computational results that demonstrate the ability of our algorithm to provide higher quality solutions than other large neighborhood algorithms for the QAP. The algorithm is also shown to be very computationally efficient.

2 - Run-time prediction and automatic parameter tuning for heuristic search algorithms

Holger Hoos, Computer Science, University of British Columbia, 2366 Main Mall, V6T 1Z4, Vancouver, BC,

Canada, hoos@cs.ubc.ca, Frank Hutter, Kevin Leyton-Brown, Youssef Hamadi

We approach the problem of automatically tuning the parameter settings of a heuristic search algorithm by using machine learning techniques to obtain predictive models of the algorithm's run-time in dependence of its parameter settings and characteristics of the given problem instance. We demonstrate that when applied to several well-known high-performance stochastic local search algorithms for the propositional satisfiability problem (SAT), our approach yields surprisingly accurate run-time predictions that provide the basis for highly effective automatic parameter tuning.

3 - Attractive Nonlinear Models for Combinatorial Optimization

Fred Glover, Leeds School of Business, University of Colorado, Ucb 419, 80309-0419, Boulder, Colorado, United States, Fred.Glover@Colorado.edu, Gary Kochenberger

Many combinatorial optimization problems are modeled as large 0/1 linear programs. Solutions are typically pursued using methodologies primarily designed for linear models such as branch and cut. In this talk we present and discuss alternative nonlinear models for such problems that can be efficiently solved via metaheuristic methods. Several examples are presented comparing the standard linear models with their nonlinear counterparts.

■ TA-27

Tuesday, 8:30-10:00

OPT Adal V=229

Optimization Modeling Systems I - Maximal, ILOG

Stream: Software for OR/MS

Invited session

Chair: Bjarni Kristjansson, Maximal Software, Inc., 2111 Wilson Boulevard, 22201, Arlington, Virginia, United States, bjarni@maximalsoftware.com

1 - Implementing Real-World Optimization Applications with MPL and OptiMax

Bjarni Kristjansson, Maximal Software, Inc., 2111 Wilson Boulevard, 22201, Arlington, Virginia, United States, bjarni@maximalsoftware.com

MPL is a modeling system that allows the model developer to efficiently formulate complicated optimization models. We will demonstrate advanced indexing and data modeling techniques that are used to provide the speed and scalability required to solve large-scale models with millions of variables and constraints. We will also demonstrate how the OptiMax 2000 Component Library can be used to embed MPL models in customized end-user applications to solve real-world optimization problems.

2 - Developing optimization applications using CPLEX, OPL and ODM

Sofiane Oussedik, ILOG, 3-5 Avenue Gallièni, Batiment Orsud, 94257, Gentilly, France, soussedik@ilog.fr

This presentation will give you an insight on the recent ILOG optimisation developments and in particular those concerning CPLEX, OPL Development Studio, and Optimization Decision Manager (ODM). CPLEX feature high-performance, robust solvers for linear, quadratic, quadratically constrained, and mixed integer programming problems. OPL let you represent optimization problems descriptively and create optimization applications with minimal computer programming. ODM is an optimization application development tool for interactive what-if analysis, soft constraints and solution comparison.

■ TA-28

Tuesday, 8:30-10:00

OPT Adal VI=207

Optimization and Data Mining II

Stream: Linear Optimization

Invited session

Chair: *Theodore Trafalis*, Industrial Engineering, University of Oklahoma, 202 West Boyd, Rm 124, 73019, Norman, OK, United States, ttrafal@ou.edu

1 - Large-scale Support Vector Machines: Decomposition and Cascade Approaches

Luca Zanni, Department of Mathematics, University of Modena and Reggio Emilia, Via Campi 213/B, 41100, Modena, Italy, zanni.luca@unimo.it, *Thomas Serafini*, *Gaetano Zanghirati*

Training the learning methodology Support Vector Machines on million of samples is a challenging quadratic program. Due to the density and large size of the problem, optimization strategies suited to exploit the resources of modern parallel architectures seem very promising. Examples are given by the PGPDT decomposition software (www.dm.unife.it/gpdt) and the Cascade algorithm (Graf et al. 2005). In this work a Cascade-like algorithm is presented and compared with PGPDT on very large data sets. Furthermore, a new scheme based on the combination of the above parallelization ideas is discussed.

2 - Convex Clustering Shrinkage and the Regularization Path

Kristiaan Pelckmans, ESAT - SCD/SISTA, Katholieke Universiteit Leuven, Kasteelpark Arenberg 10, 3001, Leuven, Belgium, Kristiaan.Pelckmans@esat.kuleuven.be, *Johan Suykens*, *Bart De Moor*

This presentation will discuss recent advances in the theory and practice of clustering methods. Specifically, we discuss the convex formulation of clustering and explore its relationship with regularized estimation methods as ridge regression and LASSO. Then it will be shown that this formulation gives a resolute road towards the theoretical analysis of the foundations of clustering, and that it implies a practical clustering method which can be related to the regularization path. We will explore relationships with standard algorithms as k-means and hierarchical clustering.

3 - Multi-classification Tikhonov Regularization Knowledge-based Support Vector Machine

Theodore Trafalis, Industrial Engineering, University of Oklahoma, 202 West Boyd, Rm 124, 73019, Norman, OK, United States, ttrafal@ou.edu, *Olutayo Oladunni*

This paper presents a knowledge-based linear classification model for multi-category discrimination of sets or objects with prior knowledge. The prior knowledge is in the form of multiple polyhedral sets belonging to one or more categories or classes, and it's introduced as additional constraints. The resulting formulation leads to a least square problem that can be solved using matrix methods or iterative methods. To evaluate the model, data and prior knowledge from the Wisconsin breast cancer prognosis and two-phase flow regimes in pipes were used to train and test the proposed formulation.

■ TA-29

Tuesday, 8:30-10:00

OPT Adal VII=225

Stochastic Methods for Global Optimization

Stream: Global Optimization: Deterministic and Stochastic Methods

Invited session

Chair: *Zelda B. Zabinsky*, Industrial Engineering, University of Washington, Box 352650, 98195, Seattle, WA, United States, zelda@u.washington.edu

1 - Optimality testing in stochastic algorithms

Vaida Bartkute, Operation Research Department, Institute of Mathematics and Informatics, Akademijos 4, 08663, Vilnius, Lithuania, vaidaba@one.lt, *Leonidas Sakalauskas*

We consider the application of order statistics to establish the optimality in stochastic Markov type algorithms. We introduce a stopping criterion - length of the confidence interval of the objective function extremum, estimated according to order statistics of the function values obtained during the optimization. We give an illustrative example for optimality testing and stopping in Stochastic Approximation and Simulated Annealing algorithms. The efficiency of the considered approach is discussed using the results of application to continuous optimization and Bin-packing problems.

2 - Globalizing the Pattern Search Method by Probabilistic Features

Montaz Ali, School of Computational and Applied Mathematics, University of the Witwatersrand, 1 Jan Smut Avenue, Private Bag-3, Wits-2050, Johannesburg, South Africa, mali@cam.wits.ac.za

The most recent direct search method for local optimization is the Pattern Search (PS) method for local optimization. The most important feature of this method, is that it has mathematical convergence guarantee. Despite the fact that pattern search is a direct search method, its theoretical guarantee is very appealing. It is a local search method. In this research, we propose to a Pattern Search Algorithm to solve global optimization problem. In particular we make the pattern search method a global algorithm by incorporating probabilistic features into it.

3 - Probabilistic Branch-and-Bound for Optimizing Complex Stochastic Systems

Zelda B. Zabinsky, Industrial Engineering, University of Washington, Box 352650, 98195, Seattle, WA, United States, zelda@u.washington.edu

Many optimization problems are complex with probabilistic interactions, so an analytical model may not exist and a simulation must be used. We introduce a probabilistic branch-and-bound (PBnB) scheme to optimize a simulation over continuous and/or discrete variables. PBnB uses a statistical analysis to guide the randomized sampling strategy, as well as to determine the number of samples to take within a subregion and the number of replications to perform at a given setting. A bound on the probability the final subregion contains the global optimum is derived. Numerical results are presented.

■ TA-30

Tuesday, 8:30-10:00

NONL Adal X=220

Linear Semi-Infinite Optimization IV

Stream: Linear Semi-Infinite Optimization

Invited session

Chair: *Sven-Åke Gustafson*, Science and Technology, Box 8002, N-4068, Stavanger, Norway, sven-aake.gustafson@tn.his.no

1 - Primal-dual stability

Maxim Todorov, Dpto. de Física y Matemáticas, Universidad de las Américas, Sta. Catarina Martir, 72820, Cholula, Puebla, Mexico, maxim.todorov@udlap.mx, *Miguel Goberna*

Any linear semi-infinite optimization problem and also its dual, can be classified as either consistent or bounded or unbounded, giving rise to nine duality states, three of them being precluded by the weak duality theorem. We have analyzed exhaustively the topological properties of the six nonempty duality states. We have shown, in particular, that they are neither closed nor open nonconvex cones, and that some of them have common parts of their boundaries. Primal and dual stability has been discussed, as well.

2 - Characterization of total ill-posedness in linear semi-infinite optimization

Marco A. López-Cerdá, Statistics and Operations Research, Alicante University, Ctra. San Vicente de Raspeig s/n, 3071, Alicante, Spain, marco.antonio@ua.es

We approach the characterization of the total ill-posedness property in linear semi-infinite optimization. In this setting, a problem is totally ill-posed when arbitrarily small perturbations of the coefficients may produce perturbed problems of different kinds, namely, inconsistent, consistent non-solvable, and solvable problems. In order to derive this characterization, we provide an extension of the Valadier-Volle formula for the subdifferential of the supremum function of affine functions at a given point. Our formula does not require relative continuity of the function at the point.

3 - Primal-dual ill-posedness in linear semi-infinite optimization: An application to conic programs.

F. Javier Toledo-Melero, Operations Research Center, Miguel Hernández University, Avda. de la Universidad, s/n, 03202, Elche, Alicante, Spain, javier.toledo@umh.es, María Josefa Cánovas, Marco A. López-Cerdá, Juan Parra

In this talk we consider a linear optimization problem with an arbitrary (possibly infinite) number of constraints, as well as its dual problem in the sense of Haar. Firstly we characterize those problems that are ill-posed with respect to some property, namely, consistency, boundedness, solvability, dual-consistency, primal-dual-consistency. The corresponding distances to ill-posedness are also given. Finally we provide a new insight for the ill-posedness in conic linear programming.

■ TA-31

Tuesday, 8:30-10:00

NONL Adal XI=222

SDP-Based Optimization in Industrial Applications

Stream: Industrial Application of Nonlinear Programming Algorithms

Invited session

Chair: Wolfgang Achtziger, Department of Mathematics, University of Dortmund, Vogelpothsweg 87, 44221, Dortmund, Germany, wolfgang.achtziger@uni-dortmund.de

1 - Solving large-scale SDP problems of structural optimization

Michal Kocvara, Decision Making Theory, Institute of Information Theory and Automation, Pod vodarenskou vezi 4, 18208, Prague 8, Czech Republic, kocvara@penopt.com, Michael Stingl

Many problems of structural optimization can be with advantage formulated as large-scale (possibly nonlinear) problems of semidefinite programming. These are, for instance, problems with constraints on the natural frequencies and buckling, or the free material optimization problem with constraints on displacements or strains. We will present solution techniques specialized for these types of problems that allow us to solve large-scale real world examples.

2 - SDP-based calibration of correlation matrices

Katrin Schöttle, HVB-Stiftungsinstitut für Finanzmathematik, TU München, Boltzmannstr. 3, 85748, Garching bei München, Germany, schoettle@ma.tum.de, Ralf Werner

The talk summarizes and compares recent approaches for the calibration of correlation matrices. It can be observed that the most efficient methods are based on SDP formulations of the calibration problem. Closer investigations of the primal and dual SDP give insight into the capabilities and limitations of the specific formulation. For low dimensional problems the primal one seems to be more flexible, allowing for broader applications in industry. We illustrate the approaches based on a real world example from finance.

3 - Structural Topology Optimization with Eigenvalues

Wolfgang Achtziger, Department of Mathematics, University of Dortmund, Vogelpothsweg 87, 44221, Dortmund, Germany, wolfgang.achtziger@uni-dortmund.de, Michal Kocvara

We consider problems of topology optimization of discrete or discretized mechanical structures with structural eigenvalues as constraints or as objective functions. Interrelations of the problems and their solutions are discussed. Particular difficulties are non-Lipschitzian behavior and even discontinuity of the eigenvalue. As a cure we consider equivalent reformulations as SDPs. For the non-convex SDP of maximizing the minimum eigenvalue we present an algorithm for finding a guaranteed tight approximation of a global optimizer. Numerical examples are provided for truss structures.

■ TA-32

Tuesday, 8:30-10:00

NONL Adal XIII=218

Semidefinite Programming and its Applications

Stream: Convex Optimization Methods

Invited session

Chair: Henry Wolkowicz, Faculty of Mathematics, University of Waterloo, N2L3G1, Waterloo, Ontario, Canada, hwolkowicz@uwaterloo.ca

1 - Conic column generation

Jean-Louis Goffin, Faculty of Management, McGill University, 1001 Sherbrooke Street West, H3A1G5, Montreal, Quebec, Canada, Jean-Louis.Goffin@McGill.ca

Dantzig-Wolfe column generation can be extended to the case where columns belong to a general self-dual cone. By duality this leads to a variant of the cutting plane method where the cutting planes may be linear, SOCC or SDP, thus leading to approximating an NDO (SOCC or SDP) function by simpler SOCC or SDP cuts. Computational results are presented.

2 - Extrapolation algorithm for convex feasibility problems with application to Semidefinite Programming

Serge Kruk, Mathematics, Oakland University, 2200 N. Squirrel Road, Science and Engineering Building, 48309, Rochester, MI, United States, kruk@oakland.edu, Heinz Bauschke, Patrick Combettes

The convex feasibility problem finds a common point of a countable family of convex sets in a Hilbert space. We describe a general parallel block-iterative algorithmic framework in which the affine subspaces are exploited to introduce extrapolated over-relaxations. This framework encompasses a wide range of projection, subgradient projection, proximal, and fixed point methods encountered in various branches of optimization. Numerical experiments in the context of large scale semidefinite programming are provided to illustrate the benefits of the extrapolations.

3 - Anchored Graph Realization and Sensor Localization

Henry Wolkowicz, Faculty of Mathematics, University of Waterloo, N2L3G1, Waterloo, Ontario, Canada, hwolkowicz@uwaterloo.ca, Veronica Piccialli, Nathan Krislock

Many applications use ad hoc wireless sensor networks for monitoring information. These include a large number of sensor nodes which communicate among themselves. The location of a subset of the sensors, called anchors, is known. We are able to establish distances between a subset of the sensors and anchors. The sensor localization problem is to find/estimate the location of all the sensors. We model this problem using Euclidean Distance Matrices and semidefinite programming. We exploit special structure and develop a robust interior-point algorithm.

■ TA-33

Tuesday, 8:30-10:00

NONL Adal A=313

Constrained optimization

Stream: Global and Local Derivative Free Optimization

Invited session

Chair: *Rafail Gasimov*, Industrial Engineering, Eskisehir Osmangazi University, Bademlik, 26030, Eskisehir, Turkey, gasimovr@ogu.edu.tr

1 - Bounded lower subdifferentiability optimization techniques

Albert Ferrer, Dpt. of Applied Mathematics I, Technical University of Catalonia, Av. Doctor Marañón, 44-50, 08028, Barcelona, Catalunya, Spain, alberto.ferrer@upc.edu, *Gleb Beliakov*

Quasiconvex programs have been widely applied to the modelization of programming problems in several fields. In this article we present a new procedure to be applied to quasiconvex programs with a boundedly lower subdifferentiable objective function. The procedure builds lower approximations to the objective function by adapting the Cutting Angle method. The properties of the quasiconvex functions allow improving the efficiency of the procedure for deleting zones of the feasible domain in which the global optimum cannot be found.

2 - Separation via Polyhedral Conic Functions and Application in Classification Problems

Gurkan Ozturk, Industrial Engineering Department, Eskisehir Osmangazi University, 26030, Eskisehir, Turkey, gurkan@ogu.edu.tr, *Rafail Gasimov*

We consider the problem of discriminating between two finite point sets A and B in the n dimensional space by using a special type of polyhedral functions. An effective finite algorithm for finding a separating function based on iterative solutions of linear programming subproblems is suggested. It has been shown that arbitrary two finite point disjoint sets can be separated by using this algorithm. An application on classification problems with some real-world data sets has been implemented.

3 - The Modified Subgradient Algorithm Based on Feasible Values

Rafail Gasimov, Industrial Engineering, Eskisehir Osmangazi University, Bademlik, 26030, Eskisehir, Turkey, gasimovr@ogu.edu.tr, *Ozden Ustun*

In this paper we continue to study the Modified Subgradient (MSG) Algorithm previously proposed by R.Gasimov (2002) for solving the nonconvex constrained optimization problems via sharp augmented Lagrangian. We introduce a new algorithm for finding a global minimum for a wide class of nonconvex optimization problems. The new algorithm does not require knowing the optimal value initially and seeks it iteratively beginning with an arbitrary number. A global minimum of the augmented Lagrangian is also not necessary for updating the step size parameter in the new algorithm.

■ TA-34

Tuesday, 8:30-10:00

DEC VR11 V-138

DDM in Supply chains

Stream: Distributed Decision Making

Invited session

Chair: *Per Agrell*, Louvain School of Management, Université Catholique de Louvain, Cescm, Place des Doyens, 1, 1348, Louvain-la-neuve, Belgium, agrell@poms.ucl.ac.be

1 - Models of the transient behaviour of production units to optimize the aggregate material flow

Hubert Missbauer, Information Systems, Production and Logistics Management, University of Innsbruck,

Universitätsstrasse 15, 6020, Innsbruck, Austria, hubert.missbauer@uibk.ac.at

Workload control (WLC) is an approach for efficient lead time management in MPC systems. It is shown that traditional WLC order release mechanisms are a rule-based approach to determine the aggregate material flow. As an alternative we propose an optimization-based approach that derives the amount of released work over time from a model of the production unit. This implies a major change in the decision hierarchy. The paper presents models that realize this approach, identifies their shortcomings and presents a research direction based on the transient behaviour of queueing networks.

2 - Transshipments and transfer prices in quick-response distribution chains

Stefan Minner, Department of Logistics, University of Mannheim, Schlossgartenstr. 7, 68131, Mannheim, Germany, minner@bwl.uni-mannheim.de

The paper analyzes the problem of inventory transshipment in distribution systems with local decision making of the involved retailers. The retailers place an initial order in advance of the selling season and face an intermediate transshipment opportunity to rebalance inventories after first demands have been observed and prior to the demands of the remaining season. We analyze the impact of different mechanisms for transshipment transfer price setting on local decisions about initial stocking levels and give suggestions on the optimal timing of the transshipment opportunity.

3 - Supply chain cannibalization and coordination in process definitions

Per Agrell, Louvain School of Management, Université Catholique de Louvain, Cescm, Place des Doyens, 1, 1348, Louvain-la-neuve, Belgium, agrell@poms.ucl.ac.be, *Xavier Brusset*

Supply chains may contain partially overlapping downstream segments to induce efficiency through competition or to maximize market coverage, e.g. national distribution on a centralized physical production and distribution organization. We study the cannibalization and coordination problem in partially overlapping chains through control of the diversity in process definitions as to avoid freeriding and other incentive problems. An agency model is used to derive some policy findings. A case based on the interactions between a parapharmacy and a cosmetics manufacturer in Europe is presented.

■ TA-35

Tuesday, 8:30-10:00

DEC VR11 V-147

Sustaining Social Schemes with PSMs

Stream: Problem Structuring Methods / Soft OR

Invited session

Chair: *John Friend*, Stradspan, 17 Birks Wood Drive, Oughtibridge, S35 0HY, Sheffield, United Kingdom, jfriend@btinternet.com

1 - Using PSMs to examine the sustainability of a forest based enterprise

Sue Merchant, Blue Link Consulting, 4, Shepherds Way, WD3 7NJ, Rickmansworth, Hertfordshire, United Kingdom, suemerchant@hotmail.com

Hill Holt Wood is a community controlled social enterprise which aims to run a self-sustaining woodland using traditional crafts. It is set up as a business and receives some income by educating children who are excluded from school: the children learn a variety of practical skills and are guided back to education/employment. A large number of stakeholders have an interest in the project and it was felt that PSMs might be useful in helping the board examine the long term sustainability of the scheme. The paper describes ways in which PSMs were used to help develop a risk analysis for the project.

2 - Inclusive Problem Structuring: Designing Support Networks using PEARL

Donna Champion, The Business School, Loughborough University, LE11 3TU, Loughborough, Leicestershire, United Kingdom, d.champion@lboro.ac.uk

The Hostel Project described in this paper is part of a long term Action Research initiative being undertaken in collaboration with key workers and residents at a charity-run hostel for the homeless in Leicestershire, UK. The paper describes the application of a new PSM, PEARL, to facilitate the residents thinking through and expressing the problems they face and also to participate fully in the design of the support networks they will need to move on to more permanent accommodation and to gain employment.

3 - Use of PSM's in Sustaining Social Development: Challenges to the Orthodoxies of OR

John Friend, Stradspan , 17 Birks Wood Drive, Oughtibridge, S35 0HY, Sheffield, United Kingdom, jfriend@btinternet.com, *Dennis Finlayson*

Examples of the use of PSM's with development planners and communities in Iceland and Venezuela are used to draw out some important points about planning under pressure in pursuit of sustainable social and economic development. In such non-corporate settings, patterns of relationships may be in continual flux, with the strategic management of uncertainty tending to become a key driver of progress. The concern of OR scientists with such desiderata as quantification and implementation now has to be re-examined in a more critical light. So how can the value of our interventions be assessed?

■ TA-36

Tuesday, 8:30-10:00

DEC VR11 V-155

Additivity and Weights for MCDA

Stream: Multicriteria Decision Analysis

Invited session

Chair: *Marc Pirlot*, Service de Mathématique et recherche opérationnelle, Faculté Polytechnique de Mons, Rue de Houdain 9, B-7000, Mons, Belgium, marc.pirlot@fpms.ac.be

1 - Conceptualizing multi-criteria decisions: what's wrong with weighted averages?

Michael Wood, SBS, University of Portsmouth, Richmond Building, Portland Street, PO1 3DE, Portsmouth, United Kingdom, michael.wood@port.ac.uk

There are a number of conceptual schemes for modeling multi-criteria decisions, but the dominant one in practice is based on the idea of a weighted average of ratings on the various criteria. This talk looks at the ubiquity of this idea, and at some of its difficulties perhaps the main one being that it encourages decision makers to think that their problem is solved. An alternative conceptual framework Pros And Cons On Common Scales is then suggested as a way of addressing these difficulties.

2 - Assigning weights by means of dimension theory

Daniel Gomez Gonzalez, Estadística e Investigación Operativa III, Complutense University, Av Puerta de Hierro, 28040, Madrid, Spain, dagomez@estad.ucm.es, *Javier Montero*

Assigning weights to criteria is a key issue in multicriteria decision making, since they use to be related to the importance of those criteria explaining decision making. In other hand, the dimension theory allows the representation of any finite set taking into account the preferences of the decision maker. Here we propose that the importance of the criteria can be approached taking into account those possible representations associated to the dimension of the binary preference relations between criteria. This method will be specially useful when incomparability between criteria appears.

3 - A method to learn additive value functions based on the analytic center

Marc Pirlot, Service de Mathématique et recherche opérationnelle, Faculté Polytechnique de Mons, Rue de

Houdain 9, B-7000, Mons, Belgium, marc.pirlot@fpms.ac.be, *Philippe Fortemps*, *Géraldine Bous*, *François Glineur*

The UTA method and several variants use linear programming to find an additive value function compatible with a ranking of a subset of the alternatives. We propose to compute instead the analytic center of the set of additive value functions compatible with the given ranking and we compare the obtained value functions to those produced by the various variants of UTA. This indicates that the analytic center method provides an attractive alternative to the classical way of doing.

■ TA-37

Tuesday, 8:30-10:00

DEC VR11 V-156

Information Systems for MCDA I

Stream: Multiple Criteria Decision Aid (c)

Invited session

Chair: *Yannis Siskos*, Department of Informatics, University of Piraeus, Karaoli Dimitriou 80, 18534, Piraeus, Greece, ysiskos@unipi.gr

1 - Tracking changes of e-customer preferences using multicriteria analysis

Evangelos Grigoroudis, Decision Support Systems Laboratory, Technical University of Crete, University Campus, Kounoupidiana, 73100, Chania, Greece, vangelis@ergasya.tuc.gr, *Panagiotis Kyriazopoulos*, *Yannis Siskos*, *Athanasios Spyridakos*, *Denis Yannacopoulos*

The objective of the paper is to present a framework for analysing changes of customer preferences in the Internet Service Providers sector. For this reason detailed results of customer satisfaction surveys conducted in different time periods are presented. The analyses are based on the MUSA method, which is a multicriteria preference disaggregation approach. Provided results are mainly focused on the evaluation of potential trends of e-customer preferences and a benchmarking analysis, based on the evolution of satisfaction levels for the quality characteristics of the provided services.

2 - MMASITI - A Decision Support System for the Selection of Information Systems/Information Technologies in a business context.

Teresa Pereira, Mathematics, ESEIG-IPP, R. D. Sancho I, 981, 4480-771, Vila do Conde, Portugal, teresapereira@eseig.ipp.pt, *Sameiro Carvalho*

This paper presents a Multicriteria Methodology for Selection of Information Technologies (MMASITI). The IT choice is a problem of multidimensional nature. Though a large number of MCDA methods have been proposed by researchers, none can be considered as the "Method" cover all decisions situations. Up until recently, no specific MCDA method existed to address the IT selection. Though some companies already adopt systematic approaches for selecting IT, few have been assisted by a structured multicriteria based decision methodology. The MMASITI has been proposed to address this gap.

3 - Collaborative Decision Making - A Knowledge Based approach in Engineering Environments

Sriram Bhamidipati, Symbiotic Solutions, Inc., 28719 Eton Glen, 48331, Farmington Hills, Michigan, United States, sriram_bhamidipati@yahoo.com

The paper presents implementation of Knowledge Management techniques in Engineering Organizations as it applies to Collaborative Decision making. The applications involve visualization techniques of different viewpoints, consensus development and the knowledge capture and sharing.

4 - A cognitive mapping technique based methodology for criteria designing activity in context with multiple decision makers

Sébastien Damart, M-Lab, Dauphine Recherche en Management, Ecole Normale Supérieure de Cachan -

M-Lab, 61, avenue du Président Wilson, 94230, Cachan, France, damart@mlab.ens-cachan.fr

In multiple criteria decision aiding area, few researches specifically focus on how facilitators help groups of decision makers to build sets of criteria. This communication suggests a methodology based upon the use of cognitive mapping techniques which is designed to support groups of decision makers to build sets of criteria.

■ TA-38

Tuesday, 8:30-10:00

DEC VR11 V-157

DEA Applications II

Stream: DEA and Performance Measurement

Invited session

Chair: *Carla Amado*, Faculdade de Economia, Universidade do Algarve, Campus de Gambelas, 8005 139, Faro, Portugal, camado@ualg.pt

1 - Development of a performance measurement model for Portuguese secondary schools

Cláudia Sarrico, Department of Social, Juridical and Political Sciences, University of Aveiro, 3810-193, Aveiro, Portugal, c.s.sarrico@csj.ua.pt, *Maria João Pires da Rosa*

The presentation will focus on the development of a performance measurement model for Portuguese secondary schools, which may be used as a managerial tool for schools and to support decision-making regarding educational policies. We start by discussing what constitutes good school performance, and by identifying quantitative and qualitative performance indicators to measure it. Finally, the extent to which the performance of public and private schools is significantly different and what difference in performance is due to input socio-economic factors or managerial factors is discussed.

2 - Value Added of Schools: A Comparison of Methodologies

Ana Camanho, Faculdade de Engenharia, Universidade do Porto, Demegi - Gein, Rua Dr. Roberto Frias, 4200-465, Porto, Portugal, acamanho@fe.up.pt, *Maria Portela*

This paper analysis the value added of a sample of Portuguese schools using DEA and the methodology used by the UK Department for Education and Skills (DfES). The value added estimates obtained by the two methods are substantially different as DEA emphasizes on best-observed performance, whereas the DfES method reveals average performance. The main advantage of the DfES methodology is simplicity, although the value-added estimates confound pupil effects with school effects. In contrast, DEA can differentiate these effects, such that the joint use of these methodologies can be useful.

3 - Exploring the use of Data Envelopment Analysis for Formative Evaluation in Oncology: An Application to Radiotherapy Services

Sérgio Santos, Faculty of Economics, University of Algarve, Campus de Gambelas, 8005-139, Faro, Portugal, ssantos@ualg.pt, *Carla Amado*

Radiotherapy is an important element in cancer treatment, both for cure and for palliation. Whilst performance measurement and performance improvement are a major concern of most radiotherapy departments, measuring and managing the performance of these departments is particularly challenging. This paper critically evaluates the use of DEA for formative evaluation of radiotherapy departments. We begin by proving the theoretical background of the research. The applicability of DEA to assess the performance of radiotherapy departments is then analysed. We conclude with some closing remarks.

■ TA-39

Tuesday, 8:30-10:00

DEC VR11 V-158

Conceptual Frameworks for DSS

Stream: Decision Support Systems

Invited session

Chair: *Marija Jankovic*, Industrial Engineering Laboratory, Ecole Centrale Paris, Grande Voie des Vignes, 92295, Chatenay Malabry, France, marija@lgi.ecp.fr

1 - Decision making in Ontology-Based Uncertainty Model

Yi Yang, Institute for Algorithms and Cognitive Systems, University of Karlsruhe, Am Fasanengarten 5, Geb.50.34, 76131, Karlsruhe, Germany, yiyang@ira.uka.de, *Jacques Calmet*

The aim of this paper is to propose a mechanism to support decision making based on an ontology-driven uncertainty model (OntoBayes) in the area of corporate knowledge. OntoBayes makes use of probability and dependency annotations to represent uncertain information in Bayesian Networks (BN). The selected overall framework is the multi-agent paradigm. Agents modelled with OntoBayes have two parts: the knowledge part and the decision part. The former is the ontology knowledge while the latter is based upon BN. OntoBayes is thus designed in agreement with the Agent-Oriented Abstraction paradigm.

2 - Collaborative Decision Making : Complementary Developments of a Model and An Architecture as a Tool Support

Marija Jankovic, Industrial Engineering Laboratory, Ecole Centrale Paris, Grande Voie des Vignes, 92295, Chatenay Malabry, France, marija@lgi.ecp.fr, *Pascale Zaraté*, *Jean Claude Bocquet*

Recent years we can hear a lot about cooperative decision-making, group or collaborative decision-making. These types of decisions are the consequences of developed working conditions: geographical dispersion, team working, concurrent working. We present the complementary points of two developments: model development and architecture development. The first work concerns conceptual model of collaborative decision-making. The second part is a proposition of architecture or platform for cooperative decisions. In the third part, we give an overview of complementary aspects of these studies.

3 - Housing quality evaluation using a web-based spatial multicriteria decision support system

Eduardo Manuel Natividade-Jesus, Department of Civil Engineering, Polytechnic Institute of Coimbra - School of Engineering, Quinta da Nora, 3030, Coimbra, Portugal, ednativi@isec.pt, *João Coutinho-Rodrigues*

Land for housing is becoming scarce and environmental and construction requirements more stringent. This results in the need for an appropriate methodology for evaluating the urban built space that can support multiple, often conflicting, criteria and would be useful to developers, consumers, and government agencies. We will present a DSS for such analysis. It integrates a problem editor, a data base management module, a MCDM tool and a suitable computer interface, which can be integrated with WEB-based GIS tools, in order to minimize the cognitive effort required of the Decision Maker.

■ TA-40

Tuesday, 8:30-10:00

SOC VR11 V-257

General Environment Planning

Stream: Environmental Planning (c)

Invited session

Chair: *Nina Karasmaa*, Transportation Engineering, Helsinki University of Technology, Raketintajankatu 4 A, 02150, Espoo, Finland, nina.karasmaa@tkk.fi

1 - Environmental Management Systems experience and effects in Latvia

Tatjana Tambovceva, Riga Technical University, Jaunciema 2.lin.30, LV-1023, Riga, Latvia, tatjana.tambovceva@rtu.lv,
Ineta Geipele

More than 88800 organizations worldwide have implemented environmental management systems. About 100 of them are located in Latvia. The purpose of this study is to explore experience and effects of EMS implementation in Latvia. The results shows that EMS often results in reduce of environmental impact. The strongest driving force of EMS implementation is the expected improvement of the organization's images. Two important problems shall be improved: the coordination between the EMS and the strategy of the organization and the synchronization of EMS and the central chains values.

2 - Regional Warming Signals of Anthropogenic Influence in Global Datasets

Achilleas Mavrellis, Department for Education Skills, 6C Sanctuary Buildings, Great Smith Street, SW1P 3BT, London, United Kingdom, ahilleas@gmail.com

We present a new approach to detecting climate change signals in global datasets. Evidently industrialized regions have significantly larger warming trends than other regions and the warming occurs at the surface and in the lower atmosphere. If this warming has an anthropogenic source such as energy inefficiency, then any source of energy, clean or otherwise, could have a serious impact on energy and environmental policy and planning around regional warming at sub-continental scales.

3 - The possibilities of company mobility management in Finland

Nina Karasmaa, Transportation Engineering, Helsinki University of Technology, Raketajanaukio 4 A, 02150, Espoo, Finland, nina.karasmaa@tkk.fi, *Elina Sala*

This paper presents the research, which aims to define responsibility issues of company mobility management in Finland, which are the most efficient actions to influence employees' mobility behaviour and which are the means to encourage employers to take company mobility management as part of company values. The research was based on literary research, an inquiry made to the employees of two institutes and theme interviews.

■ TA-41

Tuesday, 8:30-10:00

SOC VR11 V-258

Resource Planning and Forecasting

Stream: Behavioural and Experimental Economics

Invited session

Chair: *Ulrike Leopold-Wildburger*, Statistics and Operations Research, Karl-Franzens-University, Universitätsstraße 15/E3, 8010, Graz, Austria, ulrike.leopold@uni-graz.at

1 - Applicability of current energy forecast models in extreme weather situations

Benno Rothstein, European Institute for Energy Research, Emmy-Noether Str. 11, 76131, Karlsruhe, Germany, benno.rothstein@eifer.org, *Solveig Mimler*, *Heiko Hahn*, *Silja Meyer-Nieberg*, *Stefan Pickl*

For the short-term forecast of electricity consumption, several models exist with different methodological approaches. Although these models are differing, they all do not integrate sociological aspects regarding electricity consumption. A sociological analysis of the energy relevant consumer behaviour during the hot summer of 2003 revealed strongly changed consumption patterns, which have not been taken into account by electricity suppliers. The thesis is that electricity forecast models could profit from the integration of sociological knowledge in extreme weather situations.

2 - Lotka-Volterra-Equations and Resource Planning Problems: The Mathematical Framework

Stefan Pickl, Department for Computer Science, Universität der Bundeswehr München, Heisenbergstr. 39, 85577, Neubiberg-München, Bavaria, Germany,

stefan.pickl@unibw.de, *Ulrike Leopold-Wildburger*, *Otwin Becker*, *Silja Meyer-Nieberg*, *Jörg Schütze*

The Lotka-Volterra-Equations may be used to illustrate and to simulate the economic behaviour of resource planning problems. With their time-discrete formulation a simulation tool was developed (EXPO - Experimental Process Optimization) which can be used for certain experimental studies. We present the mathematical framework.

3 - Lotka-Volterra-Equations and Resource Planning Problems: The Economic Framework

Ulrike Leopold-Wildburger, Statistics and Operations Research, Karl-Franzens-University, Universitätsstraße 15/E3, 8010, Graz, Austria, ulrike.leopold@uni-graz.at, *Otwin Becker*, *Stefan Pickl*, *Jörg Schütze*

The Lotka-Volterra-Equations may be used to illustrate and to simulate the economic behaviour of resource planning problems. According to this model, actual hypotheses are formulated and tested: Can a visual information about the distance to the equilibrium may influence the willingness of the actors to take a risk? Can we detect certain phases within the control process? Can a visual information support the learning effect? Some of the first results are analysed.

■ TA-42

Tuesday, 8:30-10:00

SOC VR11 V-261

Modeling Social Systems IV

Stream: Modeling Social Systems

Invited session

Chair: *Roberto Zarama Urdaneta*, Industrial Engineering, Universidad de Los Andes, Calle 19 A #, 37 Este Edificio W Quinto Piso, 57-1, Bogota, Colombia, rzarama@uniandes.edu.co

1 - STEM, a Language for Modelling of Tempo-Spatial Enterprise Operations

Darek Eriksson, Mid Sweden University, 25 Östersund, S-831, Östersund, Sweden, darek.eriksson@hotmail.com, *Stig C Holmberg*

International trade operations are hyper complex systems with stakeholders differencing in, for example, tasks, views, culture, and location. Hence, there is a need for a language helping those actors to communicate. STEM - The Systemic Tempo-Spatial Enterprise Modelling Language - is proposed for guiding a management system's modelling of its operational system. By conceiving operations in three dimensions: form, time, and space, it is offering an extensive set of modelling constructs. STEM has proved its usefulness in easing the coordination challenges of dynamic e-logistic operations.

2 - Cohesion and Autonomy in Hierarchical Models

Jorge Villalobos, Industrial Engineering, Universidad de Los Andes, Calle 19 A #, 37 Este Edificio W Quinto Piso, 57-1, Bogotá, Colombia, jovillal@uniandes.edu.co, *Alonso Botero*, *Roberto Zarama*

We entertain the hypothesis that the characteristic of "hierarchical modularity" gives an optimal solution to the question of balance between cohesion and autonomy in a network. We make comparisons with a simple model of cooperative chores in a network and compare the hierarchical network model with other simple graph structures.

3 - Democratic Participation: towards a new conception of local development

Jose Bermeo, Industrial Engineering, Universidad de los Andes, Calle 19 A #, 37 Este Edificio W Quinto Piso, 57-1, Bogota, Colombia, j-bermeo@uniandes.edu.co, *Maria Paola Ortega*, *Andrés Gamez*, *Roberto Zarama Urdaneta*

La Calera is a Colombia's municipality. It is made up of 33 districts, crossed by two rivers. The investigation analyzes the incidence and implications of two different operators and the choice of one of them for managing the region's water resource. The results show the potential behaviour of the 33 automatons regarding their satisfaction with the operator. This is an experimental framework and possibly in decision-making, for the prediction concerning local development and the municipality's democratic social construction.

Social Systems, Agents' Dynamics, Citizenship, Leadership

■ TA-43

Tuesday, 8:30-10:00

FIN Endur Room 1

Risk Functionals in Stochastic Optimization

Stream: Stochastic Programming

Invited session

Chair: *Werner Römisch*, Institut für Mathematik, Humboldt-Universität zu Berlin, Rudower Chaussee 25, Haus 2, Raum 2.414, 12489, Berlin, Germany, romisch@mathematik.hu-berlin.de

1 - Multiperiod risk functionals in stochastic programming

Werner Römisch, Institut für Mathematik, Humboldt-Universität zu Berlin, Rudower Chaussee 25, Haus 2, Raum 2.414, 12489, Berlin, Germany, romisch@mathematik.hu-berlin.de, *Georg Pflug*

We consider multiperiod risk functionals which map (discrete-time) stochastic processes with adapted filtration into the extended real numbers and satisfy certain monotonicity, translation equi- or invariance and convexity (concavity) properties. We derive dual representations and present examples belonging to the class of polyhedral risk functionals. Properties of multistage stochastic programs with multiperiod risk functionals as objectives are also discussed.

2 - Asymptotic properties of risk functionals

Nancy Wozabal, ISDS, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, nancy.wozabal@univie.ac.at, *Georg Pflug*

A risk functional is a mapping from a subset of the real valued measurable functions to the extended reals. A risk functional is said to be version independent (or law-invariant) if it assigns the same value to any two random variables with the same probability law. We examine the asymptotic behaviour of these functionals, giving the conditions under which consistency and asymptotic normality hold. We apply the results obtained to determine the asymptotic behaviour of some of the important examples of risk measures.

3 - Distortion functionals in stochastic optimization

Georg Pflug, Department of Statistics and Decision Support Systems, University of Vienna, Universitaetsstrasse 5, A-1010, Vienna, Austria, georg.pflug@univie.ac.at

Among all coherent risk functionals, the comonotone ones play an important role. These functionals are also known under the name of "distortion functionals". The striking property is that linear problems with a distortion functional constraint can be efficiently solved as sequential linear programs (SLP). We demonstrate the simplicity and convergence of these algorithms. Some multiperiod extensions will also be discussed.

■ TA-45

Tuesday, 8:30-10:00

FIN Endur Room 3

Optimal Control and Hedging Strategies

Stream: Optimization in Financial Mathematics

Invited session

Chair: *Farid AitSahlia*, Industrial and Systems Engineering, University of Florida, P.O. Box 116595, 32611-6595, Gainesville, Florida, United States, farid@ise.ufl.edu

1 - Valuation of participating contracts and risk capital assessment: the importance of market modelling

Laura Ballotta, Cass Business School, City University London, Faculty of Actuarial Science and Insurance, 106 Bunhill Row, EC1Y 8TZ, London, United Kingdom, L.Ballotta@city.ac.uk

The aim of this paper is to provide an assessment of alternative frameworks for the fair valuation of participating contracts with minimum guarantee, in terms of impact on the market consistent price of the contracts, and on the capital requirements for the insurer. Further, we consider suitable simulation procedures based on stratified Monte Carlo/Quasi Monte Carlo with bridges, and adapt them to the specifics of the chosen contract, and to the calculation of the contract fair value, and some relevant risk measures, such as VaR and CTE.

2 - A New Solution Method for Singular Stochastic Control Problems

Erhan Bayraktar, Mathematics, University of Michigan, 530 Church Street, 48109, Ann Arbor, MI, United States, erhan@umich.edu

We propose a solution method for singular stochastic control problems of one-dimensional diffusions via a new characterization of the value function. This leads to a simple numerical procedure to find the value function and the optimal control.

3 - Efficient Pricing of American Options in a Double-Exponential Jump-Diffusion Model

Farid AitSahlia, Industrial and Systems Engineering, University of Florida, P.O. Box 116595, 32611-6595, Gainesville, Florida, United States, farid@ise.ufl.edu

In this talk I extend the numerical technique developed in AitSahlia and Lai (2001) to the pricing of American options where the underlying asset price follows a double exponential jump-diffusion. In particular, I show that the early exercise boundaries are well approximated by linear splines (in the Brownian scale) with very few knots, leading the way to a fast and accurate method to compute the option prices through a new decomposition formula.

■ TA-46

Tuesday, 8:30-10:00

FIN Endur Room 4

Matrix Analytic Models for Risk and Queues

Stream: Applied Probability

Invited session

Chair: *David Stanford*, Dept. of Statistical & Actuarial Sciences, The University of Western Ontario, Wsc 262, 1151 Richmond Street N., N6A 5B7, London, Ontario, Canada, stanford@stats.uwo.ca

Chair: *Steve Drekic*, Dept. of Statistics and Actuarial Science, University of Waterloo, 200 University Avenue West, N2L 3G1, Waterloo, Ontario, Canada, sdrekic@math.uwaterloo.ca

1 - On the analysis of the Gerber-Shiu discounted penalty function for risk processes with Markovian arrivals

Andrei Badescu, Statistics, University of Toronto, 100 St. George St., M5S 3G3, Toronto, Ontario, Canada, abadescu@math.uwaterloo.ca, *Sooahn Ahn*

We consider an insurance risk model governed by a Markovian arrival claim process and by phase-type distributed claim amounts, which also allows for claim sizes to be correlated with the inter-claim times. The use of the busy period distribution for the canonical fluid flow model is a key factor in our analysis, allowing us to obtain an explicit form of the Gerber-Shiu discounted penalty function avoiding thus the use of Lundberg's fundamental equation roots. As a special case we obtain the discounted joint and marginal moments of the surplus prior to ruin and the deficit at ruin.

2 - Optimal Dividends Under a Ruin Probability Constraint

Steve Drekić, Dept. of Statistics and Actuarial Science,
University of Waterloo, 200 University Avenue West, N2L
3G1, Waterloo, Ontario, Canada,
sdrekić@math.uwaterloo.ca

We consider an insurer's surplus process modified by the payment of dividends when the surplus exceeds a specified threshold. We obtain general expressions for the expected present value of dividend payments, and show how these expressions can be applied for certain individual claim amount distributions. We then consider the question of maximizing the expected present value of dividend payments subject to a constraint on the insurer's ruin probability.

3 - Erlangized Fluid Queues and their Relation to Finite-time Ruin Probabilities

David Stanford, Dept. of Statistical Actuarial Sciences, The
University of Western Ontario, Wsc 262, 1151 Richmond
Street N., N6A 5B7, London, Ontario, Canada,
stanford@stats.uwo.ca, Vaidyanathan Ramaswami, Douglas
Woolford

Fluid queue techniques have been applied to a variety of problems in risk theory: the time of ruin, the surplus prior to and/or deficit upon ruin for correlated claims processes (and their joint distributions) and the Erlangization approach to approximate finite-time ruin probabilities. Here we present theoretical results for Erlangization as applied to the general fluid queue model. We apply the resulting approximations to risk-theoretic questions such as approximating finite time ruin probabilities for some correlated risk processes and forest fire containment through fire line construction.

3 - Control with a threshold: an algorithm.

Ariane Szafarz, Centre Emile Bernheim (Solvay Business
School) and DULBEA, Université Libre de Bruxelles, 50
av. F.D. Roosevelt CP 145/1, 1050, Brussels, Belgium,
aszafarz@ulb.ac.be, Ariane Chapelle

Control tunnelling over firms can be reached through pyramids, cross-ownership, and other complex features. This phenomenon is frequent in Europe and in Asia. However, the theoretical literature has not yet converged toward a well-defined and robust measurement of integrated control that takes into account the threshold for control as applied in practice. Based on graph theory, this paper aims at filling this gap and proposes a new algorithm for evaluating the control tunnelling exerted by the firms' ultimate shareholders.

■ TA-47

Tuesday, 8:30-10:00

FIN Endur Room 5

Quantitative Methods in Finance

Stream: Financial Modelling

Invited session

Chair: Bertrand Mareschal, SMG, Université Libre de Bruxelles,
Boulevard du Triomphe CP 210-01, 1050, Brussels, Belgium,
bmaresc@ulb.ac.be

1 - Market Reactions to Central Bank Communication Policies : Reading Interest Rate Options Smiles

Marie Briere, Credit Agricole AM, 17 rue Henri Monnier,
75009, Paris, France, briere.marie@gmail.com

This paper compares the communication strategies of the Fed and the ECB and their impact on financial markets. Interest rates options were used to calculate daily probability distributions of market expectations and to examine how they are modified by central banks' announcements. Greenspan's speeches are found to have a stronger influence on rate levels and market uncertainty than Duisenberg's. Market expectations most significant reaction is to economic indicators central banks mention as being important. Dominant speech themes are shown to be "monetary policy" and "domestic economy".

2 - False Discoveries in Mutual Fund Performance: Measuring the Role of Lucky Alphas.

Olivier Scaillet, HEC-University of Geneva and FAME, Bd
Carl Vogt 102, 1211, Geneva, Switzerland,
scaillet@hec.unige.ch

The standard tests designed to detect funds with positive and negative alphas are subject to luck. Lucky funds have significant estimated alphas whereas their true alphas are zero. This paper measures the relative importance of these lucky funds among the significant funds with the False Discovery Rate. Using US funds, we show that luck has a substantial impact on the performance documented in previous studies. Most of the few funds with non-zero alphas yield negative performance while the small fraction of funds with positive performance is sufficient to form portfolios with positive alphas.

Tuesday, 10:30-12:00

■ TB-01

Tuesday, 10:30-12:00

KEY Askja N-132

KEYNOTE: Dynamic Programming for Dummies

Stream: Dynamic Programming

Invited session

Chair: *Moshe Sniedovich*, Dept. of Mathematics and Statistics, University of Melbourne, Parkville, 3010, Melbourne, Victoria, Australia, m.sniedovich@ms.unimelb.edu.au

1 - KEYNOTE: Dynamic Programming for Dummies

Moshe Sniedovich, Dept. of Mathematics and Statistics, University of Melbourne, Parkville, 3010, Melbourne, Victoria, Australia, m.sniedovich@ms.unimelb.edu.au

Dynamic programming is a powerful tool of thought and a major problem solving methodology in operations research and computer science. But it is not as popular as it should be. In this presentation we explain why this is so and what could/should be done to make it more accessible to students, lecturers, practitioners and the public at large.

■ TB-02

Tuesday, 10:30-12:00

APP Askja N-131

Modelling of Disease

Stream: OR in Health Care

Invited session

Chair: *Keith Cooper*, School of Medicine, University of Southampton, Boldrewood, SO16 7px, Southampton, Hampshire, United Kingdom, kc@soton.ac.uk

1 - Modelling the role of household versus community transmission of TB in Zimbabwe

Georgie Hughes, School of Mathematics, University of Southampton, Highfield, SO17 1BJ, Southampton, United Kingdom, G.R.Hughes@soton.ac.uk, *Christine Currie*

This talk discusses the development of a discrete event simulation model of Tuberculosis (TB) infection and disease for populations with high HIV prevalence. The aim of the research is to explore the likely impact of different TB control interventions, focusing in particular on the role of household versus community transmission of TB. The model will be parameterised using cross-sectional data on intervention efficacy and household risk factors such as poverty indicators, HIV and TB infection, collected in Harare, Zimbabwe.

2 - Registration for High Speed Video Sequences of the PE Segment

Michael Stiglmayr, Institute for Applied Mathematics II, University Erlangen-Nuremberg, Martensstr. 3, 91058, Erlangen, Germany, stiglmayr@am.uni-erlangen.de, *Kathrin Klamroth*, *Raphael Schwarz*, *Jörg Lohscheller*, *Günter Leugering*

Voice restoration after total excision of the larynx is an important issue in oncological therapy. As substitute voice the upper part of the esophagus (PE segment) can be used. Its quality is evaluated using a high-speed camera, following the movement of the PE contour. We present an algorithm that registers contour points of the PE segment from one video frame to the following frame. We suggest a mixed-integer programming formulation for the problem that combines an advanced outlier handling with the introduction of dummy points, and that includes normal information in the objective function.

3 - Assessing the viability of a sustainable management in a mental health care institution: a simulation approach

Margarita Castro, Ingeniería Industrial, Universidad Anáhuac, Lomas Anáhuac s/n, Col Lomas Anáhuac, C.P.

52786 , Huixquilucan, Edo. de México, Mexico, mcastro@anahuac.mx, *Gabriela Mendez*

World-wide level of mental diseases increase, in Mexico the prevalence is considered from 12-20% between the adult populations of 18-65 years. Dedicated services to mental health are not enough and the quality is low. "Fundación San Juan de Dios" (SJD) offers programs of psychiatric and psychological attention. The present operation is inefficient; the intention of this study is to offer SJD, by means of simulation, a vision of the different scenarios to stabilize, recover and rehabilitate the most needed population that suffers mental disorders a diagnosis and opportune treatment.

4 - Modelling the progression of Alzheimer's Disease

Keith Cooper, School of Medicine, University of Southampton, Boldrewood, SO16 7px, Southampton, Hampshire, United Kingdom, kc@soton.ac.uk, *Colin Green*

Alzheimer's disease (AD) is a progressive degenerative disease, characterised by deterioration in cognitive function, functional ability and behaviour. Cholinesterase inhibitors have been developed to treat mild to moderately severe AD patients. Several different methods have been used to model disease AD progression and to estimate the cost effectiveness of these drugs. Simple models for each of the methods are developed and used to estimate disease progression for a cohort of UK patients on placebo or drug treatment. The differences between the models and their outcomes is also discussed.

■ TB-03

Tuesday, 10:30-12:00

APP Askja N-130

Business and Industry OR - ILOG

Stream: Business and Industry OR - Special Track

Invited session

Chair: *Karen Strugnell*, ILOG, 3-5 avenue Gallieni, 94257, Gentilly, France, kstrugnell@ilog.fr

Chair: *Sofiane Oussedik*, ILOG, 3-5 Avenue Gallieni, Batiment Orsud, 94257, Gentilly, France, soussedik@ilog.fr

1 - Advanced optimization applications using ILOG CPLEX and ILOG OPL Development Studio

Sofiane Oussedik, ILOG, 3-5 Avenue Gallieni, Batiment Orsud, 94257, Gentilly, France, soussedik@ilog.fr, *Joris Van de Klundert*, *James Little*

Learn about optimization applications developed using ILOG CPLEX and ILOG OPL Development Studio by two ILOG customers: Cork Constraint Computation Centre, Ireland: Inventory optimisation system for the Cork University Hospital and Configuration problems in circuit pack testing Mateum, Netherlands: Optimizing customer satisfaction at ANWB Road side service - IT & planning systems developed to automatically assign service men to customer requests. We will consider strategic & operational benefits, and implementation issues.

■ TB-04

Tuesday, 10:30-12:00

APP Askja N-129

Market models II

Stream: Electricity Markets

Invited session

Chair: *Andrew B. Philpott*, Department of Engineering Science, University of Auckland, Private Bag 92019, 1001, Auckland, New Zealand, a.philpott@auckland.ac.nz

1 - Price cap regulation and investment incentives in oligopoly

Nicos Savva, Judge Business School, University of Cambridge, Trumpington Str, CB2 1AG, Cambridge, United Kingdom, ns257@cam.ac.uk

We study the effect of price cap regulation on investment in new capacity in an oligopolistic industry using a continuous time stochastic model. On the theoretical side, we show that there exists an optimal price cap that maximizes investment incentives. However this price cap does not restore the competitive equilibrium. On the practical side, we examine the effectiveness of price cap regulation as a function of volatility, concentration and lead times. Our findings cast doubts to whether price cap regulation can be effective in electricity markets.

2 - Supply function equilibria with asymmetric firms

Eddie Anderson, Australian Graduate School of Management, University of New South Wales, Unsw, 2052, Sydney, NSW, Australia, eddiea@agsm.edu.au

The most natural model for wholesale electricity markets uses supply functions, where firms offer a schedule of prices and quantities. We study the equilibrium behavior for asymmetric firms, differing both in cost functions and capacities. We characterize "strong" equilibrium solutions in which, given the other players' supply functions, optimal profits are achieved for every demand realization. We also propose a new numerical method to find such equilibria, using a discretization of the demand distribution. We present numerical results to show that this works well in practice.

3 - Supply function equilibria in electricity transmission networks with losses

Andrew B. Philpott, Department of Engineering Science, University of Auckland, Private Bag 92019, 1001, Auckland, New Zealand, a.philpott@auckland.ac.nz

Supply function equilibrium (SFE) models are a natural tool to study electricity pool markets. In nodal electricity markets, agents offer electricity at different locations and the nodal prices are determined by solving an economic dispatch model. However when there are transmission losses in the lines connecting the nodes the construction of an (unrestricted) SFE becomes problematic, even in very simple networks. In this talk we will discuss these difficulties and methodologies to deal with them.

■ TB-05

Tuesday, 10:30-12:00

APP Askja N-128

DSS Applications in Agriculture

Stream: OR in Agriculture and Forest Management

Invited session

Chair: *Beatriz Recio*, Matematica Aplicada a la Ingeniería Agronómica, ETSI Agronomos. UPM, Avd. de la Complutense, 28040, Madrid, Spain, beatriz.recio@upm.es

1 - An advanced architecture to provide open agricultural planning services

Fernando Rubio, Matematica Aplicada a la Ingeniería Agronómica, UPM, ETSI Agronomos, 28040, Madrid, Spain, Frubionavarro@hotmail.com, *Mariano Suarez de Cepeda*

Project AgriMec has objective to implant an open service of machinery park management centered in Castilla-La Mancha but applicable to any zone. To solve it, the AgriSupport system has been used in a three tier architecture: Internet server, database and model, each of them executing in separated computers. The system has an acceptable response time and guarantees that the proposed solution is optimal in terms of cost of machinery on the basis of the farms the user have, their crops and the agricultural tasks to perform.

2 - A MIP flow model for crop-rotation planning in the context of sustainable development of the Madagascan forest

Laurent Alfandari, SID, ESSEC, Avenue B. Hirsch BP 05105, 95021, Cergy-Pontoise Cedex, France, alfandari@essec.fr, *Jean-Luc Lemalade*, *Anass Nagih*, *Gérard Plateau*

We propose a MIP model for a generic crop-rotation planning problem. This work is part of a French-Madagascan project of struggle against deforestation. The objective is to help farmers to cover seasonal needs while minimizing total space. The main originality of the model lies in the combinatorial choice of cultivating or leaving fallow a plot, as well as innovative production variables. Complexity, upper bound computation and cutting planes are presented. Computational experiments on Eastern Madagascar real cases show the positive impact of land division.

3 - Integrated economic and hidrologic analysis of water-use policies

Javier Ibañez, Estadística y Metodos de Gestion en Agricultura, Universidad Politecnica de Madrid, ETSI Agronomos de Madrid, Av. Complutense s/n, 28040, Madrid, Spain, javier.ibanez@upm.es, *Fernando Rubio*, *Maria Teresa Castellanos*, *Enriqueta Garcia*, *Maria del Carmen Morato*

Objective of the SimWater project is to analyse the use of water policies in agricultural, industrial and residential sectors. For it, the system makes use of hydrological and economic simulation to evaluate proposed scenarios. In the hydrologic aspect it analyzes the predicted input and outputs into the water reserves, predicting its evolution. The economic module uses dynamic systems over temporary series to simulate the crops, costs and benefits based on the water available, considering exogenous factors like the electricity prices, etc.

■ TB-06

Tuesday, 10:30-12:00

APP Askja N-121

OR in the Public Sector V

Stream: OR in the Public Sector

Invited session

Chair: *Mali Sher*, Department of Planning, Israel Police, Rechov Kipodan 15/2, 71700, Modiin, Israel, mali_sher@yahoo.com

1 - Reconstruction of shredded documents

Anna Ukovich, DEEI, University of Trieste, v. A. Valerio 10, 34127, Trieste, Italy, aukovich@units.it, *Gianni Ramponi*, *Walter Ukovich*

For law enforcement purpose, the need may arise of reconstructing documents destroyed by a strip-cut shredder. A computer-assisted solution is proposed, in which the strips are first digitized and then their visual content is extracted by image processing algorithms. The problem can be modelled as a Vehicle Routing Problem. A suboptimal algorithm is presented, which consists of two steps. The first step groups the strips originally belonging to the same page. The second step is a minimum weight matching within the page, where each left border is assigned to the right one of another strip.

2 - OR Methods and Official Statistics: Better Indicators of Sustainable Development

Ranko Nedeljkovic, Statistical Office of Serbia and Montenegro, Kneza Milosa 20, 11000, Belgrade, Serbia and Montenegro, ranko@szs.sv.gov.yu

Systems of official statistics are among largest information systems in modern societies. Different users, from government bodies and businesses, to researchers and individuals, utilize them in a variety of ways, mainly for analyses that would enable successful decision making in all areas. Such an approach includes the implicit use of number of OR methods: Management of Information Systems, Decision Support Systems, Data Mining, Time Series Analysis, etc. Indicators of Sustainable Development are important for measuring, analyses and decision making in this very important field.

3 - An OR approach to traffic police enforcement

Mali Sher, Department of Planning, Israel Police, Rechov Kipodan 15/2, 71700, Modiin, Israel, mali_sher@yahoo.com, *Shalom Hakkert*

The issuing of traffic tickets requires police officers and automatic cameras, and a support-office to deal with the subsequent post-processing. The Israel support-office was overloaded and could not deal with all the work for a variety of reasons. Our aim was to analyze the existing traffic enforcement process, identify any bottlenecks and to maximize the number of traffic tickets handled given the constraints and parameters. Thereafter, a new policy based on the results of a LP problem was implemented. Today the back-office is not overloaded, resulting in savings for the police budget.

■ TB-07

Tuesday, 10:30-12:00

APP Askja N-120

OR in Developing Countries

Stream: OR in Developing Countries

Invited session

Chair: *Fernando Crespo*, 14 de Octubre 580, Cerrillos., 7272728, Santiago, Región Metropolitana, Chile, facrespo@puc.cl

1 - Utilizing the analytic hierarchy process in the structure optimizing of China agricultural domestic support policies

Lingxian Zhang, College of Economy Management, China Agricultural University, P.O.209#, 17.Qinghua Donglu., Haidian District, 100083, Beijing, China, zlx131@163.com

This paper analyzes the priorities of the policy options available to China from its agricultural domestic support using the analytic hierarchy process (AHP), based on its WTO Accession Protocol. The decision analysis is conducted through three hierarchies: objective, criteria, and policy options. In all, four criteria are involved in the hierarchy models. Sixteen options in Green Box as well as six in Amber Box policies were prioritized with respect to the criteria. Sensitivity analysis indicates that some policy options is the more desirable.

2 - A Quadratic Integer Linear Problem to Location

Fernando Crespo, 14 de Octubre 580, Cerrillos., 7272728, Santiago, Región Metropolitana, Chile, facrespo@puc.cl

This Quadratic Integer Linear Problem is result of one model that it uses Game Theory to Location. In this case, you like to put one noxious facility with compensation in a n-person no-cooperative game. You need to take two decisions, that they are variables binaries, where you put the facility and how much should pay as compensation. The results of this model are very important to give an intuition to proof in a rigorous methodology the existence of Nash equilibria.

■ TB-08

Tuesday, 10:30-12:00

EDU Oddi 101

The future of OR textbooks

Stream: OR Education

Invited session

Chair: *Armann Ingolfsson*, School of Business, University of Alberta, 3-40F Business Building, T6G 2R6, Edmonton, Alberta, Canada, Armann.Ingolfsson@UAlberta.Ca

1 - Teaching Outside Mainstream OR/MS

S. Christian Albright, Operations Decision Technologies, Indiana University, Kelley School of Business, 1309 E. 10th St, 47405, Bloomington, IN, United States, albright@indiana.edu

OR/MS is all about modeling: transforming inputs into useful outputs. We now use spreadsheets to teach students how to model business problems, and interest in modeling courses is high. In fact, many students are asking for more, including (1) how to be developers using VBA, (2) how to access data from databases, and (3) how to do data mining. I'll discuss what I have done in these three areas, as well as the success I've had in the classroom.

2 - The Evolution of Introductory OR Textbooks

Fred Hillier, Management Science Engineering, Stanford University, Stanford University, 94305-1057, Stanford, California, United States, fhillier@stanford.edu

It now has been 39 years since the Hillier-Lieberman textbook, Introduction to Operations Research, was first published. Now in its 8th edition and still widely used around the world, the evolution of this textbook over the years suggests likely future trends for introductory OR textbooks. I will describe this evolution and predict future trends. I also will compare and contrast the evolution and trends of another of my textbooks (joint with my son, Mark Hillier), Introduction to Management Science: A Modeling and Case Studies Approach with Spreadsheets, now entering its 3rd edition.

3 - OR Textbooks: a user's perspective

Armann Ingolfsson, School of Business, University of Alberta, 3-40F Business Building, T6G 2R6, Edmonton, Alberta, Canada, Armann.Ingolfsson@UAlberta.Ca

I will discuss my experiences as a user of operations research textbooks, as a student, instructor, and researcher. I will describe the criteria I used to judge a textbook, in each of these three roles. Finally, I will speculate on factors that might influence the evolution of textbooks in the near future.

■ TB-09

Tuesday, 10:30-12:00

IT Oddi 106

Advances in Support Vector Machines

Stream: Data Mining

Invited session

Chair: *Emilio Carrizosa*, Estadística e Investigación Operativa, Universidad de Sevilla, Fac. de Matemáticas, Avda Reina Mercedes s/n, 41012, Sevilla, Spain, emilio.carrizosa@gmail.com

1 - Evaluating discrete support vector machines

Stefan Lessmann, Institute of Information Systems, University of Hamburg, Von-Melle-Park 5, 20146, Hamburg, Germany, lessmann@econ.uni-hamburg.de

Recently, discrete support vector machines (DSVM) have been proposed as an alternative to traditional SVM providing a more reliable treatment of misclassification errors. Instead of using a continuous proxy, DSVM minimizes the classification error directly. We develop a tabu search heuristic to solve the resulting mixed integer problem and benchmark DSVM versus ordinary SVM in areas of corporate and medical decision making. In particular, the problem of cost-sensitive classification is considered assessing DSVMs' capabilities to provide cost-efficient predictions.

2 - Error bounds with application to the identification of active constraints for Support Vector Machine

Renato De Leone, Dipartimento di Matematica e Informatica, Università di Camerino, via Madonna delle Carceri 9, 62032, Camerino, MC, Italy, renato.deleone@unicam.it, *Cinzia Lazzari*

We present a new global error bound for the dual formulation of the Support Vector Machine whose penalty term is measured by Euclidean norm. A global error bound for the dual of the latter problem is derived and this error bound is used to identify those constraints in the primal problem that will be inactive at the solution.

The correct identification of active constraints is important in finding the support vectors and in building the working set of most iterative algorithms for SVM.

Based on this identification a novel SVM Active Set Algorithm is also proposed.

3 - Support Vector Machines with arbitrary norms

Emilio Carrizosa, Estadística e Investigación Operativa, Universidad de Sevilla, Fac. de Matemáticas, Avda Reina

Mercedes s/n, 41012, Sevilla, Spain,
emilio.carrizosa@gmail.com

Support Vector Machines is a powerful classification tool of increasing popularity in Data Mining. When, as customary in practice, the sets to be classified are not separable, the so-called soft margin approach is often used as a surrogate of the maximization of the margin.

In this talk we show that different soft-margin problems already studied in the literature, as well as some of their extensions, can be formulated as minimum-distance problems. Applications to Multiple-Criteria Decision Making will be outlined

■ TB-10

Tuesday, 10:30-12:00

OR Oddi 201

TUTORIAL: Logical Analysis of Data: From Combinatorial Optimization to Biomedical, Financial and Management Applications

Stream: OR - The Profession: 70th Anniversary

Invited session

Chair: *Jakob Krarup*, Dept. of Computer Science, University of Copenhagen, Universitetsparken 1, DK-2100, Copenhagen, Denmark, krarup@diku.dk

1 - TUTORIAL: Logical Analysis of Data: From Combinatorial Optimization to Biomedical, Financial and Management Applications

Peter L. Hammer, RUTCOR, Rutgers, The State University of New Jersey, 640 Bartholomew Road, 08854, Piscataway, NJ, United States, hammer@rutcor.rutgers.edu

The Logical Analysis of Data (LAD), a combinatorics, optimization, and Boolean algebra-based methodology for extracting information from data, was first proposed in 1986, with a first paper published in 1988. We present an outline of the basic concepts, techniques and algorithmic issues of LAD, its medical applications (e.g. ovarian cancer diagnosis using proteomic datasets, risk stratification among cardiac patients, distinction between various types of diffuse large B-cell lymphomas, etc.), financial applications (reverse engineering of Standard & Poor's country credit rating system, etc.).

2 - Problems I will Deal With in My Third Life

Peter L. Hammer, RUTCOR, Rutgers, The State University of New Jersey, 640 Bartholomew Road, 08854, Piscataway, NJ, United States, hammer@rutcor.rutgers.edu

Having realized that one 70-year (or even longer) life is far from being enough to deal with the problems you like, and that the second life becomes in no time too much committed to rely seriously on it, I started thinking about problems I shall work on thereafter. Some of them deal with graphs, discrete optimization, Boolean and pseudo-Boolean functions, the Logical Analysis of Data and its applications in medicine, finance and other areas, etc. And some of them may fit into my talk, but none of them would fit into the 600-character limit of this abstract.

■ TB-11

Tuesday, 10:30-12:00

TRANS Oddi 202

Network Design

Stream: Transportation

Invited session

Chair: *Masashi Miyagawa*, Graduate School of Business Sciences, University of Tsukuba, 3-29-1 Otsuka, Bunkyo-ku, 112-0012, Tokyo, Japan, miyagawa@gssm.otsuka.tsukuba.ac.jp

1 - Column generation algorithms for some network design problems

Irene Loiseau, Departamento de Computación-, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires,

Pabellón I - Ciudad Universitaria, 1428, Buenos Aires, Argentina, irene@dc.uba.ar

We present results of an improved version of a column generation algorithm for the network design problem of determining a minimum cost set of cycles on a graph, that cover pairs of nodes where demands are to be satisfied. Cycles are bounded in length, number of edges and capacity. Columns are generated solving a MIP problem and with a heuristic procedure. We present also an adapted version of our algorithm for the BCCP (bounded cycle cover problem) and compare our computational results with previous ones available from the literature.

2 - An Algorithm Based on New Search Directions for the Constrained Shortest Path Problem

Luis Alberto Santos, Instituto Superior Bissaya Barreto, Bencanta, 3040-039, Coimbra, Portugal, lsantos@dec.uc.pt, *João Coutinho-Rodrigues*

The shortest path problem with an additional constraint that establishes an upper limit on the sum of some arc cost for the path is known by constrained shortest path problem. In this paper, a new optimal algorithm for the constrained shortest path problem is introduced. Extensive computational tests are presented which compare the algorithm to the two most commonly used algorithms to solve it. The results indicate that the new algorithm can solve optimally very large problem instances and is generally superior to the previous ones in terms of solution time and computer memory requirements.

3 - A model for the design of the urban bus network

Juan Fco. Ortega Dato, Análisis Económico y Finanzas, Universidad de Castilla-La Mancha, Plaza de la Universidad, 1., 02071, Albacete, Spain, JuanFco.Ortega@uclm.es

In this paper we propose a model to design urban bus networks, that will be called Bases-Levels-Knots, is based on a network with a circular structure with a center, different levels and bus stops with the name of bases, which main characteristic is that it is possible the change to any other line of the network. Furthermore, the network has a system of lines where: the bases at any levels are connected by means of circular lines; the radial lines provide connections between levels; and there are knot lines for the connection between points of the city most far from the center.

4 - Relationship between Detour Distances and Shortest Distances on Road Networks

Masashi Miyagawa, Graduate School of Business Sciences, University of Tsukuba, 3-29-1 Otsuka, Bunkyo-ku, 112-0012, Tokyo, Japan, miyagawa@gssm.otsuka.tsukuba.ac.jp

This paper examines how travel distances increase when a road link is closed on the shortest path from the viewpoint of evaluating the robustness of road networks. First, we observe the relationship between detour distances and shortest distances on actual prefecture and city road networks in Japan. Then, in order to explain the results, we propose three different models. These models show that detour distances are independent of (resp. proportional to, inversely proportional to) shortest distances on the grid (resp. radial-arc, everywhere dense) network.

■ TB-12

Tuesday, 10:30-12:00

TRANS Oddi 205

Computation Algorithms for Routing Problems

Stream: Transportation/Transport Industry (c)

Invited session

Chair: *Cândida Mourão*, Matemática, Instituto Superior de Economia e Gestão, Rua do Quelhas, 6, Gabinete 203, 1200-781, Lisboa, Portugal, cmourao@iseg.utl.pt

1 - On approximating the distribution of the distance between two random points located within certain areas

Serge Provost, Dept. of Statistical Actuarial Sciences, The University of Western Ontario, Wsc 262, 1151 Richmond

Street N., N6A 5B7, London, Ontario, Canada,
provost@stats.uwo.ca, Kaiqi Yu, David Stanford

A moment-based methodology is proposed for approximating the distribution of the distance between two random points belonging to sets that are composed of rectangles or rectangular parallelepipeds. The resulting density approximants are expressed in terms of Legendre or Jacobi orthogonal polynomials. Two norms are being considered: the L1 norm referred to as the Manhattan distance and the Euclidean distance which corresponds to the L2 norm. Several illustrations will be presented and certain applications to transportation and routing problems will be pointed out.

2 - Simple procedures for warehouse layout optimization

Iris F.A. Vis, Faculty of Economics and Business Administration, Vrije Universiteit Amsterdam, De Boelelaan 1105, 1081 HV, Amsterdam, Netherlands, iveris@feweb.vu.nl

One of the basic functions in a warehouse is the retrieval of products from storage locations to satisfy demand. We propose a spreadsheet-based approach to determine travel distances for this order picking problem. The approach combines aspects from simulation and statistical estimates in such a way that calculations and layout optimizations can be performed with a general purpose spreadsheet program. Furthermore, the approach allows us to estimate travel times for routing methods and situations for which no suitable estimate was available.

3 - A sectoring method for arc-routing problems

Ana Catarina Nunes, DMQ, ISCTE Business School / Centro IO - UL, Av. das Forças Armadas, 1649-026, Lisbon, Portugal, catarina.nunes@iscte.pt, Cândida Mourão, Philippe Lacomme, Christian Prins

The Sectoring Arc-Routing Problem (SARP) belongs to a wide family of problems called sectoring or districting problems. The SARP is defined here in the context of waste collection. Its aim is to partition a large region into smaller sub-regions (sectors), such as the total cost of collecting trips is minimized. Each sector is collected by one vehicle with maximum working time and trip load. The presented heuristic method builds all the sectors simultaneously, based on the identification of minimum demand circuits in a balanced graph. Some computational results are presented and analysed.

4 - An Application of A Network Flow Problem Using State-Space Approach with Absolute -Value Penalty Method

Necati Özdemir, Department of Mathematics, Balikesir University, Faculty of Arts and Science, Cagıs Campus, 10145, Balikesir, -, Turkey, nozdemir@balikesir.edu.tr, Ömer Akin

In this work, we have examined an uncapacitated transportation problem which is a special case of a minimum cost network flow problem with k nodes and l arcs. This problem is given as a dynamical system with an absolute-value penalty function. It is wished finding the optimal solution of the problem. To do this, it is necessary that the matrix A , used in our system, should be stable.

■ TB-13

Tuesday, 10:30-12:00

TRANS Oddi 206

Innovative Maritime Transport Aspects

Stream: Maritime Transportation

Invited session

Chair: Dimitrios Lyridis, Naval Architecture and Marine Engineering, National Technical University of Athens, 27a Argyrokastrou St., Vrilissia, 15235, Athens, Greece, dsvlr@central.ntua.gr

1 - An Optimization-based Decision-Support Methodology for the Liner Shipping Problem

Panagiotis Tsilingiris, Maritime Transport Division (NAME), National Technical University of Athens, 9 Iroon

Polytechniou, Zografou, 15773, Athens, Attica, Greece, tsilipan@yahoo.com, Harilaos Psaraftis

The central contribution of this paper is to provide a decision-support methodology for the Liner Shipping Problem (LSP). LSP is resolved via a multi-stage optimization process in terms of Ship Routing & Scheduling, Fleet Deployment, and Transshipment. By fixing the various sources of non-linearity and by breaking down the LSP into the sequential solution of the aforesaid set of subproblems we have managed to accomplish our goals via the use of Linear, Dynamic and Integer Programming. The stages of the methodology are not completely autonomous; conversely, they interact in a dynamic way.

2 - Enhancing Port Competitiveness Via The Enactment Of Innovative Information Technologies

Athanasios Pallis, Department of Shipping, Trade and Transport, University of the Aegean, 2 Korai St., 82 100, Chios, Greece, apallis@aegean.gr, Maria Lambrou

The paper explores the potential of embracing a network model in the seaports environment, towards innovative electronic services for port stakeholders. An analytical framework is developed for enacting emerging information technologies within port organizational forms, institutional arrangements and foreseen outcomes, and establishes both the significance and the applicability of advanced eGovernment models. We present a three layered analysis encompassing policy, operations and technologies for e-port governance applications over a ubiquitous communications infrastructure.

3 - FORESIM: An innovative Simulation Technique for the Shipping Markets

Dimitrios Lyridis, Naval Architecture and Marine Engineering, National Technical University of Athens, 27a Argyrokastrou St., Vrilissia, 15235, Athens, Greece, dsvlr@central.ntua.gr, Panayotis Zacharioudakis

In this paper we present a realistic and flexible approach concerning the forecast of tanker freight rates in a pre-determined number of tanker routes. We aim to do this by using an innovative technique: FORESIM. The use of FORESIM allows the prediction of freight rates with considerable accuracy for as long as twelve months ahead and this is quantified by calculating the relative and absolute errors. The technique additionally allows risk assessment in the shipping market and has interesting implications in financial decision making.

■ TB-14

Tuesday, 10:30-12:00

PROD Arnag 101

Topics in Revenue Management

Stream: Operations Management / Revenue Management

Invited session

Chair: Ayse Kocabiyikoglu, Department of Business Administration, Bilkent University, Bilkent, 06800, Ankara, Turkey, aysekoca@bilkent.edu.tr

1 - Airline Network Revenue Management with Buy-up

Houyuan Jiang, Judge Business School, University of Cambridge, Trumpington Street, CB2 1AG, Cambridge, United Kingdom, h.jiang@jbs.cam.ac.uk, Giovanna Miglionico

Airline passengers who do not get the fare they want may buy up, i.e., buy a more expensive ticket. We model network revenue management which incorporates buy-up using dynamic programming (DP). The DP model is unlikely to be solved optimally and hence is solved approximately by various simpler models. Policies based on partitioned booking limits and bid prices are proposed to control capacity. We study asymptotic properties of the partitioned booking limit policy and the bid-price policy. Numerical results show that a significant increase in revenue is obtainable.

2 - Dynamic Pricing in the Presence of Strategic Consumers and Oligopolistic Competition

Yuri Levin, School of Business, Queen's University, 143 Union str, K7L 3N6, Kingston, Ontario, Canada,

ylevin@business.queensu.ca, *Jeffrey McGill, Mikhail Nediak*

We introduce a dynamic oligopoly model for single-product firms selling differentiated perishable goods to a finite population of strategic consumers. This problem is modeled as a stochastic dynamic game. Each firm maximizes its revenues, and each customer attempts to maximize the expected present value of utility. We prove the existence of a Markov-perfect equilibrium and explore its structure; show that customer strategic effects revenues, especially of lower-quality firms, and study the decrease in revenues when the firms deviate from equilibrium by ignoring strategic consumer behavior.

3 - Stochastic Models for Joint Pricing and Revenue Management

Ayse Kocabiyikoglu, Department of Business Administration, Bilkent University, Bilkent, 06800, Ankara, Turkey, aysekoca@bilkent.edu.tr, *Ioana Popescu*

Revenue management models have traditionally focused on optimal inventory allocation decisions, treating price and demand as exogenous. We extend this paradigm to simultaneously optimize price and inventory decisions, with a general stochastic price-dependent demand model. We identify general properties of demand that guarantee the uniqueness of the joint price-allocation solution. We demonstrate the value of coordinating price and allocation decisions by studying the improvement in optimal revenue with respect to several demand and supply parameters.

■ TB-15

Tuesday, 10:30-12:00

PROD Arnag 201

Supply Chain Management I

Stream: Supply Chain Management (c)

Invited session

Chair: *Jos van Iwaarden*, Erasmus Research Institute of Management, Erasmus University Rotterdam, Room H9-01, PO Box 1738, 3000 DR, Rotterdam, Netherlands, vaniwaarden@few.eur.nl

1 - Impact of Quality Systems on the Performance of entire Agri-food Supply Chains

Lusine Aramyan, Business Economics, Wageningen University, Hollandseweg 1, 6706 KN, Wageningen, Netherlands, lusine.aramyan@wur.nl

To assure quality of products, quality systems were introduced in agri-food supply chains. Literature reports on effects of quality systems on performance of individual firms. However, there is lack of research on how quality systems affect performance of a supply chain. The performance measurement framework developed by Aramyan is applied to a case study of an entire tomato supply chain in Holland to analyze the impact of quality systems on total performance of the chain. Conjoint analyses is used to find the contribution of different quality systems to total performance.

2 - The Influence of the Market Environment on Quality Management in the Automotive Industry

Jos van Iwaarden, Erasmus Research Institute of Management, Erasmus University Rotterdam, Room H9-01, PO Box 1738, 3000 DR, Rotterdam, Netherlands, vaniwaarden@few.eur.nl

In many industries manufacturing complexity and unpredictability have increased over the years because of an increasing variety of products and shortening product life cycles. At the same time manufacturers in these industries appear to have more problems with maintaining high quality levels. The paper reports results of a questionnaire survey among suppliers in the automotive industry in Western Europe. The application of a management control model in the field of quality management is found to be useful in explaining how contextual factors influence quality management in organizations.

3 - Supply Chain Optimization with Pharmaceutical Products Recovery

Ana Paula Barbósa-Póvoa, Dept. De Engenharia e Gestao, IST, Av. Rovisco Pais, 1, 1049-001, Lisbon, Portugal, apovoa@ist.utl.pt, *Ana Cristina Santos Amaro*

Recent developments emphasize the idea of supply chain, SC, integration to raise competitive advantage. In contrast with conceptual models only few exact formulations account for global SC integration. This paper presents a new optimization approach to the global SC planning and scheduling. This decision levels are streamed sequential while accounting for general product recovery. The formulation is applied to a real pharmaceutical supply chain. Topology, operation, recovery and market details are considered. The results show that sustainable development can be reached in a profitable way.

4 - ERP application in China - an overview

Liping Ge, Barsbuetteler Hauptstrasse 36, 22885, Barsbuettel, Germany, geliping9@hotmail.com, *Stefan Voss*

Enterprise resource planning (ERP) systems are among the most important enablers for business intelligence and planning functionality in supply chains. We provide an overview of ERP research and its development and implementation in China. We describe the current market, challenges and future trends for ERP software in China. Cases are provided where ERP implementations have been used to enhance SCM of major companies. One of the findings is that not only analytical data concepts play an important role in successful ERP implementations in China but also cultural and language aspects.

■ TB-16

Tuesday, 10:30-12:00

PROD Arnag 301

Single Machine and Open Shop Scheduling

Stream: Scheduling

Invited session

Chair: *Vitaly Strusevich*, School of Computing and Mathematical Sciences, University of Greenwich, Old Royal Naval College, Park Row, SE10 9LS, London, United Kingdom, V.Strusevich@gre.ac.uk

1 - Heuristics for the single machine scheduling problem with quadratic earliness and tardiness costs and no idle time

Jorge Valente, Faculdade de Economia - LIACC/NIAAD, Universidade do Porto, Rua Dr. Roberto Frias, 4200-464, Porto, Portugal, jvalente@fep.up.pt, *Rui Alves*

In this paper, we consider a single machine scheduling problem with quadratic earliness and tardiness costs. It is assumed that no idle time may be inserted in a schedule. Several dispatching heuristics are proposed, and simple improvement procedures are also considered. Preliminary experiments were first conducted to determine adequate values for the parameters required by some of the heuristics. Computational tests were then performed on a set of randomly generated problems, and the performance of both the various heuristics and the improvement procedures is analysed.

2 - An Algorithm for Performance Cost and Makespan Open Shop Scheduling Problem

David Alcaide, Estadística, Investigación Operativa y Computación, Universidad de La Laguna, Avenida Astrofísico Francisco Sanchez s/n, -, La Laguna, Tenerife, Spain, dalcaide@ull.es, *Antonio Sedeño-Noda, Carlos González-Martín*

This paper deals with bicriteria open-shop scheduling with time-windows. The release time and deadline of each job characterize its time-window. Time-windows must be strictly respected. To do the jobs, different qualified personal and resources are required. Personal and resources consumption generate costs. Costs are assessed with work shifts with rates. The approach is motivated by practice, because extra work hours have other rates, and resource consumptions differ from day to night shifts. The criteria are performance cost and makespan. The problem is solved with network flow models.

3 - De Werra's open shop algorithm and its applications

Vitaly Strusevich, School of Computing and Mathematical Sciences, University of Greenwich, Old Royal Naval College, Park Row, SE10 9LS, London, United Kingdom, V.Strusevich@gre.ac.uk

D. de Werra in 1989 presented a linear time algorithm that solves the two-machine open shop scheduling problem to minimize the makespan. The algorithm is based on splitting the jobs into three subsets on each machine and scheduling them in such a way that the jobs in each subset do not overlap. We demonstrate how de Werra's algorithm can be used to derive new results for scheduling problems with batching or grouping.

4 - No-wait Openshop Scheduling Problem With Bicriteria Of Makespan And Total Completion Time

Tamer Eren, Department of Industrial Engineering, K305;r305;kkale University, 71450, Kırıkkale, Turkey, teren@kku.edu.tr

In this paper, I consider a bicriteria two-machine openshop scheduling problem with a no-wait. The two criteria to be minimized are makespan and total completion time. An integer programming model is developed for the problem which belongs to NP-hard class. Results of computational tests show that the proposed model is effective in solving problems with up to 20 jobs. Heuristic methods are also used to solve large size problems. These heuristics are three tabu search based heuristics and random search method.

■ TB-17

Tuesday, 10:30-12:00

PROD Arnag 303

Cutting and Packing II

Stream: Cutting and Packing

Invited session

Chair: Jose Fernando Oliveira, Feup / Inesc, Universidade do Porto, Rua Dr. Roberto Frias, 4200-465, Porto, Portugal, jfo@fe.up.pt

1 - A neighborhood search approach for the container loading problem with load bearing strength

Shigeyuki Takahara, Kagawa Prefectural Industrial Technology Center, 587-1 Goto-cho, 761-8031, Takamatsu, Japan, takahara@itc.pref.kagawa.jp

This paper is concerned with the container loading problem with load bearing strength. As for the freight transportation, this is important from the viewpoint of avoiding freight damage. However, only a few researches, those of Ratcliff and Bischoff (1998, OR Spectrum, 20) and Bischoff (2003, Working paper EBMS), have been tackled. Therefore, the aim of this paper is to propose an efficient approach for this problem. The effectiveness of the proposed approach is shown by comparing the results obtained with the approaches presented in literature by using benchmark problems in the OR-Library.

2 - Visibility graphs based on neighbourhood structures in two-dimensional packing problems

M^a Eduarda Pinto Ferreira, Department of Mathematics, ISEP, Bernardino de Almeida 431, Nif 501540709, 4200-072, Porto, Portugal, epf@isep.ipp.pt, Jose Fernando Oliveira

The problem of cutting a rectangle into smaller rectangular pieces of given sizes is known as the two-dimensional rectangular packing problem. We are going to present a study about the use of visibility graphs based neighbourhood structures for two-dimensional rectangular non guillotinable packing problems. We are going to present computational results for these neighbourhood structures and the results of using two of these structures with the simulated annealing metaheuristic.

3 - Optimising the cutting of wood fibre plates in the hardboard industry

Reinaldo Morabito, Dept. of Production Engineering, Federal University of São Carlos, Cp 676, 13565-905, São Carlos, Sao Paulo, Brazil, morabito@power.ufscar.br

Hardboard companies transform eucalyptus trunks into rectangular wood fibre plates called hardboards, which are then cut into ordered items to satisfy customer demands. We present approaches to generate cutting patterns that minimize the cost or waste of material, considering different particular constraints of the cutting machine. The methods are based on dynamic programming recursive formulas combined with greedy constructive heuristics and the primal simplex algorithm. To illustrate the application of these approaches, a case study was carried out in a Brazilian hardboard company.

4 - Metaheuristics for VRPs with loading constraints

Richard Hartl, Dept of Management, Univ of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, richard.hartl@univie.ac.at, Karl Doerner, Günther Füllerer, Manuel Iori

We consider the capacitated vehicle routing problem with additional loading constraints, i.e. a combination of the problem classes vehicle routing and cutting and packing. We solve the problem by means of ant colony optimization and compare the results with results for tabu search from the literature. Computational results are given for both algorithms, on standard benchmark instances derived from the vehicle routing literature. It turns out that ant colony optimization outperforms tabu search in most instances.

■ TB-18

Tuesday, 10:30-12:00

PROD Arnag 304

Covering Problems

Stream: Locational Analysis

Invited session

Chair: Ken-ichi Tanaka, Management Science, Tokyo University of Science, 1-3, Kagurazaka, Shinjuku-ku, 102-0073, Tokyo, Japan, ken1@ms.kagu.tus.ac.jp

1 - Two-stage robust optimization of a location problem

Laurence Carme, Research Development, France Telecom, 38-40 rue du Général Leclerc, 92794, Issy les Moulineaux Cedex 9, France, laurence.carme@francetelecom.com, Cedric Chamayou, Adam Ouorou

When introducing new services, no telecommunication operator can foresee the exact number of clients. In order to deal with this uncertain demand, we consider the location problem in the framework of robust optimization proposed by Kouvelis and Yu. We use two-stage robust optimization with recourse. In a first stage, we determine the number of installed equipments and capacities between clients and equipments; then we estimate the potential penalties due to unsatisfied demands for some scenarios. Due to its large scale, the resulting MIP robust problem is tackled by decomposition techniques.

2 - A connectivity problem on graphs in the design of protected area networks

Leonor S.Pinto, Matematica, Instituto Superior de Economia e Gestao, Rua do Quelhas, 6, 1200-781, Lisboa, Portugal, lspinto@iseg.utl.pt, J. Orestes Cerdeira, Kevin Gaston

We consider a problem which occurs in the design of protected area networks when species have levels of dispersal quite dissimilar. Each species has its own habitat sites, a graph describing adjacencies between sites, and a target number of sites. Feasible solutions are subsets of sites whose habitats for each species induce in the corresponding graph a connected component with the required number of sites. We turn facets of the covering polytope to valid inequalities which we use in an integer cutting algorithm to obtain minimum size feasible solutions. Computational experiments are reported.

3 - A Maximum Flow-Covering Location Model Considering the Time Dimension

Ken-ichi Tanaka, Management Science, Tokyo University of Science, 1-3, Kagurazaka, Shinjuku-ku, 102-0073, Tokyo, Japan, ken1@ms.kagu.tus.ac.jp

This paper proposes a maximum flow-covering location model considering the time dimension. The problem is to decide the location and the starting time of a concert (or any other service) so as to maximize the total number of potential customers. The number of potential customers is defined as the number of office workers that can attend the concert after their work from start to end and can arrive home by a given time. We present some numerical examples under various assumptions about trip densities and examine some interesting properties of optimal solution.

■ TB-19

Tuesday, 10:30-12:00

PROD Arnag 311

Metaheuristics for Resource-Constrained Project Scheduling

Stream: Project Management and Scheduling

Invited session

Chair: *Ramon Alvarez-Valdes*, Statistics and Operations Research, University of Valencia, Faculty of Mathematics, Doctor Moliner 50, 46100, Burjassot, Spain, ramon.alvarez@uv.es

1 - New crossover and double justification operators for the RCPSP/max problem

Vicente Valls, Departamento de Estadística e Investigación Operativa, University of Valencia, Dr. Moliner, 50, Burjassot, 46100, Valencia, Spain, Vicente.Valls@uv.es, *Francisco Ballestin*, *Agustin Barrios*

In this paper we present an evolutionary algorithm for solving the RCPSP/max problem. It works on a population consisting of several distance-order-preserving activity lists representing feasible or infeasible schedules. It uses the conglomerate-based crossover operator, the objective of which is to exploit the knowledge of the problem to identify and combine those good parts of the solution that have really contributed to its quality. It also applies two double justification operators DJmax and DJU adapted to the specific characteristics of problem RCPSP/max.

2 - A hybrid genetic algorithm based on intelligent encoding for project scheduling

Javier Alcaraz, Statistics, Operations and Quality, Universidad Politécnica de Valencia, C. de Vera S/N, 46071, Valencia, Spain, jalcaraz@eio.upv.es, *Concepcion Maroto*

In this work we present a new encoding for the solutions of the RCPSP. It includes two features of previous encodings: the possibility of employing the serial or the parallel SGS, and the combination of forward and backward scheduling. The joint use of these characteristics results in an intelligent encoding which exploits the problem-specific knowledge in an efficient way. We have also extended the genetic crossover and mutation operators in order to work up on those solutions, and recombine in a beneficial way the parents' information to form the offspring.

3 - A Random Key Based Genetic Algorithm For The Resource Constrained Project Scheduling Problem

José Fernando Gonçalves, Faculdade de Economia, Universidade do Porto, Rua Dr. Roberto Frias S/N, 4200-464, Porto, Portugal, jfgoncal@fep.up.pt, *Jorge Mendes*

In this paper we present a new genetic algorithm for the Resource Constrained Project Scheduling Problem, able to provide close to optimal solutions for large instances. The approach combines a serial schedule generation scheme (SGS) with a genetic algorithm. The genetic algorithm is based on random keys and is responsible for evolving the priorities used by the serial-SGS. Forward-backward improvement is applied to every solution. Extensive computational tests on benchmark problems including procedures from other authors validate the effectiveness of the proposed approach.

4 - New heuristic algorithms for Project Scheduling under Partially Renewable Resources

M^a Fulgencia Villa, Florida Universitaria, c/ Rei En Jaume I n^o 2, 46470, Catarroja (Valencia), Spain, fvilla@florida-uni.es, *Ramon Alvarez-Valdes*, *Enric Crespo*, *Jose Tamarit*

We develop several metaheuristics for project scheduling under partially renewable resources. These resources allow us to model conditions appearing in practice which could not be modelled with standard resources. First we present a GRASP algorithm. Then we propose a Path Relinking algorithm which operates on a set of elite solutions obtained by GRASP, in order to obtain improved schedules. Finally, we develop a more complex Scatter Search procedure. We present the results of an extensive study on previously reported test problems which shows the efficiency of the proposed algorithms.

■ TB-20

Tuesday, 10:30-12:00

HEUR Arnag 422

Special Topics in Metaheuristics

Stream: Metaheuristics

Invited session

Chair: *Cesar Rego*, School of Business Administration, University of Mississippi, University, 38677, Oxford, MS, United States, crego@bus.olemiss.edu

1 - Linear programming for simultaneously optimizing solution quality and diversity

Peter Greistorfer, Institut für Industrie und Fertigungswirtschaft, Karl-Franzens-University, ReSoWi-Zentrum, Universitätsstraße 15/G2, 8010, Graz, Austria, peter.greistorfer@kfunigraz.ac.at, *Arne Lokketangen*, *Stefan Voss*, *David Woodruff*

If objective function and constraints of an optimization model are only a very rough approximation, the decision makers normally prefer to see at least two decisions that are dissimilar, yet both good. Such solutions can be generated sequentially or simultaneously. We explore the tradeoffs between these approaches. For experimental consideration of these issues, we address the multi-constrained, zero-one knapsack problem and, as a counterpart from the set of 'easy' problems, the linear assignment problem. Computational results are presented which have been generated by CPLEX.

2 - A heuristic for the collaborative production planning model with returns

Helena Ramalhinho Lourenço, Departamento de Economía y Empresa, Universitat Pompeu Fabra, R. Trias Fargas 25-27, 08005, Barcelona, Spain, helena.ramalhinho@upf.edu, *Juan Pablo Soto*

We address the medium term production-planning model called the Collaborative Production Planning model with Returns (CPPR) that deals with the concepts of Supply Chain Collaboration and Integration, and Returns Management. The algorithm draws on a four-phase decomposition model that aggregates data, solves the reduced problem to optimality, applies a heuristic to obtain a solution for the large (original) problem and improves this solution using local search. The computational results show that the method is very effective and efficient in solving large CPPR instances.

3 - A RAMP approach for large scale multidimensional nonlinear knapsack problems

Yuji Nakagawa, Faculty of Informatics, Kansai University, 2-1-1 Ryozenji-Cho Takatsuki-City, 569-1095, Osaka, Japan, nakagawa@res.kutc.kansai-u.ac.jp, *Ross J. W. James*, *Cesar Rego*

This paper proposes a relaxation adaptive memory programming (RAMP) algorithm for the solution of large scale multidimensional nonlinear knapsack problems (NKP). The algorithm takes advantage of an effective surrogate relaxation approach originally proposed for the exact solution of separable nonlinear integer programs, and appropriately combines it with tabu search adaptive memory to create a RAMP algorithm for the NKP. Computational results are presented and discussed.

■ TB-21

Tuesday, 10:30-12:00

HEUR Arnag 423

Anticipation and Optimization in Biosystems

Stream: Dynamical and Anticipatory Systems

Invited session

Chair: *Salvatore Santoli*, Research and Development, INT - International Nanobiological Testbed Ltd., via A. Zotti 86, I-0121, Rome, Italy, nanobiol@fastwebnet.it

Chair: *Arturo Graziano Grappone*, Medicine, Rome Second University, via Carlo Dossi 87, 00137, Rome, Lazio, Italy, a.grappone@mclink.it

1 - Optimisation problems in the development of biodiversity conservation instruments

Martin Drechsler, Ecological Modelling, UFZ - Centre for Environmental Research, Permoserstr. 15, 04318, Leipzig, Saxony, Germany, martin.drechsler@ufz.de

An important prerequisite of biodiversity conservation instruments is that they are cost-effective. This calls for the use of optimisation and involves various challenges: (1) heterogeneity - biodiversity is a heterogeneous good, habitats are spatially structured and dynamic; (2) uncertainty - the effects of land-use (including conservation) measures on biodiversity are generally poorly known; (3) change - global, including climatic, change is imposing additional pressures and dynamics on the managed ecosystems. We present various applications of optimisation to deal with these challenges.

2 - Anticipation in higher education: forecast or foresight?

Marek Frankowicz, Faculty of Chemistry, Jagiellonian University, ul. Ingardena 3, 30-060, Krakow, Poland, frankowi@chemia.uj.edu.pl

Higher education is presented as a complex adaptive system and its evolution as an active walk in adaptive landscape. University influences the environment through its alumni, and its own future development is conditioned by the feedback between professors and students (who become professors in future and will influence next generations). Universities acting as self-organizing flexible structures with capability of foresight and built-in intrinsic anticipatory properties will be more efficient than those relying on deterministic forecasting.

3 - Psychopharmacology as Nanohyperincursion

Arturo Graziano Grappone, Medicine, Rome Second University, via Carlo Dossi 87, 00137, Rome, Lazio, Italy, a.grappone@mclink.it

S. Santoli gives a roadmap to nanostructured and nano-to-micro integrated systems that actually can be shown here to include all psychopharmacology. D. Dubois defines incursive relations as those where values at a time are computed by nonprevious values, while hyperincursive relations are those where each step generates multiple solutions. B. Hiley eliminates space-time in quantum mechanics. From consideration of such ideas, psychopharmacology is described in this paper as a nanohyperincursive system.

4 - Nanobiosystem Optimal Adaptive Simulation Through Anticipation and Evolution

Salvatore Santoli, Research and Development, INT - International Nanobiological Testbed Ltd., via A. Zotti 86, I-0121, Rome, Italy, nanobiol@fastwebnet.it

Some recent experimental results concerning biosystem evolutionary behavior can be described by a heterohierarchical dynamics, based on the interaction at nanoscale level of micro- and macrophysics, that simulates the biosystem environment and consists in anticipatory and evolutionary steps. Such dynamics occurs through convolution of the biosystem inner dynamics with the incoming environmental time series, and is based on nanochaos and on the wave properties of the inner reaction-diffusion systems and of the electromagnetic processes in the quasi-periodical structures of subcellular members.

■ TB-22

Tuesday, 10:30-12:00

OPT Adal 050

Scalarization Approaches in Multicriteria Optimization II

Stream: Multiple Objective Optimization

Invited session

Chair: *Kaisa Miettinen*, Helsinki School of Economics, P.O. Box 1210, FI-00101, Helsinki, Finland, miettine@hse.fi

1 - Scalarization in MOP related to Constrained Programming

Kathrin Klamroth, Institute of Applied Mathematics, University of Erlangen-Nuremberg, Martensstr. 3, 91058, Erlangen, Germany, klamroth@am.uni-erlangen.de, *Jørgen Tind*

We discuss optimization problems both from a constrained programming and a multicriteria programming perspective. It is shown that both formulations share important properties, and that many classical solution approaches have correspondences in the respective models. The analysis naturally leads to a discussion of the applicability of some recent approximation techniques for multicriteria programming problems for the approximation of optimal solutions and of Lagrange multipliers in constrained programming.

2 - Solving Nonlinear Multi-Objective Optimization Problems by Adaptive Parameter Control

Gabriele Eichfelder, Institute of Applied Mathematics II, University of Erlangen-Nuremberg, Martensstr. 3, 91058, Erlangen, Germany, eichfeld@am.uni-erlangen.de

In multi-objective optimization the solution set called efficient set is, in general, very large and often it is important to have information about the whole efficient set. We present a new method for generating a good representative approximation of this set for nonlinear multi-objective optimization problems. Using sensitivity information we give an algorithm for choosing the parameters of special scalarization methods in an adaptive way such that the resulting approximation points are almost equidistant. An application to intensity-modulated radiotherapy in medicine is also shown.

3 - Multi Criteria Knowledge Management

Hans L. Trinkaus, Adaptive Systems, Fraunhofer ITWM, Fraunhofer-Platz 1, D 67663, Kaiserslautern, Germany, hans.trinkaus@itwm.fraunhofer.de

Multi criteria decision support and knowledge management are brought together. Both of these aspects serves knowCube®, a novel interactive toolbox. User-friendly visualizations and navigation features are enabling also non-experts to manage complex knowledge contents, to analyze or optimize general systems or processes, and to balance different potential scenarios - for finally getting well coordinated decisions. Some examples taken from real-life projects in various domains (like product development, production optimization, or life sciences) illustrate the application of knowCube®.

■ TB-23

Tuesday, 10:30-12:00

OPT Adal 051

Combinatorial Optimization

Stream: Combinatorial Optimization (c)

Invited session

Chair: *Valeria Leggieri*, Mathematics, University of Lecce, Via per Arnesano, 73100, Lecce, Italy, valeria.leggieri@unile.it

1 - On the queen graph coloring problem

Michel Vasquez, LGI2P, Ecole des Mines d'Alès, Parc scientifique Georges Besse, 30035 cedex 1, Nîmes, France, Michel.Vasquez@ema.fr

Queen graph coloring consists in covering a $n \times n$ chessboard with n^2 colored queens such as 2 queens of same color do not attack each other. The minimum number of colors used to do so is the chromatic number X_n of the graph defined by the squares of the board and the queen move rule. An enumeration of the maximum stable sets reinforced by a clique filtering proves that $X_{10}=11$, $X_{12}=12$ and $X_{14}=14$. Then a geometric heuristic shows that $X_n=n$ for $n = 15, 16, 18, 20, 21, 22, 24, 26, 28, 32$. Finally linear congruence computations prove that there is an infinity of n multiples of 2 or 3 so that $X_n=n$.

2 - Improved lower bounds for the linear ordering problem with cumulative costs

Giovanni Righini, D.T.I., Università degli Studi di Milano, Via Bramante 65, 26013, Crema, CR, Italy, righini@dti.unimi.it

The problem considered consists in finding an optimal acyclic tournament in a given complete digraph. The cost of a solution is given by the sum of the weights associated to the nodes and the weight of each node depends on the weights of all the nodes following it in the acyclic tournament. Bertacco et al. (2005) proposed a branch-and-bound algorithm. I present new lower bounds of increasing strength and complexity, computable in polynomial time. Computational results prove they reduce the computing time and the memory occupation required by the branch-and-bound algorithm.

3 - The minimum power multicasting problem in wireless networks

Valeria Leggieri, Mathematics, University of Lecce, Via per Arnesano, 73100, Lecce, Italy, valeria.leggieri@unile.it

We take into account the Minimum Power Multicasting (MPM) problem in Wireless Ad-Hoc Networks, which consists in assigning transmitting powers to the devices of a network in such a way that a particular terminal "the source" is connected to a selected subset of terminals called "destinations" with the minimum total transmitting power. By using an appropriate choice for the decision variables and by exploiting the topological properties of the problem, we define a formulation for the MPM problem based on a Set Covering model.

4 - Effective recognition of the vertex adjacency of permutation polytopes

Vitali Demidenko, Institute of Mathematics, Surganov str. 11, 220012, Minsk, Belarus, demidenko@im.bas-net.by

The recognition algorithm of the vertex adjacency of the permutation polytopes generated by any subsets of the symmetric group is proposed. This algorithm uses the adjacency criterion formulated for these polytopes in the paper (Demidenko, Math. Notes, 2005, in appear). The algorithm complexity is exponential number of the bit operations from m and polynomial from n , where n is the order of symmetric group, and m is a cyclic rank of the permutation determined by given vertices. This algorithm is polynomial if m is fixed. This research supported by INTAS (project 03-50-5975).

■ TB-24

Tuesday, 10:30-12:00

OPT Adal 052

Anticipative Concept in Information Systems

Stream: Dynamical and Anticipatory Systems

Invited session

Chair: *Miroљub Kljajic*, Faculty for organizational sciences, University of Maribor, Kidriceva cesta 55, 4000, Kranj, Slovenia, miroљub.kljajic@fov.uni-mb.si

Chair: *Carlos Legna*, Institutional Economics, La Laguna University, Universidad de La Laguna, Facultad de Derecho,, 38071, La Laguna, Canary Islands, Spain, clegna@ull.es

1 - Evaluating Patients' Health Condition by Hierarchical Decision Models

Olga Sustersic, University of Ljubljana, University College of Health Care, Poljanska cesta 26a, SI-1000, Ljubljana,

Slovenia, vladislav.rajkovic@ijs.si, *Vladislav Rajkovic*, *Uros Rajkovic*

In the paper the model for evaluation and analysis of patient's health condition is proposed. It is based on fourteen basic living activities (BLA) using hierarchical multi-criteria decision-making model. The central part of the model is the knowledge base. It principally determines the transformation of data of the indicators (criteria of an individual BLA) into a comprehensive evaluation. It enables the identification of nursing problems or diagnoses and evaluation of BLA thus assuring the quality of nursing care. The model was tested in the frame of information system for community nursing.

2 - The Anticipative Concept in Warehouse Optimization Using Simulation in Uncertain Environment

Davorin Kofjač, Laboratory of Cybernetics and DSS, University of Maribor, Faculty of Organizational Sciences, Kidričeva cesta 55a, 4000, Kranj, Slovenia, davorin.kofjac@fov.uni-mb.si, *Miroљub Kljajic*, *Valter Rejec*

The paper presents the optimization of warehouse ordering process so that the warehouse will operate with minimal costs while no stock-outs occur and warehouse capacity is not exceeded. Such stock control problems are difficult to solve analytically, therefore a simulation approach as core part of information system for stock assessments has been chosen for heuristics and fuzzy control algorithm realization. A dynamic analysis of the considered system behavior is the main advantage of testing the strategy with the aid of simulation scenarios. The state of the art of the research is described.

3 - Design of the strategy of an urban tourist region using qualitative models, system dynamics and Case Base Reasoning (CBR)

Carlos Legna, Institutional Economics, La Laguna University, Universidad de La Laguna, Facultad de Derecho,, 38071, La Laguna, Canary Islands, Spain, clegna@ull.es

The paper presents a methodology that is being implemented for the elaboration of the strategy of a Canary Islands city. It combines the elaboration of qualitative models, the application of system dynamics and the use of Case Base Reasoning tools, that facilitate the access to the knowledge on policies related to the detected problems. This paper is one of the results of researches that we are doing with the professors Miroљub KLAJIC and Andrej SKRABA. It may be applied to any social system. Authors: Carlos Legna and Carina González, School of Computers Sciences, La Laguna University

4 - Combined Model of Market Absorption and Failure Process - Warranty Claims Prediction

Miroљub Kljajic, Faculty for organizational sciences, University of Maribor, Kidriceva cesta 55, 4000, Kranj, Slovenia, miroљub.kljajic@fov.uni-mb.si, *Andrej Skraba*, *Davorin Kofjač*, *Ales Brglez*, *Matevz Bren*

Proposed paper will describe the warranty claims prediction applying the Kaplan-Meier estimator and variation of Markov Modulated Fluid model (MMF) which has been used on account of the inspection of considered real process. The Terminal Call Rate (TCR) which determines the proportion of warranty claims in produced batch is important information for marketing and should be correctly monitored and predicted. The process considered is the combination of two processes: a) absorption process and b) failure process.

■ TB-25

Tuesday, 10:30-12:00

OPT Adal I-111

Nonlinear Optimization and Programming II

Stream: Mathematical Programming

Invited session

Chair: *Laura Martein*, department of statistics and applied mathematics, University of Pisa, via Ridolfi, 10, 56124, Pisa, Italy, lmartein@ec.unipi.it

1 - Convex quadratic programming techniques on graphs

Domingos Cardoso, Matematica, Universidade de Aveiro, Campus Universitario de Santiago, 3810-193, Aveiro, Portugal, dcardoso@mat.ua.pt

Stable sets, induced matchings and cliques are examples of regular induced subgraphs in a graph. Convex quadratic programming techniques applied to the determination of polynomial-time upper bounds on the size of k -regular induced subgraphs are introduced. A necessary and sufficient condition for a convex quadratic programming upper bound to be tight is proved. The recognition of graphs containing a vertex subset inducing k -regular subgraphs with cardinality equal to the upper bound is analyzed for particular values of k . Finally, some applications and open problems are presented.

2 - Robust Optimization Applied to Portfolio Management with Transaction Costs

Donald Goldfarb, IEOR, Columbia University, 331 Mudd Bldg., 10010, New York, NY, United States, goldfarb@columbia.edu, *Garud Iyengar*, *Emre Erdogan*

We present robust models for active portfolio management that are able to incorporate convex transaction cost functions as well as constraints such as those on short sales and beta constraints. We show how to formulate these models as second-order cone programs and solve them efficiently. We illustrate our robust portfolio management approach on both simulated data and real data from 1994-2003 on stocks in the S&P500 index.

3 - A sequential method for a particular generalized fractional problem.

Laura Martein, department of statistics and applied mathematics, University of Pisa, via Ridolfi, 10, 56124, Pisa, Italy, lmartein@ec.unipi.it, *Laura Carosi*

The aim of the paper is to maximize a pseudoconcave function which is the sum of a linear function and a linear fractional one, subject to linear constraints. Theoretical properties of the problem are first established and then a sequential method based on a simplex-like procedure is suggested.

4 - Research On Vrp Of Optimizing Based On Fuzzy C-means Clustering And Iga Under Electronic Commerce

Xiaobo Wang, School of Management, Harbin Institute of Technology, Room 315, 11 Apartment, 150001, Harbin, Heilongjiang, China, wangxiaobobo@hit.edu.cn

The logistic distribution under electronic commerce has the character of dispersive customer positions, large order forms, little batches and many repeated routes. Therefore, the improved two-phase algorithm needs to be adopted to get solutions. Namely, the customer group can be divided into several regions using fuzzy c -means clustering algorithm in first phase. In second phase, get the solutions of the customer point in every group using the improved genetic algorithm. In the end, the test proves the validity of this improved algorithm combining with examples.

■ TB-26

Tuesday, 10:30-12:00

OPT Adal III=231

Models and Applications

Stream: Combinatorial Optimization

Invited session

Chair: *Yves Crama*, HEC - Management School, University of Liège, Boulevard du Rectorat 7 (B31), 4000, Liege, Belgium, Y.Crama@ulg.ac.be

1 - Cycle Functions in Robotic Cells

Gerd Finke, LEIBNIZ-IMAG, 46 avenue Felix Viallet, 38 031, Grenoble cedex, France, Gerd.Finke@imag.fr, *Nadia Brauner*

Robotic cells consist of a flow-shop with a robot for the material handling. A single part is to be produced and the objective is to minimize the production rate. A k -cycle is a production cycle where exactly k parts enter and leave the cell. One defines the cycle function K which is the smallest value of k so that the set of all k -cycles up to size K contains an optimal cycle for all instances. Some of these functions are known and there are conjectures about others. In this presentation, the state-of-the-art of these cycle functions for different cell configurations is given.

2 - Efficient Branch-and-Bound Algorithms for Weighted MAX-2-SAT

Mutsunori Yagiura, Graduate School of Information Science, Nagoya University, Furocho, Chikusaku, 464-8603, Nagoya, Aichi, Japan, yagiura@nagoya-u.jp, *Toshihide Ibaraki*, *Takashi Imamichi*, *Yuichi Koga*, *Hiroshi Nagamochi*, *Koji Nonobe*

Given a set of clauses on propositional variables, where each clause contains at most two literals and is weighted by a positive real, MAX-2-SAT asks to find a truth assignment that maximizes the total weight of satisfied clauses. We propose branch-and-bound algorithms for solving weighted MAX-2-SAT exactly. Our algorithms feature two new transformation rules and two efficient algorithms for computing lower bounds. Computational comparisons on benchmark instances disclose that these algorithms are highly effective in reducing the number of search tree nodes as well as computation time.

3 - Large Scale Linear Programming Applications

Endre Boros, Rutgers University, United States, boros@rutcor.rutgers.edu

We present two recent applications leading to very large-scale LP formulations. The first application involves finding optimal strategies for container inspection to intercept illicit weapons/materials hidden in ship cargoes. The other application involves embedding proteins into binary spaces such that Hamming distances are proportional to protein dissimilarities. For both problems, the developed large scale LP models provide a scalable and computationally efficient solution technique to derive the theoretically best possible solutions, improving on earlier approaches.

4 - Optimization of a portfolio of options under Value-At-Risk constraints

Yves Crama, HEC - Management School, University of Liège, Boulevard du Rectorat 7 (B31), 4000, Liege, Belgium, Y.Crama@ulg.ac.be, *Georges Hübner*, *Michaël Schyns*

We introduce an integer programming model for the optimization of a financial portfolio consisting of securities and options. Our objective is to maximize the expected return of the portfolio under Value-At-Risk constraints. We rely on scenarios to represent future security prices. We describe some features of the model, like arbitrage-free option pricing, the consideration of transaction costs, bid-ask spreads, or new options in each period. The numerical difficulty of the model is illustrated on test problems.

■ TB-27

Tuesday, 10:30-12:00

OPT Adal V=229

Optimization Modeling Systems II - GAMS, AMPL

Stream: Software for OR/MS

Invited session

Chair: *Robert Fourer*, Industrial Engineering and Management Sciences, Northwestern University, 2145 Sheridan Road, 60208-3119, Evanston, IL, United States, 4er@iems.northwestern.edu

1 - Solving Difficult Mixed-Integer Programming Problems using GAMS and Condor

Michael Bussieck, GAMS Software GmbH, Eupener Str 135-137, 59033, Cologne, Germany, MBussieck@gams.com, *Michael Ferris*

The General Algebraic Modeling System (GAMS) is a commercial modeling system for mathematical programming problems. Condor is a resource manager that delivers huge amounts of computing cycles from large collections of distributively owned computing resources. We describe new modeling features of GAMS and recent solver enhancements that allow us to harness the computational resources of Condor for solving difficult mixed-integer programming problems.

2 - A Practical Guide to Acquiring the AMPL Modeling System for Large-Scale Optimization

Robert Fourer, Industrial Engineering and Management Sciences, Northwestern University, 2145 Sheridan Road, 60208-3119, Evanston, IL, United States, 4er@iems.northwestern.edu, *David M. Gay*

AMPL has set the standard for optimization modeling languages that handle complex models naturally and large models efficiently. We present a quick but lucid tour of the current state of AMPL, with emphasis on the practical issues that come up in deciding to purchase an algebraic modeling language. Topics will include 64-bit versions, AMPL's new extra-flexible floating license manager, the AMPL Studio graphical interface and COM objects for Windows, and the range of AMPL/solver packages and distributors – including recent extensions to support new features in KNITRO 5.0 and CPLEX 10.0.

■ TB-28

Tuesday, 10:30-12:00

OPT Adal VI=207

Simulation

Stream: Simulation (c)

Invited session

Chair: *Boguslaw Bieda*, Management Department, AGH-University of Science and Technology, ul. Gramatyka 10, 30-067, Krakow, Poland, bbieda@wp.pl

1 - On planning and simulating elevator groups for vertical transport

Pablo Cortés, Industrial Engineering, University of Seville, C/ Camino de los Descubrimientos s/n, 41092, Sevilla, Spain, pca@esi.us.es, *José Guadix*, *Jesús Muñozuri*, *J. Nicolás Ibáñez*

This work describes a tool capable of providing support for the design process of elevator systems. The tool allows the dynamic construction of the target building; the dynamic construction of alternative elevator groups (number of boards, capacity, kinematics, etc.); the generation of traffic patterns; the test of uppeak, downpeak or lunchpeak scenarios; the integration together with a wide catalogue of optimization algorithms and control rules; and the presentation in a friendly graphical interface showing the data input, the simulation animation, and the final text and graphic reports.

2 - Simulation of the Computer System of an on-line University Intranet

Javier Faulin, Department of Statistics and OR, Public University of Navarra, Los Magnolios Building, 1st Floor, Campus Arrosadía., 31006, Pamplona, Navarra, Spain, javier.faulin@unavarra.es, *Joan Manuel Marques*, *Angel A. Juan*, *Antoni Roure*

In this paper, we present a discrete-event simulation study carried out on the computer system that gives support to the intranet of an on-line university. This study was developed with the purpose of helping the managers of the computer system to obtain a better understanding of its internal operation. Other objectives of our paper are related to the discovery of possible performance problems (bottle necks, weak points in the structure, etc.), and to the testing of new designs of the system that could increase its performance, reliability and scalability levels.

3 - Stochastic Model for Environmental Project Risk Assessment Case Study

Boguslaw Bieda, Management Department, AGH-University of Science and Technology, ul. Gramatyka 10, 30-067, Krakow, Poland, bbieda@wp.pl

This paper describes the application of Monte Carlo simulation in assessment the economic feasibility of producing energy from biomass via thermo chemical processes. The economic analysis method used to determine the plant gate gas selling price was discounted cash flow rate of return (IRR). Crystal Ball software aids in risk assessment decisions by giving results and probabilities for those results. In sensitivity analysis, the cost of gas was determined in terms of the plant gate cost. In this case described the medium plant size with the waste stream capacity in the range of 250 Mg/day.

■ TB-29

Tuesday, 10:30-12:00

OPT Adal VII=225

Quadratic Optimization I

Stream: Global Optimization: Deterministic and Stochastic Methods

Invited session

Chair: *Immanuel Bomze*, Isds, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, immanuel.bomze@univie.ac.at

1 - Approximation Bounds for Quadratic Optimization with Homogeneous Quadratic Constraints

Shuzhong Zhang, Dept of Systems Engineering Engineering Management, Chinese University of Hong Kong, Shatin, New Territories, NT, Hong Kong, Hong Kong, zhang@se.cuhk.edu.hk, *Zhi-Quan Luo*, *Paul Tseng*, *Nicholas Sidiropoulos*

We consider the NP-hard problem of finding a minimum norm vector in n -dimensional real or complex Euclidean space, subject to m concave homogeneous quadratic constraints. We show that a semidefinite programming (SDP) relaxation for this nonconvex quadratically constrained quadratic program (QP) provides an $O(m^2)$ approximation in the real case, and an $O(m)$ approximation in the complex case. Moreover, we show that these bounds are tight up to a constant factor.

2 - Unconstrained nonlinear formulations for Standard Quadratic Programming (StQP) problems

Laura Palagi, Dipartimento di informatica e Sistemistica, Università di Roma, Via Buonarroti, 12, 00198, Roma, Italy, palagi@dis.uniroma1.it, *Immanuel Bomze*, *Luigi Grippo*

A StQP problem consists in finding the smallest value of a (possibly indefinite) quadratic form over the standard simplex. This is a well-known NP-hard problem related to the Maximum-Clique Problem. We propose different unconstrained formulations of the StQP and we show the correspondence of the solutions of StQP with those of the unconstrained problems. We test the performance of the formulations solving StQP arising from the DIMACS challenge set of maximum clique problems. We employ efficient unconstrained algorithms that allow us to perform a very large number of local random searches.

3 - A computational comparison of some branch and bound algorithms for indefinite quadratic programs

Claudio Sodini, Statistics and Applied Mathematics, University of Pisa, Via Cosimo Ridolfi, 10, 56124, Pisa, Italy, csodini@ec.unipi.it, *Riccardo Cambini*

The aim of this paper is to compare, from a computational point of view, two different branch and bound methods for solving indefinite quadratic programs. The first method (De Angelis et al. 1997) decomposes the objective function by means of the canonical form of symmetric matrices, and implies a linear transformation of the problem given by the eigenvectors. In the second method (Cambini, Sodini 2005) the objective function is decomposed by means of various modifications of the so called Lagrange method so that no use of eigenvectors and no linear transformations are needed.

■ TB-30

Tuesday, 10:30-12:00

NONL Adal X=220

Linear Semi-Infinite Optimization V

Stream: Linear Semi-Infinite Optimization

Invited session

Chair: *Enriqueta Vercher*, Statistics and Operations Research, Universitat de València, C/ Dr. Moliner 50, 46100, Burjassot, Spain, Enriqueta.Vercher@uv.es

1 - Some stability properties and examples in convex parametric semi-infinite optimization

Soraya Gomez, FCFM, BUAP, Edificio 190 de Cuidad Universitaria, 72570, Puebla, Mexico, sgomez@fcfm.buap.mx

We consider convex semi-infinite optimization problems where the nonempty index set T is compact Hausdorff space, possibly infinite. The functions f and a are convex. In the side-conditions, we shall vary only the right hand side. We shall focus our attention on the continuity properties of the feasible Z and optimal F set mappings. We shall characterize the interior of the sets Z and F . We investigate some continuity properties of the feasible Z and optimal F set mappings and on this base, we want to characterize the interior of the sets Z and F . We present some interesting examples.

2 - Regularity modulus for the optimal set in linear semi-infinite optimization

María Josefa Cánovas, Operations Research Center, Miguel Hernández University, Avda. del Ferrocarril s/n, (Edif. Torretamarit), 03202, Elche, Alicante, Spain, canovas@umh.es, *Francisco J. Gómez-Senent*, *Juan Parra*

We deal with linear optimization problems with possibly infinitely many inequality constraints, where the left hand side coefficients are fixed and the right hand side ones, $b(\cdot)$, as well as the vector of the objective function coefficients, c , are allowed to vary. The parameter space Λ is endowed with the uniform convergence topology. The Lipschitz behavior of the optimal set mapping is focused on the modulus of metric regularity of the inverse mapping. We provide a general lower bound on this modulus, as well as an upper bound in the finite case, in terms of the problem's data.

3 - Stability of semi-infinite systems of equations and inequalities: A quantitative approach

Juan Parra, Operations Research Center, Miguel Hernández University, Avda. del Ferrocarril s/n, (Edif. Torretamarit), 03202, Elche, Alicante, Spain, parra@umh.es, *María Josefa Cánovas*, *Francisco J. Gómez-Senent*

We consider the parameter space of all the linear constraint systems, in R^n , whose inequality constraints are indexed by an arbitrary, but fixed, set (possibly infinite, with no particular structure) and the number of equations is at most n . We allow perturbations in all coefficients. Interiority conditions for consistent/inconsistent systems are given, and the associated distance to ill-posedness is calculated in terms of the system's data. For homogeneous systems this distance is closely related to the regularity radius of a mapping describing systems parametrized by their right hand side.

■ TB-31

Tuesday, 10:30-12:00

NONL Adal XI=222

Industrial Applications of SQP-Methods

Stream: Industrial Application of Nonlinear Programming Algorithms

Invited session

Chair: *Klaus Schittkowski*, Dept. of Computer Science, University of Bayreuth, Postfach, 95440, Bayreuth, Germany, klaus.schittkowski@uni-bayreuth.de

1 - Reduction of Emissions by Transmission Shifting Optimization

Oliver Scherf, Engine Development Simulation, GM Powertrain Germany GmbH, 65423 Rüsselsheim, T1-02, 65423, Rüsselsheim, Hessen, Germany, oliver.dr.scherf@de.gm.com, *Trudy Weber*, *Prasad Atluri*

Caused by tighter emission limits for vehicles with combustion engine and the rising fuel prices which increase the customers demand for an economic vehicle it is getting very important to optimize vehicles with respect to emission and fuel consumption. In this work it is shown how to achieve this by optimizing the shifting strategy of a Diesel vehicle with automatic transmission. For this purpose a vehicle simulation model has been coupled with the iSight optimization tool. With the help of a genetic algorithm it was possible to reduce the fuel consumption and the emissions significantly.

2 - Comparative analysis of some global optimization solvers

Licister Mason, Primary Recovery and Optimization, Shell International Exploration and Production B.V., Psotbus 60, 2280 AB, Rijswijk, Netherlands, ThomasLicister.Mason@shell.com, *Klaus Schittkowski*, *Adil Bagirov*, *Jean van Berkel*

This paper presents comparative analysis of some global optimization solvers. The class of solvers considered in this paper are the global solvers: NLPQLG, the DGM, and LGO solver from GAMS and the local versions of the SQP and the DGM, as well as the NLP and discontinuous nonlinear programming (DNLP) solvers. Several well-known academic test problems for global optimization were used to ascertain the capability of these seven algorithms for solving real world problems. We present the results of numerical experiments and discuss them.

3 - Daily Milk Cow Feed Optimization in the Nordic Countries with TOMLAB

Kenneth Holmström, Mathematics and Physics, Mälardalen University, P.O. Box 883, SE-72123, Västerås, Sweden, kenneth.holmstrom@mdh.se, *Anders Göran*, *Marcus Edvall*

Milk cows in different states in life, calving, milking, need different feed mixes for best health. The lowest cost feed solution need to satisfy nutritional recommendations expressed as linear and nonlinear constraints. A biological model with 100+ parameters describes the system, with about 12 possible for feed control of each animal. TOMLAB controls and optimizes the feed with SNOPT and NPSOL encapsulated in a .NET interface. Constraints binding sets of 100 animals lead to thousands of decision variables and constraints, and sometimes feasibility problems.

4 - An SQP Algorithm for Mixed-Integer Nonlinear Programming with Trust-Region Stabilization Applied to the Design of SAW Filters

Klaus Schittkowski, Dept. of Computer Science, University of Bayreuth, Postfach, 95440, Bayreuth, Germany, klaus.schittkowski@uni-bayreuth.de

We present an SQP method for solving mixed-integer nonlinear programming problems. The algorithm is stabilized by a trust region method with Yuan's second order correction. The Hessian of the Lagrangian function is approximated by BFGS updates subject to the continuous and second order differences subject to the integer variables. Numerical results are presented for a set of 50 mixed integer test problems. Moreover we introduce an industrial application, the optimal design of surface acoustic wave (SAW) filters. The mathematical structure of the optimization problem is outlined.

■ TB-32

Tuesday, 10:30-12:00

NONL Adal XIII=218

Convex models, algorithms and applications

Stream: Convex Optimization Methods

Invited session

Chair: *Michael Patriksson*, Mathematics, Chalmers University of Technology, Chalmers Tvärgata 3, SE-41296, Gothenburg, Sweden, mipat@math.chalmers.se

1 - A Heuristic for the Stability Number of a Graph based on Convex Quadratic Programming and Tabu Search

Carlos Luz, Math, Escola Sup. Tecnologia Setúbal / Instituto Politécnico de Setúbal, Campus do IPS, Estefanilha, 2900-761, Setúbal, Portugal, cluz@est.ips.pt,
Luis Cavique

Recently a convex quadratic characterization of the Lovász theta number was established. This talk is oriented to the following question: can we use this characterization to approximate the stability number of high order graphs? With this in mind we present a two-phase heuristic to the stability problem which begins by computing suboptimal solutions using the above mentioned characterization. In the second phase a multi-start tabu heuristic is implemented. The results of applying this heuristic to some DIMACS clique benchmark instances are also reported.

2 - A survey on the continuous nonlinear resource allocation problem

Michael Patriksson, Mathematics, Chalmers University of Technology, Chalmers Tvärgata 3, SE-41296, Gothenburg, Sweden, mipat@math.chalmers.se

Our problem is to minimize a separable, convex and differentiable function over a convex set defined by bounds and an explicit constraint described by a separable convex function. Applications include equilibrium problems in the engineering and economic sciences, resource allocation and balancing problems in manufacturing, statistics, military operations research and production and financial economics, and subproblems in algorithms for a variety of more complex optimization models. We survey the history and applications of the problem, as well as algorithmic approaches to its solution.

3 - Numerical implementation of maximum likelihood estimation of Gaussian graphical models

Joachim Dahl, Communication Technology, Aalborg University, Fr. Bajersvej 7A-208, 9220, Aalborg, Denmark, joachim@kom.aau.dk

We describe algorithms for maximum likelihood estimation of Gaussian graphical models with conditional independence constraints. It is well-known that this is an unconstrained convex optimization problem with a closed-form solution if the underlying graph is chordal. The topic of this talk is efficient numerical algorithms for large sparse graphs that are non-chordal.

■ TB-33

Tuesday, 10:30-12:00

NONL Adal A=313

Derivative free Global Optimization

Stream: Global and Local Derivative Free Optimization

Invited session

Chair: *Alexander Rubinov*, School of Information Technology and Mathematical Sciences, University of Ballarat, 1, University Drive, Ballarat, VIC, Australia, 3353, Ballarat, Victoria, Australia, a.rubinov@ballarat.edu.au

1 - About metric regularity of collections of sets

Alexander Kruger, School of Information Technology Mathematical Sciences, University of Ballarat, University Drive, Mount Helen, P.O. Box 663, 3353, Ballarat, Victoria, Australia, a.kruger@ballarat.edu.au

Regularity concepts for collections of sets are considered with the emphasis on strong or metric regularity. This property is closely related to the metric regularity of multifunctions. Moduli of regularity for quantitative characterization of the properties are defined. Primal and dual characterizations of metric regularity as well as some relations to other properties are presented. The absence of strong regularity can be treated as weak stationarity of the collection of sets. The equivalence of primal and dual conditions of weak stationarity takes the form of extended extremal principle.

2 - A lower bound for the volume of bounded convex sets

Rosalind Elster, Dept.d'Economia i d'Història Econòmica, Universitat Autònoma de Barcelona, 08193, Bellaterra, Barcelona, Spain, r.elster@t-online.de

For the n-dimensional golden search method used to solve a constrained optimization problem with a bounded closed convex feasible set X in the n-dimensional Euclidean space, one can evaluate the number of computations of the objective values. This evaluation requires however a search for the lower bound for the volume of X which is based on elementally geometrical facts. Applying the obtained results to an n-dimensional simplex S one can easily see that the convex hull of S is a bounded convex set with minimal volume.

3 - A global optimization approach to adverse drug reaction problems

Musa Mammadov, School of Information Technology Mathematical Sciences, University of Ballarat, University Drive, Mount Helen, P.O. Box 663, 3353, Ballarat, Victoria, Australia, m.mammadov@ballarat.edu.au

We develop an optimization approach for the study of Adverse Drug Reaction (ADR) problems. This approach is based on drug-reaction relationships represented in the form of a vector of weights, which can be defined as a solution to some global optimization problem. Although it can be used for solving many ADR problems, we concentrate on the problem of accurate identification of drugs that are responsible for reactions that have occurred. The approach is applied to Australian Adverse Drug Reaction Advisory Committee (ADRAC) database.

■ TB-34

Tuesday, 10:30-12:00

DEC VR11 V-138

DDM in Hierarchical organizations

Stream: Distributed Decision Making

Invited session

Chair: *Rudolf Vetschera*, Dept. of Business Studies, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, rudolf.vetschera@univie.ac.at

1 - Groves Mechanism vs Profit Sharing for Corporate Budgeting - An Experimental Analysis

Heike Schenk-Mathes, Institut für Wirtschaftswissenschaft, Technische Universität Clausthal, Julius-Albert-Str. 2, D-38678, Clausthal-Zellerfeld, Germany, heike.schenk-mathes@tu-clausthal.de

The paper experimentally explores the efficiency of the Groves mechanism and a profit sharing scheme in a corporate budgeting context. It further examines the effects of anonymous communication on both incentive schemes. The results show that although the Groves mechanism is theoretically superior to the profit sharing scheme, the latter turns out to be advantageous for headquarters in our experimental setting. This is essentially due to the effects of communication on both incentive schemes.

2 - Do You Get What You Reward? An Experimental Analysis of Managers' Decisions and Owners' Expectations

Markus Arnold, Department of Finance, Accounting and Taxes, Georg August University of Göttingen, Platz der Göttinger Sieben 3, 37073, Göttingen, Germany, markus.arnold@wiwi.uni-goettingen.de, *Robert Gillenkirch*, *Susanne Welker*

What you reward is what you get is a fundamental principle of management accounting. We analyze this principle in an experiment in which "managers" make one-period investment decisions and "owners" estimate these decisions. Three alternative performance measures are considered: Income, residual income, and RoI. We find that although managers' decisions significantly deviate from standard theoretical predictions, owners by and large expect to get what they reward. However, when confronted with the managers' decisions in early rounds, owners consistently revise their beliefs.

3 - Why employers may prefer unskilled workers

Georg Schneider, Dept. of Business Studies, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, georg.schneider@univie.ac.at

The selection of employees is an important issue in corporate practice. Intuitively, one would suppose that it will be in the employers' interest to contract with skilled workers. Contrary to this intuition we show that employers may be better off contracting with unskilled workers in an agency theoretic setting. This effect stems from the basic trade-off between reducing information rents and setting operative actions efficiently.

■ TB-35

Tuesday, 10:30-12:00

DEC VR7 V-147

Problem Structuring in Organisational Practice

Stream: Problem Structuring Methods / Soft OR
Invited session

Chair: *Eugene Zhuchenko*, Nijmegen School of Management, Radboud University Nijmegen, P.O. Box 9108, 6500 HK, Nijmegen, Netherlands, e.zhuchenko@fm.ru.nl

1 - Collective Intentionality and Group Decision Making

Ashley Carreras, Leicester Business School, De Montfort University, Marketing, The Gateway, LE24DH, Leicester, United Kingdom, acarreras@dmu.ac.uk

This presentation develops an understanding of group decision making by taking a position that seeks a coherent link between individual decision making and group decision making. This done by utilizing Searle's work on the notion of the intentional basis of individual decision making which has been extended to the broader concept of collective intentions, which in turn is the basis for his explanation of social reality. Implications for the practice of PSMs are discussed.

2 - On the concept of a problem

Jac Christis, Nijmegen School of Management, Radboud University Nijmegen, P.O.Box 9108, 6500 HK, Nijmegen, Netherlands, j.christis@fm.ru.nl

Business administration has as its topic both problems of and problems with organizations. Generally speaking, empirical research of problems and their causes, consequences and solutions is both language and theory dependent: without concepts we would not understand what we see and without theories we would not know where to look (for causes and consequences). In this paper we will look at the concept of 'organizational problems'. More specifically we will try to elucidate what it means when we talk about organizations that have problems and cause problems.

3 - The use of causal diagramming in Problem Structuring: how the question to be answered defines the method to be used

Ingrid Bastings, Operational Analysis, TNO Defence, Safety and Security, PO Box 96864, 2509JG, The Hague, Netherlands, ingrid.bastings@tno.nl

Problem structuring methods often use causal diagrams for visualisation, looking basically the same at first sight. This conclusion also came to our mind learning about Group Model Building and Cognitive/Oval Mapping, which motivated us to compare both methods. Would the selection of one of both methods influence the answer to the problem/question? Would the outcome be the same, or point in the same direction? We performed a case study, in which we applied both methods to the same problem/question. This presentation will address the case study and further recent practical experiences.

4 - A diagnostic approach to problem structuring interventions design

Eugene Zhuchenko, Nijmegen School of Management, Radboud University Nijmegen, P.O. Box 9108, 6500 HK, Nijmegen, Netherlands, e.zhuchenko@fm.ru.nl

Just like querying symptoms is prerequisite to effective medical care, design of effective problem structuring interventions deserves attention to the problem characteristics. From interviewing managers and management consultants, we compiled a framework articulating what prototypical problem structuring approaches are applied in the organisational practice in response to different kinds of messy problems. Comparing the scope of identified prototypical approaches to the scope of 'conventional' problem structuring methodologies helps us develop demand supply analysis for the PSMs.

■ TB-36

Tuesday, 10:30-12:00

DEC VR7 V-155

Decision-making support methodologies

Stream: Multicriteria Decision Analysis

Invited session

Chair: *Raymond Bisdorff*, Applied Mathematics Unit, University of Luxembourg, L-1511, Luxembourg, Luxembourg, raymond.bisdorff@uni.lu

1 - Developing a Portal Implementation Framework: How can MCDM help?

Matt Glowatz, Management Information Systems, University College Dublin, Quinn School of Business, Belfield, D4, Dublin 4, Ireland, matthias.glowatz@ucd.ie

Enterprise Information Portals (EIPs) have often been touted as a solution to the vast dissemination of information held across organisations. However, the lack of a well-grounded EIP implementation framework has resulted in a high failure rate of EIP projects.

I examine how one particular decision making support methodology, namely Multi-Criteria-Decision-Making (MCDM), can be adopted by decision makers to implement EIP projects successfully. In addition, I propose an "EIP Implementation Framework Checklist" aligned with an organisation's overarching business strategy.

2 - Kappalab : an R package for Choquet integral based MAUT

Patrick Meyer, Service de Mathématiques Appliquées, University of Luxembourg, 162a, avenue de la Faïencerie, 1511, Luxembourg, Luxembourg, patrick.meyer@uni.lu, *Michel Grabisch*, *Ivan Kojadinovic*

This contribution presents the Kappalab toolbox in the framework of Choquet integral based MAUT. Kappalab, which stands for "laboratory for capacities", is a package for the GNU R statistical system. Kappalab contains high-level routines for capacity and non-additive integral manipulation on a finite setting which can be used in the framework of decision aiding. Some of the main approaches to capacity identification proposed in the literature are reviewed. The use of these identification methods is presented via the Kappalab package.

3 - Multiple Criteria Preferences from Chains of Comparisons - a Direct Extraction Method

William Wedley, Faculty of Business Administration, Simon Fraser University, 8888 University Drive, V5A 1S6, Burnaby, BC, Canada, wedley@sfu.ca

Methods such as AHP/ANP derive priority vectors from numerous paired comparison matrices. Local priorities for each cluster or subset of items are then weighed and synthesized into a composite priority vector representing all criteria. Sometimes, this synthesis process is troubled by issues such as rank reversal. In this study, the weighing and synthesis step is avoided. Rather, the original comparison matrices are chained into a much enlarged matrix that creates a spanning tree across all influences. This expanded matrix is then solved with Harker's method for incomplete matrices.

4 - RuBy: a new methodology for the best choice problematics

Raymond Bisdorff, Applied Mathematics Unit, University of Luxembourg, L-1511, Luxembourg, Luxembourg, raymond.bisdorff@uni.lu, *Patrick Meyer*

The goal of this presentation is to discuss how a best choice recommendation may be rationally constructed from a bipolar valued outranking relation defined on a finite set of potential decision alternatives. We propose to revisit, in the light of new theoretical results concerning choices and kernels in bipolar valued digraphs, the pragmatic and logical foundations of the best choice problematics. The objective is to present, in the tradition of the pioneering work of Roy and Bouyssou, a new and innovative best choice support methodology we call RuBy.

■ TB-37

Tuesday, 10:30-12:00

DEC VR7 V-156

Mathematical Approaches in MCDA II

Stream: Multiple Criteria Decision Aid (c)

Invited session

Chair: *Laura Riesgo*, Dept. of Economics, Pablo de Olavide University, Ctra. Utrera km.1, 41013, Seville, Spain, lriealv@upo.es

1 - Discussing a tie in Entropy Method

Mohammad Shahalizadeh, Productivity and System Management, Islamic Azad University-Tehran South B, P.o.box 14195/116, Tehran, Iran, Islamic Republic Of, mshahalizadeh@hotmail.com, *Mahboobeh Hasani Zonoozi*

The Shannon entropy method is widely used in MADM to evaluate the weights of the different indexes in decision making matrix. The authors using the entropy method to evaluate the different financial ratios from the viewpoint of the different financial experts faced a situation that the indexes were ranked such that the rank series were completely similar while the priority of indexes was completely different. In the indicated situation, the entropy method yields misleading results. The authors discuss on the occurred tie and propose an alternative solution.

2 - A duality procedure to elicit nonlinear multiattribute utility functions

Laura Riesgo, Dept. of Economics, Pablo de Olavide University, Ctra. Utrera km.1, 41013, Seville, Spain, lriealv@upo.es, *Francisco Andre*

The implementation of the MultiAttribute Utility (MAU) Theory is limited partly for the lack of operative methods to elicit the parameters of the MAU Function, particularly when this function is not linear. We propose an indirect method to elicit the parameters of a nonlinear utility function to be compatible with the actual behaviour of decision makers, rather than with their answers to direct surveys. The idea rests on approaching the parameter estimation problem as a dual of the decision problem and making the observed decisions to be compatible with a rational decision making process.

3 - Reflections On The Structuring Of The Organizational Performance Problem Using An Mcda-c Approach From An Integrative Systemic-synergetic Perspective

Gustavo Daniel Roig-Sannemann, Technical Area, Itaipu Binacional, Av. Silvio A. Sasdelli 2882, 85869-580, Foz do Iguaçu, Paraná, Brazil, gustavo.roig@compubras.com.br, *Leonardo Ensslin*, *Sandra Ensslin*, *Ademar Dutra*

The present study views organizations as entities that can and should be analyzed and evaluated based on the notion of systems. By incorporating this notion (of systems) three new perspectives are proposed from which one seeks to give a more adequate and encompassing treatment to the structuring issue and the performance problem of organizational systems. As a result, it was verified that the combination and exploration of the three new perspectives can offer a more encompassing approach to deal with the performance of organizational systems, thus promoting organizational competitiveness.

4 - Using Conjoint Analysis to Elicit Preference Weights in Outranking MCDA

Carolyn Hermans, Western Geography Science Center, United States Geological Survey, 345 Middlefield Road, 94025, Menlo Park, CA, United States, chermans@usgs.gov

Eliciting stakeholder preferences is one of the most difficult aspects of multicriteria decision analysis (MCDA) and has been pinpointed as a major focus area in MCDA research. In this paper, we use cases from a small, exploratory environmental management field study to illustrate the possibilities for implementing conjoint analysis (CA) as an approach to elicit stakeholder weights in the outranking MCDA method, PROMETHEE. A direct weighting scheme is also evaluated, and the two methods are compared.

■ TB-38

Tuesday, 10:30-12:00

DEC VR7 V-157

Performance Measurement and the contribution of MS/OR

Stream: DEA and Performance Measurement

Invited session

Chair: *Mik Wisniewski*, Management Science, University of Strathclyde, G1 1QE, Glasgow, United Kingdom, m.wisniewski@strath.ac.uk

1 - Measuring performance in public organisations with diverse activities

Snjolfur Olafsson, Faculty of Economics and Business Administration, University of Iceland, Oddi, IS-101, Reykjavik, Iceland, snjolfur@hi.is

The city of Reykjavik is using the Balanced Scorecard as a basis for measuring performance. Scorecards for different organisations (e.g. services) within Reykjavik have been under development for many years now, but the development has varied considerably in the different organisations, in some cases with poor results. We discuss the task of measuring the performance of Reykjavik, both as whole and individual activities. The situation is similar for many other public organisations with diverse activities, e.g. universities.

2 - Performance measurement and management at a Local Strategic Partnership

Robert Dyson, Warwick Business School, University of Warwick, Gibbett Hill Road, CV4 7AL, Coventry, United Kingdom, R.G.Dyson@warwick.ac.uk

The Coventry Partnership is a public/private/voluntary/community sector partnership charged with developing and implementing a community plan for Coventry(UK). The development of the performance measurement system and its role in providing information for Partnership control and development to the Partnership Board and to the Government is discussed.

3 - Measuring Partnership Performance

Mik Wisniewski, Management Science, University of Strathclyde, G1 1QE, Glasgow, United Kingdom, m.wisniewski@strath.ac.uk, *Nichola Leslie*

In much of the public sector, more and more emphasis is being placed on partnership working as a way of delivering services and tackling community problems. The UK Audit Commission estimated that in the UK there are over 5,500 such partnerships accounting for over £4billion of public expenditure and reported major problems in performance measurement. This paper will outline some of the challenges involved in measuring partnership performance using experience from community safety and community planning partnerships in Scotland.

1 - Decision support and multimethodology: different strategies for combination of OR methods

Louise Sibbesen, Centre for Traffic and Transport, Technical University of Denmark, DTU building 115, 2800, Kgs. Lyngby, Denmark, lks@ctt.dtu.dk, *Steen Leleur*

Multimethodology is the concept of combining different operations research (OR) methods for solving complex problems. This work deals with a broad range of OR methods, including both hard and soft approaches. Different classification criteria are presented in order to constitute a framework for choosing and combining different methods in a practical problem-solving process. A principal finding is that problem-solving for messy problems can be arranged as a search-learn-debate process based on so-called communicative rationality. Finally, conclusions and a research perspective are presented.

2 - A method of analyzing ordinal data

Tohru Ueda, Faculty of Science and Technology, Seikei University, 3-3-1 Kichijoji-Kitamachi, 180-8633, Musashino-Shi, Tokyo, Japan, ueda@st.seikei.ac.jp

Nishisato proposed a simple method of analyzing ordinal data, which are obtained by asking N subjects to rank M objects according to the order of their preference. He assigned a predetermined score for each order of objects, but the score is similar to an initial value in conjoint analysis. A method of determining scores which should be given for ordinal data is proposed, where variance among stimuli is maximized. For the purpose of treating variance among subjects a special formulation is also proposed.

3 - Comparing the Aggregation Method in Analytic Hierarchy Process

Chang-tzu Chiang, Graduate School of Management, Ming Chuan University, 250, Chung Shan N. Road, Sec.5., 11103, Taipei, Afghanistan, ctcamber@mail.yust.edu.tw, *Lin Chin-Tsai*

In AHP, individual judgments can be aggregated in several ways, and the most useful are the aggregation of individual judgments and the aggregation of individual priorities. There were some articles discussed arithmetic and geometric means and propose their suggestions. In this article the simulation work are used to generate the weights of judges and then generated the AHP weights by arithmetic and geometric means. After the statistic test for the relative mean square errors between parameter and estimator from simulation, we propose suitable situation that these method should used.

4 - The Dominance-based Rough Sets Approach Applied to Multicriteria Countries Classification Problem by Economic Growth

Iwona Gruszka, Operation Research, The Karol Adamiecki University of Silesia, Ul. Bogucicka 14, 40-287, Katowice, Poland, gruszka@ae.katowice.pl

The rough set approach is a method belonging to artificial intelligence area. The method allows solving the multicriteria classification problem in the presence of uncertainty. This is the main reason of applying mentioned method to the regarded decision problem. Furthermore, the created decision model of "if then" terms is easy to interpret and is explaining the decision maker's preferences. The aim of the paper is to solve the multicriteria countries classification problem by economic growth.

■ TB-40

Tuesday, 10:30-12:00
SOC VR11 V-257

Environmental OR Applications

Stream: Environmental Planning (c)

Invited session

Chair: *Peter Kolesar*, Business, Columbia University, 408 Uris Hall, 10027, New York, NY, United States, pj4@columbia.edu

1 - Optimizing biomass facility layout and delivery based on a pure MILP model

Ferenc Brachmann, Faculty of Business and Economics, University of Pécs, Rákóczi str. 80., 7621, Pécs, Baranya, Hungary, brachmann.ferenc@tk.pte.hu

The role of the facility layout problem is a pivotal one in the case of biomass systems: environmental and social aspects have to be included in any decision concerning these investments.

To tackle this complex decision-space, the Research team at the University of Pécs developed a pure MILP model which aims to place 7 core-functions (fuel logging, transport, condensation, burning, byproduct disposal, energy distribution and energy consumption) in an optimal layout based on the complex goal structure with a set level of biomass input and energy consumption.

2 - Allocation of refuse bins for selective urban waste management

Joaquín Bautista Valhondo, Nissan Chair, Universidad Politécnica de Cataluña, Av. Diagonal 647, planta 7., 08028, Barcelona, Spain, joaquin.bautista@upc.edu, *Jordi Pereira*

One of the problems found in Municipal Waste Management is the allocation of refuse bins to different collection areas where waste is left by the citizens. This paper is focused on the allocation of refuse bins under availability and space constraints as it is faced by most Spanish municipalities. The relationship between the studied problem and the apportionment of seats in a parliament is tackled and it is used to develop an ant algorithm approach to solve the problem. The algorithm is then compared to an exact procedure for a real life instance found in the metropolitan area of Barcelona.

3 - Fisherman versus Landscapers: Water Release Policies in the Delaware River

Peter Kolesar, Business, Columbia University, 408 Uris Hall, 10027, New York, NY, United States, pj4@columbia.edu

The Delaware River is both the source of half of New York City's water and a habitat for wild trout.

We aim to revise the water release rules from the dams to benefit the fishery while not increasing the City's drought risk. Our policies are conservative in that they decrease reservoir levels less in dry years than in wet years. In wet years the difference is larger, but it matters less since reservoir levels are much higher. Side benefits are increased flood protection and a simpler structure to administer. We focus on the complex political environment and on the analysis.

4 - Cost-based Sensitivity Analysis in Reverse Logistics

Peter Letmathe, FB 5: Wirtschaftswissenschaften, University of Siegen, Chair of Value Chain Management, Hoelderlinstr. 3, 57068, Siegen, Germany, peter.letmathe@uni-siegen.de

The presentation first shows how to calculate and assign internal costs of returns (reverse product flows). The complexity of cost assignment is caused by several cyclical relations. Second, sensitivity analysis is used to demonstrate the impact of return volume, recycling rate and quality of returns. This information can be used to optimize volume and quality of return flows as well as to improve quality management and return processing. Since these measures are related to additional costs, it is crucial to determine tradeoffs to allow minimization of overall costs.

■ TB-41

Tuesday, 10:30-12:00
SOC VR11 V-258

Monitoring and optimizing working conditions in Europe

Stream: Human Centered Processes

Invited session

Chair: *Andranik Tangian*, WSI, Hans Boeckler Foundation, Hans Boeckler Str. 39, 40476, Duesseldorf, Germany, andranik-tangian@boeckler.de

1 - TUTORIAL: A composite indicator of working conditions in the EU-15 for policy monitoring and analytical purposes

Andranik Tangian, WSI, Hans Boeckler Foundation, Hans Boeckler Str. 39, 40476, Duesseldorf, Germany, andranik-tangian@boeckler.de

A composite indicator Working Conditions for European countries is constructed from data of the 3rd European Survey on Working Conditions. The main findings are as follows: (a) European countries differ with respect to working conditions statistically more significantly (= more certainly) than with respect to earnings, and (b) earnings play no essential role in subjective estimations, including job satisfaction, which mainly depends on working conditions; consequently, more attention should be paid to improving the latter (NB for governments, employers, and trade unions).

2 - Risk management and decision aid

Gurvan Uguen, LUSI, ENST Bretagne, Cs 83818, 29238, Brest Cedex 3, France, gurvan.uguen@enst-bretagne.fr,
Philippe Lenca, Gilles Coppin, Claire Lassudrie

Major technological risks are characterized by very weak probabilities of appearance coupled with consequences of very high gravity and ubiquity. Roles and responsibilities redistribution within organisation particularly impacts process pilots, on the strategic, organisational as functional levels. Cognitive, psychological and cultural biases intervene in their perception of such risks. From now on, these decision makers want to base their choices on a management system of risks as a whole but allowing apprehending them in differentiated ways. We present the characteristics of such a system.

■ TB-42

Tuesday, 10:30-12:00

SOC VR11 V-261

Modelling of Economies and Societies in Transition and Development

Stream: Modelling of Economies and Societies in Transition (c)

Invited session

Chair: *Tibor Kis*, Quantitative methods in economy, Faculty of Economics, Segedinski put 9-11, 24000, Subotica, Serbia, Serbia and Montenegro, tbkis@yahoo.com

1 - Competitiveness as a Condition for Developing the Economy in Transition

Radmilo Todosijevic, Faculty of Economics, Segedinski put 9-11, 24000, Subotica, Serbia and Montenegro, radmilot1@yahoo.com

This paper deals with the following fields: spheres of changes in the economy, influence of knowledge on competition; influence of technology on product competitiveness, crises and the discontinuity of development; development as a supposition of competitiveness; suppositions for strengthening competitive capabilities; challenges and ability to adapt; evolution of cultural changes and turnabouts in competition; competition-art of strategy; structural scenario of development of transitional economies.

2 - Assessing the Significance of Production Capability to the Firm

Seena Rejal, Institute for Manufacturing, University of Cambridge, Mill Lane, CB2 1RX, Cambridge, United Kingdom, seena.rejal@gmail.com

The significance of production to firms is only partially understood in theory, and in practice decisions are often informed by limited cost-based analyses. Through a series of case studies of manufacturing firms across various, a new approach to understanding the significance of production is developed. In comparison to conventional perspectives, this new approach offers a richer, more dynamic, context-specific and granular insight which can augment quantitative analyses.

3 - Economic and Social Performance of Serbia's and Europe's Regions

Tibor Kis, Quantitative methods in economy, Faculty of Economics, Segedinski put 9-11, 24000, Subotica, Serbia, Serbia and Montenegro, tbkis@yahoo.com, *Marija Cileg*

Strategies of development not only give emphasis to sustainable economic growth of Europe's nations, but also to the development of their regions. Serbia's regional units have been mainly ignored in international studies. The objective of this paper is to analyze levels of social and economic development of Serbia compared to other European nations and above all the place that Serbia's particular regional units take among Europe's regions. A range of factors is taken into account and a composite indicator based on factor analysis and data envelopment analysis is derived.

■ TB-43

Tuesday, 10:30-12:00

FIN Endur Room 1

Stochastic optimization for pension fund management

Stream: Stochastic Programming

Invited session

Chair: *Georg Pflug*, Department of Statistics and Decision Support Systems, University of Vienna, Universitaetsstrasse 5, A-1010, Vienna, Austria, georg.pflug@univie.ac.at

1 - A stochastic optimization model for asset liability management of a Finnish pension insurance company

Matti Koivu, Risk Management Division, European Central Bank, Kaiserstrasse 29, 60311, Frankfurt am Main, Germany, matti.koivu@ecb.int

This talk describes a stochastic optimization model developed for asset liability management of a Finnish pension insurance company. In many respects the model resembles those presented in the literature, but it has some unique features stemming from the statutory restrictions for Finnish pension companies. Particular attention is paid to modelling the stochastic factors, numerical solution of the optimization problem and evaluation of the solution. Out-of-sample tests clearly favour the strategies suggested by our model over static Fixed-mix and dynamic portfolio insurance strategies.

2 - Asset and Liability Management for Swiss Pension Funds

Gabriel Arnon Dondi, Inst. f. Mess- u. Regeltechnik, ETH Zürich, ETH Zentrum, ML, Sonneggstr. 3, 8092, Zürich, Switzerland, dondi@imrt.mavt.ethz.ch

We present an asset and liability management model for Swiss pension funds. It consists of dynamic, stochastic models for both, liabilities and asset prices. With the models, an optimisation technique to allocate the funds with regard to the structure of the liabilities is formulated. The method is applied using member's data of two Swiss pension funds with a total of 5000 members and 1.6 billion Swiss Francs of wealth. In an extensive out of sample case study with historical data, the method is applied over a long time period and changing market environments superiorly to passive benchmarks.

3 - Models and solution methods for asset and liability management (ALM)

Cormac Lucas, Mathematical Sciences, Brunel University, Kingston Lane, UB8 3PH, Uxbridge, Middlesex, United Kingdom, mastcal@brunel.ac.uk, *Gautam Mitra, Kristine Rasmussen*

We present an ALM problem using two approaches: deterministic and stochastic. We hedge the portfolio against interest rate risk using swaps. In the deterministic model we trade off PV01 matching with cash funding. (PV01 is the change in NPV of a bond for a 0.01% positive parallel shift in the yield curve). In the stochastic programming model we have two random variables: liabilities and interest rates. We create interest rate scenarios and trade off cash funding with NPV deviations in assets and liabilities. We contrast the two computational models determining the mismatch of both approaches.

■ TB-44

Tuesday, 10:30-12:00

FIN Endur Room 2

Valuation

Stream: Long Term Financial Decisions

Invited session

Chair: *Jan Körnert*, Stiftungslehrstuhl f. Allgem. BWL, Universität Greifswald, Friedrich-Loeffler-Straße 70, 17489, Greifswald, Germany, koernert@uni-greifswald.de

1 - A note on the relation between book value and market value of firms

Andreas Loeffler, Banking and Finance, Universität Hannover, Königsworther Platz 1, 30167, Hannover, Germany, al@wacc.de

It is well known that the book value of a company has an important impact on the market value of the firm. If we simply plug this empirical relation into the existing theories on market valuation, arbitrage opportunities or irrational behavior of investors would result. Our aim is to present a DCF model that incorporates both the market as well as the book value. It turns out that, given a particular investment policy, it can be proven that both values are highly correlated. If the cash flows are normally distributed however, the book-to-market ratio has no expectation...

2 - Determining a discount rate in environmental management from financial-option theory

Pierre Kunsch, MOSI, Vrije Universiteit Brussel, Pleinlaan 2, 1050, Brussels, Belgium, pkunsch@vub.ac.be, *Alain Chevalier*

The authors propose a financial-option-theory procedure for establishing a range of possible discount rates in environmental issues like radioactive waste disposal. In such issues part of the future liabilities have distant time horizons. It is assumed that the funding is placed in a portfolio managed according to a defined asset allocation strategy and that the technical-scenario uncertainties have been assessed. The adequacy of any discount rate in the range is analysed at different time horizons by considering a European put option on the portfolio value.

3 - Interest rate margin in the management accounting of banks

Jan Körnert, Stiftungslehrstuhl f. Allgem. BWL, Universität Greifswald, Friedrich-Loeffler-Straße 70, 17489, Greifswald, Germany, koernert@uni-greifswald.de, *Ursula Walther*

Interest rate margins are still key players in banking business and its management. They are linked to the profit and loss account and measure banks' performances periodically. Schierenbeck's interest rate margins are based on the internal rate of return and rely on some arbitrary assumptions. We calculate interest rate margins based on the term structure of interest rates. This reduces theoretical inconsistencies. By taking advantage of term structure information, we decompose the margins in components induced by interest rate and credit default risk. Our approach is linked to RAPM.

■ TB-45

Tuesday, 10:30-12:00

FIN Endur Room 3

Optimal pricing and risk management

Stream: Optimization in Financial Mathematics

Invited session

Chair: *Holger Kraft*, University of Kaiserslautern, Erwin-Schrodinger-Str., 67663, Kaiserslautern, Germany, kraft@mathematik.uni-kl.de

1 - An optimal control theoretic transfer pricing model under the constraints of non-renewable resources and deterministic corporate taxes

Michaela Nettekoven, Institute of Quantitative Management and Operations Research, University of Economics and

Business Administration Vienna, Nordbergstrasse 15, 1090, Vienna, Austria, michaela.nettekoven@wu-wien.ac.at, *Helmut Sorger*

We develop a model to study different transfer pricing regimes for enterprises in the initial production sector. Production and distribution subsidiaries want to optimize their total profit, whereas the headquarters aims at maximizing the group's profit. The subsidiaries have access to markets in an intermediate product, furthermore they may negotiate transfer prices. If negotiations fail, transfer prices are set by the headquarters. We use a dynamic optimization model to compare different transfer pricing regimes subject to centralized and decentralized investment strategies.

2 - Optimization of Recent Risk Measures for Elliptically Distributed Returns

Bahar Kaynar, Industrial Engineering, Sabanci University, MDBF binasi, Oda No:1021, Tuzla, 34956, Istanbul, Turkey, baharkaynar@su.sabanciuniv.edu, *S. Ilker Birbil*

We discuss a class of risk measures for portfolio optimization with linear loss functions. The recent risk measures, Value-at-Risk (VaR) and Conditional-Value-at-Risk (CVaR), belong to this class. The random return variables of financial instruments are distributed by elliptical distributions. Under this setting, the optimal solution of the corresponding mathematical models formed by these measures, is equivalent to the solution of the classical Markowitz model. To solve the Markowitz model, we use a fast and finite step algorithm proposed in the literature.

3 - Optimal choice of the catastrophic risks reinsurance

Bogdan Ciupek, Department of Operations Research, The Karol Adamecki University of Economics, ul. Bogucicka 14, 40-226, Katowice, Silesia, Poland, ciupek@ae.katowice.pl

Reinsurance is necessary to perform correct financial economy of an insurance company. Hence, appropriate selection of a scope and methods of reinsurance in the context of insuring risks of catastrophic nature gains in particular importance. Catastrophical risk are more and more frequently observed and they are more and more expensive. The paper suggests application of a decision tree as a tool that supports an optimal selection of the scope of reinsurance for a given structure of the insurance portfolio.

■ TB-46

Tuesday, 10:30-12:00

FIN Endur Room 4

Actuarial risk theory

Stream: Applied Probability

Invited session

Chair: *Jan Dhaene*, Katholieke Universiteit Leuven, Leuven, Belgium, Jan.Dhaene@econ.kuleuven.be

1 - Worst case risk measurement: back to the future?

Marc Goovaerts, AFI, Katholieke Universiteit Leuven, Naamsestraat 69, 3000, Leuven, Belgium, marc.goovaerts@econ.kuleuven.be

Worst case risk measurement: back to the future? This paper studies the problem of finding best-possible upper bounds on risk measures under incomplete probabilistic information. Both the univariate and the multivariate case are considered. The problem is phrased in the framework of finite dimensional convex analysis and extensive use is made of primal-dual representations.

2 - Supervision of Solvency

Georgios Pitselis, Statistics and Insurance Science, University of Piraeus, Karaoli & Dimitriou 80, 18534, Piraeus, Greece, pitselis@unipi.gr

The purpose of this work is to present a statistical methodology for investigating the solvency of insurance companies and predicting future insolvency. The variables that have been used for this investigation are some financial characteristics of the company such as those presented in the balance sheet. Some other financial characteristics have been provided by regulatory authorities. Multivariate techniques have also been used for predicting the theoretical amount of capital needed to absorb the risks of conducting business.

3 - Fuzzy Random Variables

Arnold Shapiro, Insurance Real Estate, Penn State University, 359 Business Building, 16802-3603, University Park, PA, United States, afs1@psu.edu

Risk theory is based on two sources of uncertainty: randomness and fuzziness. Randomness models the stochastic variability of all possible outcomes of a situation and fuzziness relates to the unsharp boundaries of the parameters of the model. Clearly, randomness and fuzziness are complementary, and so a natural question is how fuzzy variables interact with the types of random variables found in risk theory. This study focuses on one important dimension of this issue, fuzzy random variables, and illustrates how naturally compatible and complementary randomness and fuzziness are.

4 - Longitudinal Modeling of Singapore Motor Insurance

Emiliano Valdez, Unsw, Sydney, Australia, e.valdez@unsw.edu.au

This work describes longitudinal modeling of detailed, micro-level automobile insurance records where we propose models for three components: frequency, type and severity of claims. The first is random effects Poisson model for frequency while the second is multinomial logit model to predict the claim type. For the severity component, we use a Burr XII long-tailed distribution and using t-copulas, we show a significant dependence among the different claim types. When taken together, the integrated model allows an actuary to predict automobile claims more efficiently than traditional methods.

■ TB-47

Tuesday, 10:30-12:00

FIN Endur Room 5

Riskiness

Stream: Financial Modelling (c)

Invited session

Chair: *Yuji Sato*, Mie Chukyo University, Graduate School of Policy Science, 1846, Kubo, 515-8511, Matsusaka, Mie, Japan, ysatoh@mie-chukyo-u.ac.jp

1 - Optimizing Safe Investment: A Case Study for a Chemical Industry

Yuji Sato, Mie Chukyo University, Graduate School of Policy Science, 1846, Kubo, 515-8511, Matsusaka, Mie, Japan, ysatoh@mie-chukyo-u.ac.jp

The objective of this study was to develop the quantitative model of risk assessment and to clarify the optimal safe investment for a chemical industry. To obviate disasters is inseparable from generating profit for a company due to serious rekindling of interest in CSR and sustainability. However, valuation technique for safety is not established, because of its quantization limit. In this study, the degree of risk reduction was evaluated based on the percent complete of each measure for risk management, and cost effectiveness concerning safe investment for each measure was clarified.

2 - A concept for business intelligence support in financial crisis management

Ljiljana Kascelan, Informatics, Faculty of Economics, Jovana Tomasevica 37, 81000, Podgorica, Montenegro, Serbia and Montenegro, ljiljak@cg.ac.yu

The paper presents a concept for applying business intelligence (BI) tools in financial crisis management. This concept is based on proposed decomposition of business decision processes in financial crisis management. So, first we identify models which supports that decision processes. Then, we define an appropriate relational data warehouse design. Finally, we present a methodology of models generation and OLAP analyses by Oracle BI tools.

3 - Market microstructure analysis of interest rates

Helgi Tomasson, Faculty of Economics and business administration, University of Iceland, Oddi v/ Sturlugötu, IS-101, Reykjavik, Iceland, helgito@hi.is

Data on transaction of treasury bills and bonds are collected electronically in an on-line system. The rate of return is assumed to follow a continuous-time diffusion process. The transaction price and time of transaction are interpreted as discrete measurements of the process. Numerical methods for estimating the parameters by approximating the likelihood function of the process are implemented. The approach offers a method of monitoring the interest rates.

4 - Measuring a Risk for Managing a Project Financing

Zoran Ciric, Informatics, Economic Faculty Subotica, Segedinski put 9-11, 24000, Subotica, Serbia, Serbia and Montenegro, zotisz@tippnet.co.yu, *Otilija Sedlak*

In the last decades the problem of measuring and managing risk has been the object of analysis by researchers. Financial organisations, banks, credit institutions, project financiers need predictions of failure for firms in which they have kind of interest. The more widely used methods are based on econometric models. The complexity of the several phases and a very long time horizon add a vague and imprecise character and the risk parameter is made more flexible under fuzziness. The aim of this paper is to introduce a method to evaluate a project risk level and forecast its financing.

■ TB-48

Tuesday, 10:30-12:00

EWG Logberg 102

EWG: OR in Computational Biology and Bioinformatics

Stream: EWG Meetings

Invited session

Chair: *Metin Turkey*, Department of Industrial Engineering, Koc University, Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey, mturkay@ku.edu.tr

1 - Foundation Meeting of EURO WG "OR in Computational Biology and Bioinformatics"

Metin Turkey, Department of Industrial Engineering, Koc University, Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey, mturkay@ku.edu.tr, *Gerhard-Wilhelm Weber*

For this meeting, the foundation of the new EURO Working Group "OR in Computational Biology and Bioinformatics" is planned and closer explanations prepared. Future plans will be discussed. Participants are cordially welcome, also for membership: to become Founding Members!

■ TB-50

Tuesday, 10:30-12:00

DISCUSS Adal 1

Discussion Presentation (A1)

Stream: Poster - Discussion Presentations

Invited session

Chair: *Valerie Belton*, Dept. Management Science, University of Strathclyde, 40 George Street, G1 1QE, Glasgow, United Kingdom, val.belton@strath.ac.uk

1 - A New Problem of Stochastic Programming with an Application in Agriculture

Bela Vizvari, Operations Research, Eotvos Lorand University, Pazmany Peter setany 1/c, H-1117, Budapest, Hungary, vizvari@math.elte.hu

The underlying problem is that how should the management assign the arable land of a farm among crops if the assignment must meet the constraints of a fixed production plan, i.e. quantities of crops to be produced. The plan ensures the existence of the cash flow required by the company. The new feature of the probabilistic programming model is that the correlated random variables are the right-hand sides of the constraints. Numerical results on the agricultural application will be presented.

2 - Applying optimization modeling techniques for making a railway track tamping schedule

Masashi Miwa, Track Management, Railway Technical Research Institute, 2-8-38 Hikari-cho Kokubunji-shi, 185-8540, Kokubunji, Tokyo, Japan, miwa@rtri.or.jp, Tatsuo Oyama

Track maintenance schedule plays a very important role from economical, managerial and physical aspects for the railway company. We try to build a mathematical programming model in order to find an optimal railway track tamping schedule so that track irregularities be kept at a desirable level. We apply our model to some district of the Japanese railway company using the actual data. Numerical results showing the validity and efficiency of our model will be given under various kinds of criteria such as minimizing the tamping cost, attaining the minimum irregularity and combining.

3 - Furniture supply chain tactical planning optimization using Bender's decomposition and cross decomposition methods

Mustapha Ouhimmou, Genie mécanique, Université Laval, Pavillon Alexandre-Vachon, G1K 7P4, Québec, Québec, Canada, mustapha.ouhimmou@centur.ulaval.ca, Sophie D'Amours, Robert Beauregard, Daoud Ait-Kadi, Satyaveer S Chauhan

We study the supply chain planning problem of furniture company in a multi-periods context. The model obtained is a mixed integer program which is NP-complete problem. We present implementation of two approaches for solving the problem Bender's decomposition and cross decomposition methods. The cross decomposition method integrates both Benders decomposition and Lagrangean relaxation into a single framework that exploits the primal and dual structure. Computational and comparisons results of the two methods with cplex are presented.

■ TB-50

Tuesday, 10:30-12:00

DISCUSS Adal 2

Discussion Presentation (B1)

Stream: Poster - Discussion Presentations

Invited session

Chair: Valerie Belton, Dept. Management Science, University of Strathclyde, 40 George Street, G1 1QE, Glasgow, United Kingdom, val.belton@strath.ac.uk

1 - Community health schemes in rural developing areas: an application of hierarchical location models

Honora Smith, School of Mathematics, University of Southampton, Highfield, SO17 1BJ, Southampton, Hampshire, United Kingdom, hs@maths.soton.ac.uk, Paul Harper, Chris Potts

The provision of basic accessible health care is often inadequate for large numbers of people living in rural areas of developing countries. Private health care providers tend to concentrate in the cities where incomes are higher, leaving rural dwellers in a situation where illness can lead to poverty. An NGO or faith-based organisation may be the sole provider of quality health care in a rural area. We are investigating the use of hierarchical location models in these situations, and the factors needed to plan sustainable community health schemes.

2 - Discussion Presentation: Improving Sustainable Living in Rural Areas in Turkey

Ali Gökmen, Department of Chemistry, Middle East Technical University, 06531, Ankara, Turkey, agokmen@metu.edu.tr, Inci Gokmen, Gerhard-Wilhelm Weber, Dorien DeTombe

The Discussion is devoted to OR for Sustainable Living, exemplified by Balaban Valley Project, a rural underdeveloped area near Ankara Turkey. Goal is increasing the level of living. Challenges for sustainable living are: high costs of fertilizers, pesticides and fuel. Uncertainty in decision making on the type of crop, limited opportunities for education, and unequal and unbearable workload for men and women. This project will be realized by an integrated approach based on COMPRAM method. This work serve as impulse and model network for similar OR applications in Turkey and other countries.

3 - Shelters selection with multiattribute.

José G. Hernández R., Gestión de la tecnología, Universidad Metropolitana, Distribuidor universidad, autopista, Guarenas, 78239, Caracas, 1074, Miranda, Venezuela, jhernandez@unimet.edu.ve, María J. García G.

In catastrophes, part the population is affected, and its displacement towards shelters where they can remain is necessary, but these refuges must fulfill requirements so that the people can be in favor there of an indefinite time, in suitable conditions.

A first step is to previously evaluate the places that can serve as shelters, that can be made with multiattribute models, and from the objective of this work arises: To construct to a multiattribute model, that allows to evaluate in a fast and simple way those places that can be used as possible shelters in case of a catastrophe.

■ TB-50

Tuesday, 10:30-12:00

DISCUSS Adal 3

Discussion Presentation (C1)

Stream: Poster - Discussion Presentations

Invited session

Chair: Valerie Belton, Dept. Management Science, University of Strathclyde, 40 George Street, G1 1QE, Glasgow, United Kingdom, val.belton@strath.ac.uk

1 - Measures for detemerning effects of web personalization methods

Ilija Subasic, Department of Business Information Systems and Quantitative Methods, Faculty of Economics Subotica, Segedinski put 11, 24000, Subotica, Serbia and Montenegro, ilija@eccf.su.ac.yu, Zita Boshnjak

In recent years the problem of web personalization had become the area widely researched by number of authors. They developed several techniques for web personalization such as collaborative filtering, content filtering and web usage mining. Although all of these methods were applied by number of web sites they failed to deliver expected results. The goal of this paper is neither to show effects of each of these methods nor to show their advantages or disadvantages, but to point out to the flaws in metrics used for evaluation of the effects that each method has on web personalization.

2 - Pmtthe Project Management Trainer

Avraham Shtub, Industrial Engineering Management, Technion - Israel Institute of Technology, 32000, Haifa, Israel, shtub@ie.technion.ac.il

This paper presents a new approach to the teaching and training in project management approach based on a software tool that combines an interactive, dynamic case study and a simple yet effective Project Management System. This tool, the Project Management Trainer (PMT) applies recent developments in the area of learning histories in simulation-based teaching. The PMT is designed to support training and to provide an environment for practicing teamwork in managing dynamic stochastic multiple projects.

3 - A model investigating the unemployment of the TEI WM graduates in Greece

Lazaros Tsikritzis, Pollution Control Technologies, Technological Educational Institute (TEI) of West Macedonia, Koila, 50100, Kozani, Greece, elsa@teikoz.gr, Athanasios Papavasileiou, Paraskevi Boubourekas, Kirois Koios

In Greece, the unemployment of new scientists has been on the increase for the last five years. Thus it is essential a monitoring research into the graduates' future career.

The present paper deals with graduates of the Optional Programmes of Studies of TEI WM in Greece. These Programmes have mostly adult students. The research focuses on the data collected by the Career's Advisory of the TEI and analyzes them on the basis of a statistical model.

■ TB-50

Tuesday, 10:30-12:00

DISCUSS Adal 4

Discussion Presentation (D1)

Stream: Poster - Discussion Presentations

Invited session

Chair: *Valerie Belton*, Dept. Management Science, University of Strathclyde, 40 George Street, G1 1QE, Glasgow, United Kingdom, val.belton@strath.ac.uk

1 - Firm expansion with a limited budget under competitive delivered pricing

Blas Pelegrin, Statistics and Operations Research, University of Murcia, Spain, pelegrin@um.es, *Pascual Fernandez*, *Jose Fernandez*, *María D. García*

The location problem of new facilities for a firm in an area where the firm already owns some pre-existing facilities in competition with other firms is considered. The objective is to maximize the total profit coming from the new facilities taking into account that cannibalisation may occur. The budget for the expansion is fixed and it will be spent for constructing the new facilities. The problem is analysed on a transportation network. An integer linear programming formulation of the problem is also presented.

2 - The Impact of Correlation on Insider Trading with Information Leakage

Katsumasa Nishide, Graduate School of Economics, Kyoto University, Yoshida Honmachi, Sakyo-ku, 6068501, Kyoto, Japan, knishide@econ.kyoto-u.ac.jp

We analyze a Kyle-type model in which noise trades and a public signal are correlated. We show that, in contrast to the previous literature as Kyle (1985), Back et al. (2000) and Baruch (2002), Kyle's λ , the price sensitivity to the order flow, can be of any shape, depending on the correlation structure. We also show that the informational efficiency of the price with a public signal may be lower than that without a public signal.

Tuesday, 12:30-13:30

■ TC-01

Tuesday, 12:30-13:30

PLEN HBio Big Stage

The Society of Operations Research

Stream: Semi-Plenary Sessions

Invited session

Chair: *Michael Trick*, Tepper School of Business, Carnegie Mellon University, Tepper Room 243, 15213, Pittsburgh, PA, United States, trick@cmu.edu

Chair: *Jakob Krarup*, Dept. of Computer Science, University of Copenhagen, Universitetsparken 1, DK-2100, Copenhagen, Denmark, krarup@diku.dk

1 - The Society of Operations Research

Michael Trick, Tepper School of Business, Carnegie Mellon University, Tepper Room 243, 15213, Pittsburgh, PA, United States, trick@cmu.edu

The field of operations research, like every area of professional endeavor, can be seen as a society, one definition of which is "an enduring and cooperating social group whose members have developed organized patterns of relationships through interaction with one another". Key to the operation of a society is the concept of "social capital", the value that members of a society gain through ongoing interactions. Social capital is particularly important for those of us in OR because we rely on interactions both within and outside our field to generate new applications and research directions. Without external linkages, OR becomes sterile and self-serving; without internal linkages, the field cannot advance. But there are convincing data that broad societal trends point to a decrease in activities that lead to social capital. These trends have an effect on researchers and practitioners in OR, along with their Societies. How can we advance and thrive in an increasingly isolated and isolating environment? One broad societal response has been alternative virtual activities as exemplified by wiki, blogs, social networking websites, and so on, a trend that is only slowly catching on in our field. But do these activities really lead to social capital and the advancement of a society? Or are they ersatz substitutes, no more useful at generating social capital than watching TV? I will discuss the challenges we face as a field and the opportunities for individuals within the field who recognize the importance of social capital.

■ TC-02

Tuesday, 12:30-13:30

PLEN HBio Hall 1

How Good are Interior Point Methods? Klee-Minty Cubes, the Central Path and Iteration Complexity

Stream: Semi-Plenary Sessions

Invited session

Chair: *Tamas Terlaky*, Computing and Software, McMaster University, 1280 Main Street West, L9B 2S9, Hamilton, Ontario, Canada, terlaky@mcmaster.ca

Chair: *Tuula Kinnunen*, Kirkkotie 285, FI-21370, Aura kk, Finland, euro@tuulakinnunen.fi

1 - Redundancy and Interior Point Methods: How curvy are the central paths of Klee-Minty cubes?

Tamas Terlaky, Computing and Software, McMaster University, 1280 Main Street West, L9B 2S9, Hamilton, Ontario, Canada, terlaky@mcmaster.ca, *Antoine Deza*, *Eissa Nematollahi*, *Yuriy Zinchenko*

We consider a family of LO problems over the n -dimensional Klee-Minty cube and show that the central path may visit all of its vertices in the same order as simplex methods do. This is achieved by carefully adding an exponential number of redundant constraints that forces the central path to take at least $2n-1$ sharp turns. This fact suggests that any feasible path-following IPM will take at least $2n$ iterations to solve this problem. This construction exhibits the worst-case iteration-complexity of IPMs. In addition, we discuss some implications for the curvature of the central path.

■ TC-03

Tuesday, 12:30-13:30

PLEN HBio Hall 2

Social Choice and Computer Science

Stream: Semi-Plenary Sessions

Invited session

Chair: *Fred Roberts*, DIMACS, Rutgers University, 96 Frelinghuysen Road, 08854, Piscataway, NJ, United States, froberts@dimacs.rutgers.edu

Chair: *Marino Widmer*, Département d'Informatique, Université de Fribourg, Boulevard de Pérolles 90, 1700, Fribourg, Switzerland, marino.widmer@unifr.ch

1 - Social Choice and Computer Science

Fred Roberts, DIMACS, Rutgers University, 96 Frelinghuysen Road, 08854, Piscataway, NJ, United States, froberts@dimacs.rutgers.edu

The social choice problem is to find a consensus given different opinions, preferences or votes. Social science methods developed over the years for dealing with this problem are finding novel, important applications in computer science and computer science points of view are impacting social science applications. We will describe connections between social choice and computer science, concentrating on such topics as meta-search (combining results from multiple search engines), image processing, collaborative filtering, software measurement, and processing information in large databases.

■ TC-04

Tuesday, 12:30-13:30

PLEN HBio Hall 3

Operational Research and Fisheries Management

Stream: Semi-Plenary Sessions

Invited session

Chair: *Ragnar Arnason*, Economics, University of Iceland, Sturlugata, IS-101, Reykjavik, Iceland, ragnara@hi.is

Chair: *orkell Helgason*, National Energy Authority of Iceland, Grensásvegi 9, 108, Reykjavík, Iceland, thh@os.is

1 - Operations Research and Fisheries Management

Ragnar Arnason, Economics, University of Iceland, Sturlugata, IS-101, Reykjavik, Iceland, ragnara@hi.is

Fisheries management consists of establishing and operating a set of institutes to manage fishers. This set of institutes, the fisheries management regime has to be appropriately designed and implemented. This requires modelling, measurement and calculations. At the same time it is important to keep an eye on the cost of management. The problem is to strike the right balance between the efficacy of the fisheries management regime and its cost of design, implementation and operation. This is a complicated practical problem well suited to the application of operations research techniques.

Tuesday, 14:00-15:30

■ TD-01

Tuesday, 14:00-15:30

KEY Askja N-132

TUTORIAL: Introduction to COIN-OR

Stream: COIN-OR: Open Source Software

Invited session

Chair: *Robin Lougee-Heimer*, Mathematical Sciences, IBM Research, T.J. Watson Research Center, 1101 Kitchawan Road, 10598, Yorktown Heights, NY, United States, robinlh@us.ibm.com

Chair: *Jp Fasano*, TJ Watson Research Center, IBM Research, 1101 Kitchawan Road, 10598, Yorktown Heights, NY, United States, jpfasano@us.ibm.com

1 - Introduction to COIN-OR

Jp Fasano, TJ Watson Research Center, IBM Research, 1101 Kitchawan Road, 10598, Yorktown Heights, NY, United States, jpfasano@us.ibm.com, *Alan King*, *Robin Lougee-Heimer*, *Ted Ralphs*, *Matthew Saltzman*

The Computational Infrastructure for Operations Research (COIN-OR) is an initiative to promote open-source software for the operations research community. At the COIN-OR website, www.coin-or.org, a number of open-source software tools for solving optimization problems are available. These include full-featured codes for linear, nonlinear, and integer programming, as well as component libraries that can be combined in various ways to build custom solvers. In this workshop, we will provide an overview of COIN-OR. The main focus of the workshop will be on tools for linear and integer programming, such as the COIN LP Solver, the Open Solver Interface, the Cut Generation Library, and the COIN Branch Cut Solver. We will also cover the Stochastic Modeling Interface, a tool for modeling stochastic programming problems.

■ TD-02

Tuesday, 14:00-15:30

APP Askja N-131

Hospital Planning Models

Stream: OR in Health Care

Invited session

Chair: *Jan Vissers*, Technology Management, Eindhoven University of Technology, PO Box 513, 5600 MB, Eindhoven, Netherlands, j.m.h.vissers@tm.tue.nl

1 - Constraint-based Inventory Management

James Little, Computer Science, University College Cork, College Road, na, Cork, Ireland, jlittle@4c.ucc.ie, *Brian Coughlan*

Standard EOQ models for periodic inventory review, do not consider limited space. Using Constraint Programming, we propose optimal inventory policies; frequency, service level and stock levels, across all products, within a fixed space. We use data from Cork University Hospital, where the system is being trialled in one of its departments.

2 - Modelling waiting lists and bedblocking in a mental health hospital

Jan Vissers, Technology Management, Eindhoven University of Technology, PO Box 513, 5600 MB, Eindhoven, Netherlands, j.m.h.vissers@tm.tue.nl

Long waiting lists and bedblocking are common phenomena in mental health care settings. We developed a simulation model for supporting decisions on matching demand and supply in a local setting. The model can be used to investigate the effect of increasing capacity of wards or changes in the patient mix. By using a description of the trajectories that patients follow through the system, and by grouping patients according to these trajectories into 'iso-process' clusters, the model allows to visualize resource impacts of changes in the process of individual patient groups.

3 - Optimal outpatient appointment scheduling

Guido Kaandorp, Department of Mathematics, Vrije Universiteit, Amsterdam, Saenredamstraat 51 zwart, 2021ZN, Haarlem, Netherlands, gckaando@few.vu.nl, *Ger Koole*

We study outpatient appointment scheduling. For a given number of patients and equally distributed treatment times we derive a local search procedure that converges to the optimal schedule. The objective is a weighted average of expected waiting times of patients, idle time of the doctor and tardiness. We allow for no-shows to happen. For certain combinations of parameters we find the well-known Bailey-Welch rule as optimal appointment schedule. A tool in which this algorithm is implemented can be found on the internet: www.math.vu.nl/~gckaando/schedule.

4 - Virtual reality as a training tool in a hospital sector

Ludmila Gabcan, PEC-LAMCE, COPPE/UFRJ, Cidade Universitária - Ilha do Fundão Centro de Tecnologia,, Bloco I-2000/sala I-214, Po. Box 68552, 21949-900, Rio de Janeiro, Brazil, gabcan@lamce.ufrj.br

A virtual reality model can present characteristics of a complex system as a hospital system and it is able to study many important points as flow of patients, allocation of human resources, etc. The construction of the first virtual clinic layout (ORAH2003) was planned in such a way that the admission sector of patients does not interfere with the work routines of the care patients that are already operating. This work presents a logical model of generated simulation that can present the results in a virtual model and it can be used as training tool in an emergency decision support.

■ TD-03

Tuesday, 14:00-15:30

APP Askja N-130

PANEL: Business and Industry OR - Maximal

Stream: Business and Industry OR - Special Track

Invited session

Chair: *Bjarni Kristjansson*, Maximal Software, Inc., 2111 Wilson Boulevard, 22201, Arlington, Virginia, United States, bjarni@maximalsoftware.com

1 - Practical OR: Developing and Deploying Solutions that Delight and Dazzle Clients

Harlan Crowder, Dieselbrain Partners, 897 Humewick Way, 94087, Sunnyvale, CA, United States, hpc@acm.org

The operations research profession has done a great job of defining and teaching the underlying problem-solving technologies of OR - optimization, simulation, statistical analysis, applied probability - and how to apply these methods to a wide range of important business and engineering problems. The area we are still struggling with is how to make sure the real-world OR solutions that we develop and deploy are appreciated and adopted by the right people in client organizations, and these people then use our solutions to obtain results in their enterprise that would not otherwise be realized.

2 - PANEL: Operations Research in Practice

Bjarni Kristjansson, Maximal Software, Inc., 2111 Wilson Boulevard, 22201, Arlington, Virginia, United States, bjarni@maximalsoftware.com, *Harlan Crowder*, *Karla Hoffman*, *Michael Haydock*

The practical application of OR requires more than expertise in optimization, simulation and applied statistics. A good OR practitioner needs to now how to manage clients and projects, budget time and resources, and identify the unique characteristics of a business problem that will lead to a successful OR solution.

This discussion will address practical issues in applying OR to real-world business problems. The panel members have a wide range of knowledge and experiences in both OR applications and technology. Bring your questions about how to really use OR for your client or company and help make this a stimulating and informative discussion.

■ TD-04

Tuesday, 14:00-15:30

APP Askja N-129

Forward markets and risk

Stream: Electricity Markets

Invited session

Chair: *Derek Bunn*, Decision Sciences, London Business School, Sussex Place, NW1 4SA, London, United Kingdom, dbunn@london.edu

1 - Risk management in energy market design

Esma Gaygisiz, Dept. of Economics, Middle East Technical University, 06531, Ankara, Turkey, esma@metu.edu.tr

Introduction of market mechanisms in energy sector has demonstrated the need for designing these markets. The occurrence of some severe market failures has especially brought the attention to the importance of risk management in market design. This study first identifies the sources and types of risks in energy markets and then analyzes the risk hedging instruments for a successful market design. In this context, multi-settlement scheme, bidding, bilateral contracts and other instruments are discussed as risk management mechanisms in energy market design.

2 - The Value of (Production) Flexibility in Electricity Markets

Hans-Jakob Lüthi, D-MATH, ETHZ, Ifor, Clp, 8092, Zürich, Switzerland, luethi@ifor.math.ethz.ch

Based on the axiomatic foundation of convex risk measure we introduce a new formal concept, the value of flexibility as the risk absorption capacity of an economic system to react on unexpected changes in order to limit the associated threat of losses. We present a generic portfolio optimization model wherein we can quantify the notion of (marginal) flexibility. As an important application, we investigate the effect of system flexibility in electricity markets (based on flexible (production) technologies) similar to the risk diversification effect in financial markets.

3 - Pricing flow commodity derivatives by fixed-income market techniques

Juri Hinz, Mathematics, Institute for Operations Research, Clausiusstrasse 47, 8092, Zurich, Switzerland, hinz@ifor.math.ethz.ch, *Martina Wilhelm*

In this work, we elaborate on valuation of energy-related financial contracts written on prices of flow commodities (such as natural gas, oil and electrical power). Due to restrictions on storability of the underlying, pricing of flow commodity derivatives is not trivial. We here follow an axiomatic setting which provides a connection to interest rate theory whose toolkit is utilized to consistently price frequently quoted flow commodity options like caps, floors, collars and cross commodity spreads. As an illustration, we discuss the valuation of virtual production capacity.

4 - Risk Premia and Contagion in European Electricity Forward Prices

Derek Bunn, Decision Sciences, London Business School, Sussex Place, NW1 4SA, London, United Kingdom, dbunn@london.edu

This paper reports an empirical analysis of ex post forward risk premia in electricity prices, from day ahead to quarterly, across several European markets. Questions of efficiency, integration and predictability are tested, and the transmission of shocks across related markets identified. From this, we are able to generalise some insights upon the nature and pricing of risk in electricity, its implications for contracting and the relative importance of behavioural and fundamental factors. (Co-authored with Angelica Gianfreda, London Business School)

■ TD-05

Tuesday, 14:00-15:30

APP Askja N-128

Multi-Criteria Approaches for Sustainable Environmental Management

Stream: OR in Agriculture and Forest Management

Invited session

Chair: *Carlos Romero*, Department of Forest Economics and Management, Technical University of Madrid, ETS Ingenieros de Montes-Avda Complutense s/n, 28040, Madrid, Spain, auggiegp@montes.upm.es, carlos.romero@upm.es

1 - Methodological approach to develop an overall sustainability function for dairy farming by using stakeholder perceptions

Klaas Jan van Calker, Agricultural Economics Research Institute (LEI), Wageningen University and Research centre, Postal code 29703, 2502 LS, Den Haag, Netherlands, KlaasJan.vanCalker@wur.nl, *Paul Berentsen*, *Gerard Giesen*, *Ruud Huirne*

Difficulty for determining the sustainability of farming systems is the combination of the different attribute measures into one overall sustainability function. The Multi-Attribute Utility Theory (MAUT) is used to develop an overall sustainability function for Dutch dairy farming. A goal programming approach is used to aggregate preferences of experts and stakeholders into a single collective sustainability function. This collective sustainability function is applied in Dutch dairy farming.

2 - The objectives of public policy from the viewpoints of stakeholders: A multi-criteria analysis of the Common Fisheries Policy

Simon Mardle, CEMARE, University of Portsmouth, Boathouse No. 6, College Road, H.M. Naval Base, PO1 3LJ, Portsmouth, United Kingdom, simon.mardle@port.ac.uk, *Bertrand Le Gallic*, *Jean Boncoeur*

In this paper stakeholders' preferences concerning fisheries management objectives are elicited using a multicriteria decision analysis method. They are used as inputs in a multi-objective optimisation model of the fishery under survey. As regards the case under survey, the results of stakeholders' preference elicitation and modelling suggest that public authorities and representatives of the fishing industry share rather similar views on the objectives of fisheries management, and influence the actual state of the fishery more significantly than scientists involved in fisheries management.

3 - A model for calculating the environmental burdens of livestock production

Daniel Sandars, Institute of Water and Environment, Cranfield University at Silsoe, Barton Road, MK45 4DT, Silsoe, Bedfordshire, United Kingdom, daniel.sandars@cranfield.ac.uk, *Adrian Williams*, *Eric Audsley*

We produced a mathematical model to calculate the environmental burdens and resource use in the production of agricultural commodities and to enable the impact of changes to be assessed.

The model is a set of simultaneous linear equations. The solution represents the level of activity of all the subsystems that yields the desired unit of production.

Lamb meat (1 t) required 44 GJ of fossil energy and involved 6.7, 20 and 18 non-organic ewes in various hill, upland and lowland systems, respectively, as well as 5.2 organic upland/ lowland ewes.

4 - Analytical approaches for obtaining consensus solutions among stakeholders within an environmental context

Jacinto González-Pachón, Department of Artificial Intelligence, Technical University of Madrid, Campus de Montegancedo s/n, Boadilla del Monte, 28660, Madrid, Spain, jgpachon@fi.upm.es, *Carlos Romero*, *Luis Diaz-Balteiro*

It is nowadays widely accepted that the sustainable management of the environment implies the recognition of the existence of several criteria, as well as the participation of several stakeholders with different perceptions towards these criteria. Hence, the aggregation of these preferences into a single collective one is a crucial issue in this context. This paper aims to review different systems of aggregation of preferences that seem specially suitable within an environmental context. To illustrate the potentiality of these methods, they will be applied to simple but realistic examples.

■ TD-06

Tuesday, 14:00-15:30

APP Askja N-121

Postal Logistics and Optimization

Stream: Optimization in Postal Logistics

Invited session

Chair: *Hans-Jürgen Sebastian*, Deutsche Post Endowed Chair of Optimization of Distribution Networks, RWTH Aachen University, Templergraben 64, 52062, Aachen, Germany, sebastian@or.rwth-aachen.de

Chair: *Ulrich Ploesser*, Optimization, Production Control Systems, Deutsche Post World Net, Headquarters, 53250, Bonn, Germany, u.ploesser@deutschepost.de

1 - Introduction to Postal Logistics

Ulrich Ploesser, Optimization, Production Control Systems, Deutsche Post World Net, Headquarters, 53250, Bonn, Germany, u.ploesser@deutschepost.de, *Joachim Wessels*

This presentation is intended as an overview of postal logistics and the wide range of optimization and management issues that present themselves in this area. For a real-life example, the talk focuses on a survey of Deutsche Post MAIL operations in Germany, describing the network structure, processes and resources in key facts and figures. In addition, we present some of the past and current management challenges as well as our approach of using Operations Research methods for optimizing postal logistics.

2 - Optimization Problems in Postal Logistics

Hans-Jürgen Sebastian, Deutsche Post Endowed Chair of Optimization of Distribution Networks, RWTH Aachen University, Templergraben 64, 52062, Aachen, Germany, sebastian@or.rwth-aachen.de

We will consider a generic distribution network for letter and/or parcel mail consisting of the subsystems mail collection, sorting centers and delivery stations, multi-modal and long-haul transportation and the so-called last mile. The main classes of optimization problems, which arise in the strategic, tactical and operational planning phases are facility-location, service-network-design, location-routing and vehicle-routing and scheduling problems. We will present an overview and examples of joint research projects of the Deutsche Post World Net and our department.

3 - A Facility Location Problem For Letter and Parcel Delivery

Christoph Hermanns, Deutsche Post Lehrstuhl für Optimierung von Distributionsnetzwerken, RWTH Aachen University, Templergraben 64, Raum 608, 52062, Aachen, Germany, Christoph.Hermanns@RWTH-Aachen.DE

The talk presents a two-stage capacitated facility location problem for letter and parcel delivery. There are direct shipments from depots to customers, whereas the depots are served on delivery tours by one or more distribution centres. Actually, these tours are part of another complex transportation network which is why they have to be approximated in an adequate way. By comparing different options for modelling the transportation costs, a formulation of an appropriate model is developed and an efficient heuristic solution for large-scaled instances is presented.

■ TD-07

Tuesday, 14:00-15:30

APP Askja N-120

Sports and OR I

Stream: OR in Sports

Invited session

Chair: *Mike Wright*, The Management School, Lancaster University, Dept. Of Management Science, LA1 5AG, Lancaster, Lancashire, United Kingdom, m.wright@lancaster.ac.uk

1 - Modelling the Development of World Records

Elmer Sterken, Economics, University of Groningen, PO Box 800, 9700 AV, Groningen, Netherlands, e.sterken@rug.nl, *Gerard Kuper*

In this paper we model the development of world records in cycling, running, skating, and swimming since 1890. The historical pattern of improvement allows for the use of e.g. the Gompertz (1825) curve to model progress in performance. We analyze the resulting limits in world records for different events, such as the UCI hour record for male cyclists using a "Merckx-era" bike. Our models also allow us to predict the 2008 Olympic year results; for instance we estimate the 2008 world records in the 100m dash world records at 9.71 and 10.18 seconds for men and women respectively.

2 - Measuring the importance of a match in a sports tournament

Phil Scarf, Salford Business School, University of Salford, Centre for OR and Applied Statistics, Maxwell 626, M5 4WT, Manchester, United Kingdom, philscarf@hotmail.com

Match importance is used as an explanatory variable in models of football attendance and TV audience size. Such models inform policy-making regarding football income distribution and its relationship with match outcome uncertainty. To date measures of match importance have been relatively naïve. We propose a measure that considers the effect of a particular match on the end of tournament position, given the results of all other matches, some played, some predicted. We use logistic regression to predict matches and Monte Carlo simulation to measure match importance, and apply these to the FAPL.

3 - Evaluation of Formula One drivers with Data Envelopment Analysis

João Carlos Soares de Mello, Engenharia de Produção, Universidade Federal Fluminense, Rua Passo da Pátria 156, São Domingos, 24240310, Rio de Janeiro, RJ, Brazil, jcsmello@yahoo.com.br, *Silvio Figueiredo Gomes Junior*

We analyze the pilots outcomes in 2005 Formula One World Championship with DEA, considering all the results got by each pilot. The single input is the number of races each pilot runned. The outputs are the number of times that each pilot achieves every possible position. As we have a few number of DMUs and a great number of variables, we used weights restrictions to improve discrimination among DMUs. This method also allows the incorporation of ordinal opinions concerning the importance of each position. We create a different kind of restrictions, named non-arquimedean cone ratio.

■ TD-08

Tuesday, 14:00-15:30

EDU Oddi 101

New Topics for SCM Education: Real Options Thinking and Efficient Consumer Response

Stream: OR Education

Invited session

Chair: *Arnd Huchzermeier*, Production Management, WHU Otto Beisheim School of Management, Burgplatz 2, 56179, Vallendar, Germany, ah@whu.edu

1 - Teaching a course on 'International Operations and Risk Management: A Real Options Perspective'

Arnd Huchzermeier, Production Management, WHU Otto Beisheim School of Management, Burgplatz 2, 56179, Vallendar, Germany, ah@whu.edu

Operations management plays a key role in providing the technological and network structure for developing, producing and delivering the company's value-adding activities. The goals of the course are to facilitate students' understanding of the global supply chain under various sources and types of risk. Moreover, software tools are provided for the analysis and the design of integrated supply chain networks and the evaluation of (compound) real options, i.e., the evaluation of the benefit of operational flexibility and the option value of managerial flexibility.

2 - Teaching Cases in ECR

Daniela Burkhardt, Production Management, Otto Beisheim Graduate School of Management (WHU), Burgplatz 2, 56179, Vallendar, Germany, daniela.burkhardt@whu.edu, *Arnd Huchzermeier*

Efficient Consumer Response (ECR) is about the collaboration of retailers and manufacturer on four major dimensions: demand and supply management, enablers and integrators. The authors developed six cases on the current adoption level of ECR in Germany. We present the two cases of Metro Group AG and Kraft Foods Deutschland GmbH, with a special focus on how these company adapted ECR concepts to their specific company requirements.

3 - Teaching a course on 'Real Options Analysis' for Executives

Stefan Spinler, Production Management, Beisheim School of Management, WHU, Burgplatz 2, 56179, Vallendar, Germany, sspinler@whu.edu

Arguably the central problem in OR and MS is better coordination of supply and demand, including price discovery and reduction of transaction costs of buyer-supplier interactions. In this context, the author has frequently taught real options analysis to executives at the Wharton school and MIT.

■ TD-09

Tuesday, 14:00-15:30

IT Oddi 106

Combinatorial problems and classification

Stream: Data Mining

Invited session

Chair: *Emilio Carrizosa*, Estadística e Investigación Operativa, Universidad de Sevilla, Fac. de Matemáticas, Avda Reina Mercedes s/n, 41012, Sevilla, Spain, emilio.carrizosa@gmail.com

1 - Scatter Search for bi-objective feature selection

Miguel García-Torres, Estadística, I.O. y Computación, University of La Laguna, Avda. Astrofísico Francisco Sánchez s/n, 38202, La Laguna, Spain, mgarciat@ull.es, *José A. Moreno-Pérez*, *Belen Melian Batista*, *Marcos Moreno-Vega*

In supervised classification, a model is induced to classify a given object described by a pattern of features into one of several classes. The aim of feature selection applied to supervised classification is to reduce the number of features so as to improve the performance of the classification algorithm. In this work, we use a scatter search metaheuristic to solve the feature selection as a bi-objective optimization problem, in which both the classification error and the features subset size have to be minimized.

2 - Finding linear classifiers by VNS with alternating local searches

Steven De Bruyne, MOSI, Vrije Universiteit Brussel, Pleinlaan 2, 1050, Elsene, Belgium,

Steven.De.Bruyne@vub.ac.be, *Frank Plastria, Emilio Carrizosa*

The goal of classification is to find a simple rule to classify data into one of the given classes. Our goal is to find a linear classifier for numerical data belonging to one of two classes, whose convex hulls are not necessarily disjoint. Given Mangasarian's criterion to minimise the sum of misclassification distances, i.e. the distance to the separating hyperplane for each misclassified point, we show that by alternating two heuristics with different local minima and search directions in a variable neighbourhood search, it is possible to find the global optimum with a high success rate.

3 - Construction of a separating ball in a classification problem with sets of instances

José Gordillo, Estadística e Investigación Operativa, Universidad de Sevilla, Avenida Reina Mercedes, 41012, Sevilla, Andalucía, Spain, jgordillo@us.es, *Emilio Carrizosa, Frank Plastria*

In this work, we consider a classification problem where the objects to be classified are sets or bags of instances which are vectors measuring d different attributes. The classification rule is defined in terms of a ball, whose center and radius are the parameters to be computed. Given a bag, it is assigned to the positive class if at least one element is strictly included inside the ball, and it is labelled as negative otherwise. The problem of determining an optimal ball on some testdata is formulated as a mixed integer optimization problem, and heuristically solved via a VNS algorithm.

■ TD-10

Tuesday, 14:00-15:30

OR Oddi 201

Ethics: A major stream for OR

Stream: OR - The Profession: Ethics in OR

Invited session

Chair: *Pierre Kunsch*, MOSI, Vrije Universiteit Brussel, Pleinlaan 2, 1050, Brussels, Belgium, pkunsch@vub.ac.be

1 - Ethics in OR: To be or not to be

Jean-Pierre Brans, MOSI (CSOO), V.U.B. , Pleinlaan,2, 1050, Brussels, Belgium, jpbrans@vub.ac.be

First a panorama of the evolution of Mankind since its very beginning will be given. It will emphasize how the contributions of the XXth century have completely modified the Human landscape. JANUS has two faces. On the one hand we are now living in a Paradise, on the other hand Mankind is now facing terrible and dreadful threats. OR has a major role to play. Some avenues for future OR will be proposed.

2 - On the Role of Operations Research Planning Tools in a Deregulated Environment

João Clímaco, University of Coimbra and INESC Coimbra, 3000-033, Coimbra, Portugal, jclimaco@inescc.pt, *José Craveirinha*

An increasing deregulation has been occurring in key areas of the utility sector, firstly in telecommunications and later in the energy and water distribution domains. This trend put in question the role of traditional OR planning tools in this turbulent environment. Firstly the way in which OR tools should adapt in order to take into account the drastic changes in these application areas, is outlined. Secondly a brief discussion of the ethical-political issues raised by these trends, namely concerning environmental impacts and long-term social-economic implications, is presented

■ TD-11

Tuesday, 14:00-15:30

TRANS Oddi 202

Railways Transport

Stream: Transportation

Invited session

Chair: *Marte Fodstad*, Technology and Society, SINTEF, S.P. Andersens vei 5, 7465, Trondheim, Norway, marte.fodstad@sintef.no

1 - Delay Analysis in Railway Systems

Carla Conte, Institut for Numeric and Applied Mathematic, Lotsestrasse 16-18, 37073, Göttingen, Germany, conte@math.uni-goettingen.de, *Anita Schoebel*

A high punctuality level is a performance measure of train services but not so easily achievable. Investigation on how delays propagate in the system is a crucial point for timetable rescheduling in case of capacity conflicts.

To model explicitly all the constraints involved explicitly results in a problem which is too complicated from a numerical point of view. Our approach is based on a graphical model, called Tri-graph, to identify dependencies among delays using real-world data a large railway company. These predictions are then included in the model to minimize the overall delay.

2 - Model and Algorithm for Rerouting Delayed Trains On-Line

Gabrio Curzio Caimi, Institute for Operations Research, ETH Zurich, Hg G21.2, Rämistrasse 101, 8092, Zurich, Switzerland, caimig@ifor.math.ethz.ch, *Thomas M. Herrmann*

Many railway companies face increasing train frequencies, creating needs to optimise the utilisation of the existing infrastructure. However, the tighter the schedules the more susceptible to the propagation of delays the timetables are. For mitigating delays on-line we present a model and algorithm to decrease the impact of delayed inbound trains while still adhering to the planned schedule. Based on on-line information, we reroute trains while avoiding unnecessary deceleration of trains near main stations, which are the assumed capacity bottlenecks in the rail network.

3 - A railway rolling stock planning tool

Marte Fodstad, Technology and Society, SINTEF, S.P. Andersens vei 5, 7465, Trondheim, Norway, marte.fodstad@sintef.no, *Kenneth Aschehoug*

We have developed a prototype for an optimization based railway rolling stock planning tool. It is designed for the long term and yearly planning problem of The Norwegian State Railways (NSB). The tool consists of a model for optimal rolling stock allocation to a timetable based on passenger seat demand and a procedure building rosters based on the allocation. Functionality for user support on infeasibility detection is also included. Results from tests on NSB's data will be given.

■ TD-12

Tuesday, 14:00-15:30

TRANS Oddi 205

City Logistics

Stream: Transportation

Invited session

Chair: *Guido Gentile*, Dipartimento di Idraulica Trasporti e Strade, Università degli Studi di Roma , Via Eudossiana, 18, 00184, Roma, Italy, guido.gentile@uniroma1.it

1 - Microscopic simulation of urban freight deliveries

Jesús Muñozuri, Industrial Engineering, University of Seville, Camino de los Descubrimientos s/n, 41092, Sevilla, Spain, munuzuri@esi.us.es, *J. Nicolás Ibáñez, José Guadix, Luis Onieva*

While microscopic simulation is a commonplace tool for traffic planning, it is often difficult to apply the capabilities of commercial packages to represent freight delivery practices. The building of a microscopic simulation application using general-purpose simulation software can help to better understand the effects of traffic modifications on urban freight deliveries. Using the case study of a street with high commercial density, different scenarios are simulated and compared, in order to determine the best pedestrianisation option from the point of view of all the stakeholders.

2 - A demand model for freight movements applied to citylogistics

Guido Gentile, Dipartimento di Idraulica Trasporti e Strade, Università degli Studi di Roma, Via Eudossiana, 18, 00184, Roma, Italy, guido.gentile@uniroma1.it, *Daniele Vigo*

The quantification of freight movements due to the urban distribution of goods is essential for evaluating the effects of any citylogistic policy. To this end we propose an innovative demand model which avoids to aggregate the many categories of economic activities into predefined groups. The key idea is to take into account the hierarchy and similarity among the different categories defined by the official classification of the economic activities, which is based on a tree. This approach has been successfully applied to the case of Regione Emilia Romagna.

3 - C-DISPATCH in Frosinone: Clean goods distribution of the intermodal transport chain

Luca Lucietti, FIT Consulting srl, Via Lavinio 15, 00183, Rome, Italy, lucietti@fitconsulting.it, *Cossu Paola, Maria Pietrobelli, Marciani Massimo, Francesco Scalia, Guglielmo Bilanzona*

C-DISPATCH, project co-funded by EU Commission, develops an innovative approach to city logistics finding light measures which can help improving quality of life in cities. Main objective is a sustainable model (from environmental, social, economic point of view) to improve efficiency of goods transport in urban areas, collaboratively providing demand-supply side information in a single environment. A public-private body manages the last mile of supply chain, to achieve improvement in the actual commercial traffic organization in urban areas and thus a reduction of negative environmental impacts.

4 - ECOLOGISTICS Parma: a revolution in city logistics

Luca Lucietti, FIT Consulting srl, Via Lavinio 15, 00183, Rome, Italy, lucietti@fitconsulting.it, *Pietro Vignali, Paolo Gabbi, Marciani Massimo*

ECOLOGISTICS, follow-up of CITYPORTS EU project, as innovative city logistics project running in Parma urban area. The Municipality to implement city logistics turned common procedures from top-bottom to bottom-up approach. Freight Quality Partnership has been established as mean for local bodies, business, operators, local community and other actors to face problems and achieve sustainable/shared solutions to reconcile goods deliveries with local environmental-social concerns. The FQP allows a rational and efficient urban goods distribution service provided by a PPP among involved local actors

■ TD-13

Tuesday, 14:00-15:30

TRANS Oddi 206

Maritime transportation and logistics

Stream: Maritime Transportation

Invited session

Chair: *Kristin Tolstad Uggen*, Applied economics and operations research, SINTEF Technology and society, S.P. Andersens v 5, 7465, Trondheim, Norway, ktu@sintef.no

1 - An IP model for optimizing container positioning in marine terminals

Louise Sibbesen, Centre for Traffic and Transport, Technical University of Denmark, DTU building 115, 2800, Kgs. Lyngby, Denmark, lks@ctt.dtu.dk

The work presented deals with optimization of container positioning in yards of marine terminals. The problem consists in finding optimal sequences of positions for each container transported through the terminal. A decomposition approach is applied such that the problem is solved for each storage block in the terminal, thus reducing the problem size significantly. An integer linear programming model for the problem - not previously treated in the literature - is presented and some solution approaches to solve the problem are discussed.

2 - MARITIME TRAFFIC INFORMATION SYSTEM - SisAqua (in Portuguese Sistema de Transporte Aquaviário)

Carlos Francisco Simoes Gomes, Operation Research, CASNAV - Brazilian Navy Center of Operation Research and Analysis System, Pr Barao De Ladario S/n, Ilha Das Cobras, Ed 8, 3 Andar, Centro, 20091-000, Rio De Janeiro, RJ, Brazil, cfsimoes@fgvmail.br

The SisAqua is primarily designed to track all merchant vessels and their routes, along the Brazil's ocean, coast and inland navigation area. Can be use for assistance to vessels in cases of emergency, illegal fishing surveillance, piracy and drugs fighting. It's compatible with the USA's AMVER system. Includes graphic interface, DB administrator and Automatic Identification System (AIS). Receives installed in strategic location in the coast, Brazilian Navy Ships and others, in order to receive data from Merchant Ships' AIS. This equipment is in agreement with the established for the regulation by IMO.

3 - Dynamic Slaughterhouse Units - Optimal transportation and Processing in Coastal Areas

Kristin Tolstad Uggen, Applied economics and operations research, SINTEF Technology and society, S.P. Andersens v 5, 7465, Trondheim, Norway, ktu@sintef.no, *Asgeir Tomasgard, Frode Rømo*

The farms in Norway are scattered around the country, and this represent a major logistical challenge in an increasingly competitive European food market. SINTEF has carried out a project to investigate the relevance of a ship-based slaughterhouse concept, serving the farmers along the Norwegian coastline. We have developed an optimization model combining routing the trucks on shore transporting animals, with planning the sailing pattern for the ship-based slaughterhouse. We will present the model and results.

■ TD-14

Tuesday, 14:00-15:30

PROD Arnag 101

Revenue Management: Tools and Applications

Stream: Operations Management / Revenue Management

Invited session

Chair: *Kristin Fridgeirsdottir*, Decision Sciences, London Business School, Regent's Park, NW1 4SA, London, United Kingdom, kristin@london.edu

1 - Dynamic Pricing of Airline Tickets with Competition

Christine Currie, School of Mathematics, University of Southampton, Highfield, SO17 1BJ, Southampton, United Kingdom, christine.currie@soton.ac.uk, *Russell Cheng, Honora Smith*

Competition has a huge influence on customer buying behaviour and will impact on the optimal price to charge for goods or services. In this talk we will describe a probabilistic dynamic pricing model that can be used to maximise revenue when selling an inventory of identical items by a fixed time and where there is a competing seller. Calculus of variations is used to find the optimal prices to charge and simple conditions will be given that ensure the uniqueness of a solution. The talk will discuss a practical implementation of the method, which has been used by a major UK airline.

2 - Choice-Based Revenue Management: An Empirical Study of Estimation and Optimization at a Major U.S. Airline

Gustavo Vulcano, Stern School of Business, New York University, 44 West 4th Street KMC 8-76, 10012, New York, NY, United States, gulcano@stern.nyu.edu, *Garret van Ryzin, Wassim Chara*

We consider the demand estimation problem faced by an airline flying an origin–destination market, where demand is influenced by the firm's availability controls and by the competitors offer, hence endogenizing customer choice behavior. Based on data available to the airline, we developed an statistical estimation algorithm based on MLE. The procedure was tested over data provided by a major commercial U.S. airline. These estimates were then used to assess the airline's current Revenue Management controls, leading to promising results.

3 - Online Advertisement: A Revenue Management Approach

Kristin Fridgeirsdottir, Decision Sciences, London Business School, Regent's Park, NW1 4SA, London, United Kingdom, kristin@london.edu, *Victor Araman*

Online companies providing advertising space on their websites face complex problems related to pricing and capacity management. The issues stem from the various uncertainties present in the system, both from the demand side and the supply side. We develop a stylized model that aims at addressing some of these issues.

■ TD-15

Tuesday, 14:00-15:30

PROD Arnag 201

Supply Chain Management II

Stream: Supply Chain Management (c)

Invited session

Chair: *Fikri Karaesmen*, Dept. of Industrial Engineering, Koc University, Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey, fkaraesmen@ku.edu.tr

1 - Capacity allocation, ordering, and pricing decisions in a supply chain with supply and demand uncertainties

Chung-Chi Hsieh, Department of Industrial and Information Management, National Cheng Kung University, 1, University Road, 701, Tainan, Taiwan, jcchsieh@mail.ncku.edu.tw, *Cheng-Han Wu*

This study examines coordination decisions in a decentralized supply chain with one OEM, one manufacturer, and one distributor. The distributor who faces price-sensitive random demand orders from the manufacturer who has finite capacity. If the order exceeds the manufacturer's capacity, he will outsource to the OEM who has supply uncertainty. We are to develop the supply chain members' decisions in order to improve the total supply chain profit in the absence and in the presence of coordination.

2 - Retail Assortment Planning under Consumer-Based Demand Substitution

Fikri Karaesmen, Dept. of Industrial Engineering, Koc University, Rumelifeneri Yolu, Sariyer, 34450, Istanbul, Turkey, fkaraesmen@ku.edu.tr, *Eda Yucel*, *Sibel Salman*, *Metin Turkey*

We propose a model for retail assortment planning in an environment where customers may substitute their demand if their preferred choice is not available. Employing a probabilistic mathematical programming framework, we jointly optimize the assortment and the replenishment quantities. We present numerical results that assess the impact of ignoring the demand substitution phenomenon in planning the assortment.

3 - Manufacturer's return policies within a newsvendor framework

Francisco Arcelus, Faculty of Administration, University of New Brunswick, P.o. Box 4400, E3A 5A3, Fredericton, New Brunswick, Canada, arcelus@unb.ca, *Satyendra Kumar*, *Gopalan Srinivasan*

This paper models the profitability of a returns policy within a newsvendor framework in the presence of a secondary market to a manufacturer and a retailer who maximize their combined profit and who share the risks of demand uncertainty. The decision variables are the wholesale price and the returns policy for the manufacturer and the retail price and the order quantity for the retailer. The key question is to determine if the system solution yields enough of a bargaining range to render a dominant set of negotiated solutions. Numerical examples provide further managerial insights.

4 - MS2Value - Modeling and Simulation of Manufacturing Systems for Value Networks

Ricardo Velez Osuna, Institute of Production Engineering, Tampere University of Technology, Korkeakoulunkatu 6, 33720, Tampere, Finland, ricardo.velez@tut.fi, *Reijo Tuokko*, *Juhani Heilala*, *Craig Lybeck*, *Hannu Asmala*

Modeling and simulation technologies represent tremendous opportunities for radical improvement of our ability to design, develop, manufacture, operate, and support complex products and supply chains - to reduce the time and cost of translating products from concept to delivered systems, to improve operational performance and availability, and to reduce total cost of ownership. The present paper introduces the research agenda and current development status of the generic modeling and simulation framework that would enable the modeling and analysis of manufacturing operations in value networks.

■ TD-16

Tuesday, 14:00-15:30

PROD Arnag 301

Flow Shop Scheduling

Stream: Scheduling

Invited session

Chair: *Frank Werner*, Faculty of Mathematics, Otto-von-Guericke University, FMA,I, nstitute of Mathematical Optimization, Psf 4120, 39016, Magdeburg, Germany, frank.werner@mathematik.uni-magdeburg.de

1 - A new lower bound for the two-machine total tardiness flow shop scheduling problem

Jean-Charles Billaut, Laboratoire d'Informatique, University of Tours, 64 av. Jean Portalis, 37200, Tours, France, jean.billaut@univ-tours.fr

We consider the classical two machine flow shop scheduling problem, with total tardiness criterion. This problem is strongly NP-hard and literature contains already some lower bounds and dominance conditions. The more recent lower bound of the literature is due to Pan Chen and Chao (COR 2002) and is an improvement of the lower bound proposed by Pan and Fan (IJSE, 1997), Kim (COR 1993) and Sen Dileepan and Gupta (COR 1989). We propose here a new lower bound. Computational experiments show that this bound allows to obtain better results, both in terms of generated nodes and computation time.

2 - Multiple-Pass-Based Heuristic Algorithms for Group Flexible Flow-shop Scheduling Problems

Cheng-Yan Kao, Dept. of Computer Science and Information Engineering, National Taiwan University, No. 1. Roosevelt Rd, 106, Taipei, Taiwan, cykao@csie.ntu.edu.tw, *Pei-Ying Huang*, *Tzung-Pei Hong*

This paper focuses on solving the flexible flow-shop group scheduling problem with more than two machine centers, which have the same number of parallel machines. The problem is solved at two levels, one for the job sequence in each group, and the other for the group sequence. Two multiple-pass heuristics, (Logendran and Nudtasomboon, 1991(LN)) and (Campbell, Dudek and Smith, 1970(CDS)), are combined to solve it. Experiments are made and a statistical model based on the split-plot design is also used to analyze the performance of these four algorithms.

3 - Algorithms for flexible flowshop problems with unrelated parallel machines, setup times and dual criteria

Frank Werner, Faculty of Mathematics, Otto-von-Guericke University, FMA,I, nstitute of Mathematical Optimization, Psf 4120, 39016, Magdeburg, Germany, frank.werner@mathematik.uni-magdeburg.de, *Jitti*

Jungwattanakit, Manop Reodecha, Paveena Chaovalitwongse

We consider a flexible flowshop problem with release and due dates and two types of setup times, where each stage consists of unrelated parallel machines. The problem is to determine a schedule that minimizes a convex combination of makespan and number of tardy jobs. A 0-1 mixed integer program is formulated and a lower bound are presented. Several generalized constructive heuristics from flowshop scheduling are discussed. Metaheuristics, namely a genetic algorithm, simulated annealing, tabu search and hybrid algorithms are suggested, and the performance of the heuristics is evaluated.

4 - An Efficient Heuristic for a Flowshop Scheduling by Minimizing the Makespan Criterion

Abdenour Laped, Computer science, Polytechnic School of Bordj El Bahri, Bp 17 Bordj El Bahri, 16111, Algiers, Algeria, a-laped@mailcity.com, Hamid Hentous, Mohamed Maiza

The aim of this paper deals with the problem of sequencing n jobs over m machines in unconstrained flowshop. A branch & bound based heuristic is proposed to solve the problem. Though, the idea of our algorithm is in some way similar to Bertolissi's one, the fact that we minimize the makespan instead of the total flowtimes sum, makes them different. To show the effectiveness of our heuristic, we compared it to that proposed by Nawaz et al. The numerical experiments show that our heuristic is good in term of quality of the solutions, computing times and simplicity of implementation.

■ TD-17

Tuesday, 14:00-15:30

PROD Arnag 303

Cutting and Packing III

Stream: Cutting and Packing

Invited session

Chair: *Jose Fernando Oliveira, Feup / Inesc, Universidade do Porto, Rua Dr. Roberto Frias, 4200-465, Porto, Portugal, jfo@fe.up.pt*

1 - MIP-based Heuristics for Non-standard Packing Problems

Giorgio Fasano, Infrastructures Transportation Systems, Alcatel Alenia Space, Strada Antica di Collegno 253, 10146, Turin, Italy, Giorgio.Fasano@aleniaspazio.it

This paper focuses on a MIP formulation for non-standard (orthogonal) packing problems. Static balancing is considered with separation planes and tetris-like items. Items can be fixed, if necessary. A heuristic procedure is proposed to solve recursively the MIP model. It is based on a local search philosophy. The concept of abstract configuration (concerning the relative positions between items) is introduced: the relative positions determined by an abstract configuration give rise to a feasible solution in any unbounded domain. The approach is suitable to interact with a graphical system.

2 - A Branch-and-Price algorithm for a class of assortment problems

Fabrizio Marinelli, Computer Science, University of L'Aquila, via Vetoio (Coppito), 67010, L'Aquila, Italy, marinelli@di.univaq.it, Claudio Arbib

In the Cutting Stock Problem, one calls for an efficient way to cut a given demand of small parts from a given collection of large parts. Many cutting processes, however, must also face the problem of determining a restricted subset of large sizes to be stocked. In this work we deal with the special case where just one part type can be cut from each large size. We describe a PLI formulation obtained by convexifying a straightforward big-M formulation. A pricing problem is indicated and Ryan-Foster's branching rule adapted with a view to implement a branch-and-price exact algorithm.

3 - A scheme to generate constrained exact checkerboard patterns

Horacio Yanasse, CTE, INPE, Av. dos Astronautas 1758, Cp 515 - Inpe/cte, 12227-010, São José dos Campos, SP, Brazil, horacio@lac.inpe.br, Daniel Katsurayama

We propose an enumerative algorithm to generate exact constrained checkerboard patterns. A constructive algorithm is imbedded in the enumerative scheme and bounds were developed to decrease the search space. The algorithm was implemented and the computational test results performed indicate that the proposed scheme outperforms previous methods of the literature.

4 - A branch and bound algorithm for the two-dimensional strip packing problem

Ramon Alvarez-Valdes, Statistics and Operations Research, University of Valencia, Faculty of Mathematics, Doctor Moliner 50, 46100, Burjassot, Spain, ramon.alvarez@uv.es, Francisco Parreno, Jose Tamarit

The Strip Packing Problem (SPP) consists of placing a set of rectangular pieces of given dimensions into a strip of given width and infinite length so as to minimize the length required to accommodate all pieces. This problem appears whenever large rolls have to be cut in paper, textile or metal industries. In this paper we propose a new branch and bound algorithm for the SPP. We use some dominance criteria to reduce the search tree. Some of the existing lower bounds are refined and new bounds are proposed. The computational results show that our approach is very efficient for the SPP.

■ TD-18

Tuesday, 14:00-15:30

PROD Arnag 304

Discrete Location II

Stream: Locational Analysis

Invited session

Chair: *Vladimir Beresnev, Sobolev Institute of Mathematics, pr. Akademik Koptyug, 4, 630090, Novosibirsk, Russian Federation, beresnev@math.nsc.ru*

1 - Capacitated facility location problem with connectivity constraints

Karima Djebali, France Telecom RD, 38-40, rue du Général Leclerc, 92794, Issy Moulineaux, France, karima.djebali@rd.francetelecom.com, Cedric Chamayou, Christelle Scala

The capacitated facility location problem (CFLP) with connectivity constraints consists in selecting a subset of sites to install facilities and assigning strongly connected demand points to them, such that a total cost is minimized. We propose two integer program formulations. The first one, solved by a standard solver, is similar to the classical program for the (CFLP) with new constraints satisfying strong connection between demand points. In the second one, the problem is formulated as a clique partitioning problem and solved by a standard solver and also a branch-and-price algorithm.

2 - Solving The Optimal Camera Placement Problem by Binary Integer Programming

Biröl Yuceoglu, Manufacturing Systems/Industrial Engineering, Sabanci University, Orhanli, 34956, Tuzla, Istanbul, Turkey, biroly@su.sabanciuniv.edu, S. Ilker Birbil

Optimal camera placement problem focuses on providing security in a venue by using a set of cameras with limited visibility. We propose a discrete approximation approach to solve this continuous NP-hard problem by binary integer programming. Approximation is achieved by dividing the area into grids. The resulting mathematical model is a variant of the set covering problem. We then focus on relaxing this model in order to improve our performance (reducing the cost) with a minimum damage to coverage. Finally, we present a numerical study and compare our results with the literature.

3 - Polynomial Solvable Cases of the Uncapacitated Facility Location Problem

Vladimir Beresnev, Sobolev Institute of Mathematics, pr. Akademik Koptyug, 4, 630090, Novosibirsk, Russian Federation, beresnev@math.nsc.ru

We consider a generalization of the well-known uncapacitated facility location problem. In our problem, each user selects one open facility by own preferences which can be differed from the classical service cost preferences. It is known that this problem can be reduced to some minimization problem for pseudo-Boolean function. It is shown that the uncapacitated facility location problem with user preferences is polynomial solvable if the characteristic matrix of the pseudo-Boolean function is totally balanced or connected.

■ TD-19

Tuesday, 14:00-15:30

PROD Arnag 311

New Topics in Project Management and Scheduling

Stream: Project Management and Scheduling

Invited session

Chair: *Mario Vanhoucke*, Management Information, Operations Management and Technology Policy, Ghent University and Vlerick Leuven Gent Management School, Hoveniersberg 24, 9000, Ghent, Belgium, mario.vanhoucke@ugent.be

1 - Reactive approaches for resource-constrained project scheduling problems with variable project environments

Christoph Mellentien, Institute for Economic Theory and Operations Research, School of Economics and Business Engineering, University of Karlsruhe, Kollegium am Schloss, Bau IV, 76128, Karlsruhe, Germany, mellentien@wior.uni-karlsruhe.de

Project scheduling usually deals with the determination of a schedule for a static deterministic environment, i.e. all data are assumed to be well-known and fixed. In practice, however, data are mostly uncertain or variable. As a result, after changes in data a predetermined schedule can not be performed anymore. Previous approaches concentrate on specific project types or variable data. In our talk we present reactive approaches for dealing with project scheduling problem PS—temp,d—f and a given schedule in face of a general variability of data as well as results of a performance analysis.

2 - Applications and solution methods for resource-constrained project scheduling with work content constraints

Cord-Ulrich Fündeling, Institute for Economic Theory and Operations Research, University of Karlsruhe, Geb. 20.14, Kaiserstraße 12, 76128, Karlsruhe, Germany, fuendeling@wior.uni-karlsruhe.de

We consider a modification of the resource-constrained project scheduling problem PS—prec—Cmax where work contents, e.g. in man-hours, are given for the activities instead of fixed durations and resource requirements. An assignment of resource usages to periods has then to be determined for each activity such that several work content constraints are met in addition to precedence and resource constraints. In our talk, we state possible fields of application and work content constraints important to practice. We then briefly present and compare several exact and heuristic solution methods.

3 - The impact of parallel processing and set-up times on preemptive resource-constrained project scheduling

Dieter Debels, Management Information, Operations Management and Technology Policy, Ghent University, Hoveniersberg 24, 9000, Ghent, Belgium, dieter.debels@ugent.be, *Mario Vanhoucke*

During the past decades, many researchers have studied the non-preemptive resource-constrained project scheduling problem. Less research efforts have been spent on the preemptive resource-constrained project scheduling, since previous results revealed little effect of activity preemption on a makespan reduction. In our research, we study the positive impact of allowing subparts of an activity to be scheduled simultaneously and the negative effect of imposing set-up times whenever an activity is pre-empted.

■ TD-20

Tuesday, 14:00-15:30

HEUR Arnag 422

Special Topics in Metaheuristics II

Stream: Metaheuristics

Invited session

Chair: *Kenneth Sörensen*, Faculty of Applied Economics, University of Antwerp, Prinsstraat 13, 2000, Antwerp, Belgium, kenneth.sorensen@ua.ac.be

1 - Ant colony optimization for continuous domains

Marco Dorigo, IRIDIA, Université Libre de Bruxelles, Ave. F. Roosevelt 50, Cp 194/6, 1050, Brussels, Belgium, mdorigo@ulb.ac.be, *Krzysztof Socha*

We present an extension of Ant Colony Optimization (ACO) to continuous domains. We show how ACO, which was initially developed to be a metaheuristic for combinatorial optimization, can be adapted to continuous optimization without any major conceptual change to its structure. We present the general idea, implementation, and results obtained. We compare the results with those reported in the literature for other continuous optimization methods.

2 - Automatically learned strategies

Eric Bourreau, KAYOU, LIRMM, 161 Rue Ada, 34000, Montpellier, France, eric.bourreau@lirmm.fr, *Remi Coletta*

In OR, solving parts are based on an exploration scheme. Heuristics have to decide the next variable to refine and order to enumerate assignments. Generally, at that point start the black art, a mixture from model paradigm, combinatoric analysis, experience and/or randomized strategies. Machine learning has made improvements in data prediction, behaviour recognition or automatic modelling. We propose a generic learning vision to deduce and refine a branching strategy automatically. We will demonstrate this on some various problems, modeled with constraint programming.

3 - A metaheuristic for the generalized assignment problem with special ordered sets and related problems

Alan French, The Business School, Loughborough University, Ashby Road, LE11 3UT, Loughborough, United Kingdom, A.P.French@lboro.ac.uk, *John Wilson*

The generalized assignment problem with special ordered sets (GAPS2) is the problem of allocating n tasks to m time-periods, where each task must be assigned to a time-period, or shared between two consecutive time-periods. GAPS2 is NP-hard and becomes intractable for reasonably large values of m and n using standard mathematical programming software. It will be shown how an LP-based heuristic developed previously for the generalized assignment problem can be modified and extended to solve GAPS2 and related problems. Encouraging results, in terms of speed and accuracy, are described.

4 - An extensible approach to examination timetabling

Denis Seale, CELCAT, Torwood Close, Westwood Business park, CV8 8HX, Coventry, United Kingdom, timetabler@gmail.com

Educational timetabling is a large-scale computationally hard problem. The specifics can vary between institutions and so are the various techniques used in solving each case. This paper aims to introduce a strong technique that is applicable to all problems of this class and is guaranteed to find feasible solutions every time. The main emphasis of the paper will be to demonstrate the versatility of the technique to all Educational timetabling problems as well as to a wide range of other scheduling problems.

■ TD-21

Tuesday, 14:00-15:30

HEUR Arnag 423

Nonlinear Boundary Value Problems I

Stream: Dynamical and Anticipatory Systems

Invited session

Chair: *Milan Tvrđy*, Mathematical Institute, Academy of Sciences of Czech Rep., Žitná 25, CZ 115 67, Prague, Czech Republic, tvrdy@math.cas.cz

1 - Collocation Methods for Index-1 DAEs with Singularities

Ewa Weinmueller, Institute for Analysis and Scientific Computing, Vienna University of Technology, Wiedner Hauptstrasse 6-10, A-1040, Vienna, Austria, e.weinmueller@tuwien.ac.at, *Othmar Koch*, *Roswitha März*, *Dirk Praetorius*

In this talk, we study the convergence behavior of collocation schemes applied to approximate solutions of index one DAEs, including the case of a singularity of the first kind. We give a proof for the convergence order of the scheme and illustrate the convergence behavior by means of experiments for model problems exhibiting different difficulties. The convergence orders for the algebraic and the differential components are in general different, typically with algebraic components showing a certain order reduction.

2 - Lower and upper solutions in the theory of Phi - Laplacian equations.

Alberto Cabada, Mathematical Analysis, University of Santiago de Compostela, Faculty of Mathematics, 15872, Santiago de Compostela, Galicia, Spain, cabada@usc.es

In this talk we speak about the well known theory of lower and upper solutions applied to boundary value problems that involve the Phi - laplacian equations. The existence of a pair of lower and upper solutions gives us, under additional conditions, the existence and location of some solutions of the considered problem. The Phi - laplacian equations appear in the literature as a generalization of the p - laplacian ones, that models some important physical phenomena as the non Newtonian fluid theory.

3 - Positive and dead core solutions of singular boundary value problems

Svatoslav Stanek, Faculty of Science, Palacky University, Olomouc, Czech Republic, stanek@inf.upol.cz

The existence of positive solutions, pseudodead core solutions and dead core solutions of second order singular differential equations with Laplacian satisfying two-point boundary conditions is discussed. All the types of solutions have continuous derivatives on considered intervals. Nonlinearities of differential equations are singular at the value 0 of their phase variables.

4 - Existence of periodic solutions to singular Lienard equation with quasilinear differential operator

Milan Tvrđy, Mathematical Institute, Academy of Sciences of Czech Rep., Žitná 25, CZ 115 67, Prague, Czech Republic, tvrdy@math.cas.cz

In the contribution we will present a survey of the recent development in the theory of periodic solutions to singular Lienard differential equations with quasilinear differential operator (Laplacian operator). New results obtained jointly with Irena Rachunkova will be included.

■ TD-22

Tuesday, 14:00-15:30

OPT Adal 050

Representation of the Nondominated Set I

Stream: Multiple Objective Optimization

Invited session

Chair: *Ralph E. Steuer*, Terry College of Business, University of Georgia, Department of Banking and Finance, Brooks Hall, 30602-6253, Athens, GA, United States, rsteuer@uga.edu

Chair: *Margaret Wiecek*, Department of Mathematical Sciences, Clemson University, Martin Hall O-208, 29634, Clemson, SC, United States, wmalgor@clemson.edu

1 - Generating efficient frontiers for efficiency and trade-off analyses

Jian-Bo Yang, Manchester Business School, The University of Manchester, Booth Street East, M15 6PB, Manchester, United Kingdom, jian-bo.yang@manchester.ac.uk, *Dong-Ling Xu*

This paper investigates analytical methods within the minimax reference point - data envelopment analysis (DEA) approach for generating data envelopes and efficient frontiers. This investigation provides unprecedented insights into integrated efficiency and trade-off analyses and leads to the definitions of new efficiency indices. Several examples are studied to illustrate the findings and a new procedure is proposed to generate data envelopes and efficient frontiers. A case study for UK retail banks is conducted to demonstrate how the approach can be used for performance management.

2 - An interactive method to guide over a wide Pareto Set.

Julian Molina, University of Malaga, Campus el Ejido s.n. Fac. de CC. Economicas, 29071, Malaga, Spain, julian.molina@uma.es, *Rafael Caballero*, *Mercedes Gonzalez*, *Guerrero Flor*, *Concepción Paralara*

We present an interactive method to guide the decision maker over the Pareto Set of a Multiobjective Problem. This method is designed as a second step in a problem solved using a metaheuristic. We apply this method to a real Multiobjective Location Routing problem where we have to locate some plants within a set of possible locations (in Andalusia, Spain) to meet the demands of a number of clients with multiple objectives. In a previous step, a wide approximation of the Pareto set was found and now the interactive method will guide the decision maker to find his most preferred solution.

3 - Graphical Representation on the Decision Space of the Efficient Set for Convex Multiobjective Problems

Francisco Ruiz, Applied Economics (Mathematics), University of Málaga, Campus El Ejido s/n, School of Economics and Management, 29071, Málaga, Spain, rua@uma.es, *Jose Manuel Cabello*, *Francisca Miguel*, *Mariano Luque*, *Lourdes Rey*, *María del Mar Muñoz*

Graphical representations of the efficient set of multiobjective problems on the objective space are not hard to find in the literature. But it is not so frequent to find representations on the decision space. In this paper, the graphical structure of the efficient set for nonlinear convex problems is shown. Based on the Kuhn-Tucker conditions, a graphical characterization of the efficient solutions is developed, for both unconstrained and constrained problems. Some examples of two dimensional problems are used to illustrate the results. An efficiency test based on these results is developed.

■ TD-23

Tuesday, 14:00-15:30

OPT Adal 051

Evolutionary Computation

Stream: Combinatorial Optimization (c)

Invited session

Chair: *Krunoslav Puljic*, Department of Mathematics, University of Zagreb, Bijenicka cesta 30, 10000, Zagreb, Croatia, nuno@math.hr

1 - Timetabling in minimum of classrooms by evolutionary computation using virus evolutionary theory

Susumu Saito, School of Management, Tokyo University of Science, 500 Shimokiyoku, 346-8512, Kuki, Saitama, Japan, ssaito@ms.kuki.tus.ac.jp, *Chiharu Tanifuji*

The timetabling for the minimum number and area of the classrooms was investigated using the class data of our university. At first, the minimum of the classrooms was sought without constraints and then the timetabling under the constraints such as the teaching stuff, the required subjects and etc was tried by the evolutionary computation with virus infection. Escapement from the local minima was tried by changing the value of the parameters. It was proved that the timetabling for the minimum of the classrooms was available and the computation is effective for the combinatorial problem.

2 - A grid environment for hybrid evolutionary algorithms

Jason Digalakis, Applied Informatics, Parallel Distributed Processing Laboratory, 23, Kritis, street, 10438, Athens, Attica, Greece, jason@uom.gr, *Constantine Claudius Tsouros*

In this paper, we present a powerful and inexpensive cluster-grid framework for facilitating parallelism in hierarchical parallel hybrid evolutionary algorithms. Further, we study the utility of hierarchical parallel HAS on two potential grid frameworks and analysis how it fares on a grid environment with multiple heterogeneous clusters. From the results, it is possible to conclude that a grid hierarchical parallel hybrid evolutionary algorithm is not mere hype but offers a credible alternative, providing significant speed-up to solve optimization problems.

3 - An improved evolutionary algorithm with repeated mutations for solving the vehicle routing problem

Krunoslav Puljic, Department of Mathematics, University of Zagreb, Bijenicka cesta 30, 10000, Zagreb, Croatia, nuno@math.hr, *Robert Manger*

An improved evolutionary algorithm for solving the capacitated vehicle routing problem is presented. The algorithm uses repeated mutations in order to act local search procedures. Algorithm has been evaluated on a well known family of benchmark problem instances. Experiments are described.

■ TD-24

Tuesday, 14:00-15:30

OPT Adal 052

Models of Dynamical Systems in Management

Stream: Dynamical and Anticipatory Systems

Invited session

Chair: *Brian Dangerfield*, Salford Business School, University of Salford, Centre for OR & Applied Statistics, Maxwell Building, The Crescent, M5 4WT, Manchester, United Kingdom, b.c.dangerfield@salford.ac.uk

Chair: *Tadeja Jere-Lazanski*, College of Tourism, University of Primorska, Sencna pot 10, 6320, Portorose, Slovenia, tadeja.jere-lazanski@guest.arnes.si

1 - Mathematical Models for Hotel Revenue Management

José Guadix, Industrial Engineering, University of Seville, Camino de los Descubrimientos s/n, Isla de la Cartuja, 41092, Sevilla, Spain, guadix@esi.us.es, *Pablo Cortés, J. Nicolás Ibáñez, Jesús Muñuzuri*

This paper deals with the special case of hotel revenue management, which can be solved using deterministic and stochastic mathematical programming techniques. We first describe the problem with a theoretical framework that sets the revenue maximization criteria for a hotel. We consider the general case of the problem that accept independent and group guests, with a general mixed integer linear programming model that maximize the total forecasting. Finally, we made comparisons between different proposed models and were found good-quality solutions in short running times.

2 - Towards Vision 2020 in Sarawak with the aid of a System Dynamics Model

Brian Dangerfield, Salford Business School, University of Salford, Centre for OR & Applied Statistics, Maxwell Building, The Crescent, M5 4WT, Manchester, United Kingdom, b.c.dangerfield@salford.ac.uk

A system dynamics based economic model for the State of Sarawak in E. Malaysia has been developed. The model's purpose is to assist the management of the transformation of the State's economy from a resource-based economy to a knowledge economy (k-economy) in line with the national Malaysian plan Vision 2020. The scope of the model and the detail of important sectors (such as education) will be described. Various simulations to show the effects of possible government policy options will be discussed. Finally, a microworld interface has also been created and this will be briefly described.

3 - System Dynamics Modelling in Tourism

Tadeja Jere-Lazanski, College of Tourism, University of Primorska, Sencna pot 10, 6320, Portorose, Slovenia, tadeja.jere-lazanski@guest.arnes.si

Tourism is a complex system with certain structural end behavioural properties. Problems are defined softly. The demands for fast and integrated decisions in tourism require an excellent problem solving methodology. With system dynamics we will develop models, which can serve as describers of the activity of basic mutual model values determination.

■ TD-25

Tuesday, 14:00-15:30

OPT Adal I-111

Integer Programming

Stream: Mathematical Programming

Invited session

Chair: *Truls Flatberg*, CMA, University of Oslo, P.O. Box 1053 Blindern, 0316, Oslo, Norway, trulfs@ifi.uio.no

1 - Implementational Details of a Flow Cover Cut Separation Algorithm

Philipp Christophel, Decision Support OR Lab, University of Paderborn, Warburger Str. 100, 33098, Paderborn, Germany, pmc@dsor.de, *Leena Suhl, Uwe Suhl*

Flow cover cuts are used in mixed-integer programming solvers since many years to strengthen the LP relaxation of mixed-binary problems. This talk discusses implementational details of a separation algorithm for flow cover cuts. We describe known issues as constraint reformulation and lifting as well as small changes to other parts of the algorithm that are crucial to obtain good results for certain problems.

2 - A New Arbitrary Starting Variable Dimension Algorithm for Computing an Integer Point of an n-Dimensional Simplex

Chuangyin Dang, Manufacturing Engineering Engineering Management, City University of Hong Kong, 83 Tat Chee

Avenue, HK SAR, Kowloon, Hong Kong,
mecdang@cityu.edu.hk

Determining whether there is an integer point in a simplex is an NP-complete problem. A new arbitrary starting variable dimension algorithm is developed for computing an integer point of a simplex. The algorithm is composed of two phases, one of which forms a variable dimension algorithm and the other a full-dimension pivoting procedure. Starting at an arbitrary integer point, the algorithm follows a finite simplicial path that either leads to an integer point of the simplex or proves that no such points exist. Efficiency of the algorithm is illustrated by numerical examples.

3 - Branch And Bound Method For Stochastic Multi-objective Integer Linear Problem

Mustapha Moulai, Department of Operations Research,
Faculty of Mathematics UTHB, BP 32, El-Alia., 16111,
Bab-Ezzouar, Algiers, Algeria, mustapha_moulai@yahoo.fr,
Salima Amrouche

In this work, we deal with obtaining integer efficient solutions for stochastic multi-objective integer linear problems. In general, these solutions are obtained in two stages: in one of them, the stochastic problem is transformed into its equivalent deterministic problem MOILP, and in the other one, a new method is applied for solving the MOILP problem. Based on a branch and bound technique, the proposed method determines the discrete efficient set of the main problem in a finite number of steps such that no efficient solution is missed. A numerical example is included to explain the method.

4 - An integer programming approach to image segmentation and reconstruction problems

Truls Flatberg, CMA, University of Oslo, P.O. Box 1053
Blindern, 0316, Oslo, Norway, trulsf@ifi.uio.no, *Geir Dahl*

This presentation will focus on segmentation and reconstruction problems using an integer linear programming approach. These problems have important applications in remote sensing, medical image analysis and industrial inspection. We focus on methods that produce optimal or near-optimal solutions for the corresponding optimization problems. We show that for the two problems one may use similar ideas in both modeling and solution methods. These methods are based on Lagrangian decomposition and dynamic programming for certain subproblems (associated with lines in the image).

■ TD-26

Tuesday, 14:00-15:30

OPT Adal III=231

Vehicle Routing

Stream: Combinatorial Optimization

Invited session

Chair: *Richard Eglese*, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom,
R.Eglese@lancaster.ac.uk

1 - Solving the Multi-Depot Capacitated Vehicle Routing Problem with Stochastic Demands

Christian Holk Christiansen, Department of Business Studies, Aarhus School of Business, Fuglesangs Allé 4, 8210, Aarhus V, Denmark, CHC@asb.dk, *Richard Eglese*, *Adam Letchford*, *Jens Lygaard*

This presentation focuses on the Multi-Depot Vehicle Routing Problem with Stochastic Demands (MDVRPSD). The MDVRPSD is relevant in many practical situations, where the customer's actual demand is not known until arrival at the customer. This is often the case in for instance petrol delivery or milk collection. Even so, the problem has received very little attention. We present an exact solution method for the MDVRPSD. The method is based on a set partitioning formulation, to which we apply column generation. We present both heuristic and exact column generation procedures.

2 - Practical Dynamic and Stochastic Vehicle Routing

Eivind Nilssen, Applied Mathematics, SINTEF ICT, Boks 124, Blindern, 0314, Oslo, Norway,
eivind.j.nilssen@sintef.no, *Oddvar Kloster*, *Atle Riise*

One of the current challenges in transport optimization is the dynamics and uncertainty that influence the daily operations of many transport companies. Modeling and resolution of dynamic and stochastic Vehicle Routing Problems therefore demands increasing attention from application oriented OR practitioners. We develop learning mechanisms and optimization algorithms for problems that are dynamic and stochastic in several properties, with a focus on fast and robust heuristic search techniques. We present our approach, two selected applications, preliminary results and ongoing work.

3 - A Branch-and-Cut Algorithm for the Capacitated Open Vehicle Routing Problem

Richard Eglese, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom,
R.Eglese@lancaster.ac.uk, *Jens Lygaard*, *Adam Letchford*

In open vehicle routing problems, the vehicles are not required to return to the depot after completing service. An exact optimization algorithm is presented for the open version of the capacitated vehicle routing problem (CVRP). The algorithm is based on branch-and-cut. An effective way of modifying the integer programming formulation for the CVRP is presented together with the cutting planes used. Computational results are given for several standard test instances and compared to those from existing heuristic methods.

■ TD-27

Tuesday, 14:00-15:30

OPT Adal V=229

Optimization Modeling Systems III - AIMMS, SIMUL8

Stream: Software for OR/MS

Invited session

Chair: *Mark Elder*, SIMUL8 Corporation, 141 St James Road, G4 0LT, Glasgow, United Kingdom, mark.e@SIMUL8.com

1 - AIMMS: Experience the Power of Optimization

Frans de Rooij, Paragon Decision Technology B.V., Julianastraat 30, 2012ES, Haarlem, Netherlands,
f.de.rooij@aimms.com, *Ovidiu Listes*

We will demonstrate the power of the extended possibilities of AIMMS for optimization modeling. The intuitive modeling environment of AIMMS allows you to create advanced and complex optimization models. AIMMS interfaces with state-of-the-art solvers and allows for interactive solution approaches and decomposition.

Some powerful features that are currently under development will also be illustrated.

Go to www.aimms.com for more information and a free trial copy of AIMMS.

2 - Reflections from cases on component technology in discrete event simulation

Mark Elder, SIMUL8 Corporation, 141 St James Road, G4 0LT, Glasgow, United Kingdom, mark.e@SIMUL8.com

For many years the notion of "templates" has been a recommended solution for helping decision-makers build and run discrete event simulations when simulation experts are unavailable. The author has seen this recommendation fail to deliver successful outcomes in a number of cases that will be discussed. Over the last three years an alternative method, based on "componentization", has been implemented with some degree of success. Cases illustrate the success. Component design factors, that appear to be key, will be proposed and discussed. Software will be used to illustrate both approaches.

■ TD-28

Tuesday, 14:00-15:30

OPT Adal VI=207

Dynamic Programming I

Stream: Dynamic Programming

Invited session

Chair: *Jaroslav Sklenar*, Statistics and Operations Research, University of Malta, Tal-Qroqq, MSD 06, Msida, Malta, jaroslav.sklenar@um.edu.mt

1 - Some Myths and Facts about Dynamic Programming

Moshe Sniedovich, Dept. of Mathematics and Statistics, University of Melbourne, Parkville, 3010, Melbourne, Victoria, Australia, m.sniedovich@ms.unimelb.edu.au

There are conflicting views about certain aspects of dynamic programming. In this presentation we shall attempt to distinguish between some of the Myths and Facts about dynamic programming.

2 - Dynamic programming principle and optimal synthesis in nonlinear optimal control

Helene Frankowska, CNRS CREA Ecole Polytechnique, 1 Rue Descartes, 75005, Paris, France, helene.frankowska@shs.polytechnique.fr

It is well known that value functions of optimal control do satisfy the Bellman principle. In smooth case, it allows to obtain the optimal synthesis via an associated HJB equation. The notion of viscosity solution is convenient from the PDE point of view to have uniqueness of non smooth solutions to HJB, but does not yield the optimal synthesis. We characterize the synthesis by using a differential inclusion derived from the dynamic programming principle and provide conditions for semiconcavity of value function. Such smoothness implies some regularity of synthesis.

3 - Engine for Deterministic Dynamic Programming Models

Jaroslav Sklenar, Statistics and Operations Research, University of Malta, Tal-Qroqq, MSD 06, Msida, Malta, jaroslav.sklenar@um.edu.mt

Generalized mathematical model of Deterministic Dynamic Programming applications is presented. It enables specification of a common solver algorithm that performs the optimization procedure. Applications are represented by sets of few simple functions. Implementation in Matlab and Java is outlined. Use of the solver is demonstrated by two selected applications.

■ TD-29

Tuesday, 14:00-15:30

OPT Adal VII=225

Quadratic Optimization II

Stream: Global Optimization: Deterministic and Stochastic Methods

Invited session

Chair: *Immanuel Bomze*, Isds, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, immanuel.bomze@univie.ac.at

1 - Nonlinear and Global Optimization Algorithms for the Eigenvalue Complementarity Problem

Joaquim Judice, Dept. Mathematics, University of Coimbra, Largo D. Dinis, 3000, Coimbra, Portugal, Joaquim.Judice@co.it.pt, *Isabel Ribeiro*, *Silvério Rosa*

The Eigenvalue Complementarity Problem (EiCP) searches a positive scalar and non-negative vectors x , w satisfying a bilinear equality, involving matrices A and B , and a complementarity constraint between x and w . If A and B are symmetric, the EiCP reduces to find a stationary point of a merit function on the simplex. In the asymmetric case, EiCP reduces to a Mathematical Programming Problem with Linear Complementarity Constraints (MPLCP). Projected-Gradient and Enumerative Tree-Search algorithms are proposed for solving the EiCP in these cases and fully exploit the formulations stated above.

2 - Linear Approximations of Copositive Programs

Stefan Bundfuss, FB4 Mathematik AG10, TU Darmstadt, Schlossgartenstrasse 7, 64289, Darmstadt, Hessen, Germany, bundfuss@mathematik.tu-darmstadt.de, *Mirjam Duer*

Many nonconvex quadratic problems as well as some combinatorial optimization problems (e.g. maximum clique) can be formulated as copositive programs (i.e. linear programs over the cone of copositive matrices). Therefore, copositive programming is hard. We propose a new polyhedral approximation of the cone of copositive matrices. Our approach can be used to obtain criteria for copositivity. On the other hand, it can also be used to approximate copositive programs. We end our talk by discussing possible applications to the maximum clique problem.

3 - Improving SDP bounds for maximum clique by adding linear cuts

Florian Frommlet, Statistics, University of Vienna, Bruennerstrasse 72, 1210, Vienna, Austria, Florian.Frommlet@univie.ac.at, *Immanuel Bomze*, *Marco Locatelli*

We present an improvement of the Lovasz - Schrijver bound for the maximum clique number by adding linear cuts. Based on the quadratic formulation of the maximum clique problem by Motzkin and Straus we obtain valid cuts by considering subgraphs of the original graph with known clique number. We develop simple heuristic algorithms to find suitable subgraphs and study several classes of graphs for which we can actually obtain an improvement of the Schrijver bound, among them circulant graphs.

■ TD-30

Tuesday, 14:00-15:30

NONL Adal X=220

Modern numerical methods in semi-infinite optimization

Stream: Nonlinear Semi-Infinite Optimization

Invited session

Chair: *Oliver Stein*, Dept. of Mathematics - C, RWTH Aachen University, Templergraben 55, 52056, Aachen, Germany, stein@mathC.rwth-aachen.de

1 - An algorithm based on active sets and smoothing for discretized semi-infinite minimax problems

Elijah Polak, Electrical Engineering Computer Sciences, University of California at Berkeley, Cory Hall, 94720-1770, Berkeley, CA, United States, polak@eecs.berkeley.edu, *Robert Womersley*

We present a new active-set strategy which can be used in conjunction with exponential (entropic) smoothing for solving large-scale minimax problems arising from the discretization of semi-infinite minimax problems. The main effect of the active-set strategy is to dramatically reduce the number of gradient calculations needed in the optimization.

2 - On Polynomial Algorithms in Semi-infinite Programming

Georg Still, Mathematics, University of Twente, P.O.Box 217, 7500 AE, Enschede, Netherlands, g.still@math.utwente.nl

Linear and convex semi-infinite problems are considered. We describe some special structured semi-infinite problems from robust optimization which are known to be polynomially solvable. Then we report on some attempts to generalize the interior point method from the linear finite to the linear semi-infinite case. We discuss the limitations of such extensions. Finally we present a new algorithmic idea which could lead to polynomial algorithms for a larger class of linear and convex semi-infinite programs. The approach is based on the so-called Reduction Ansatz.

3 - Homotopy methods for mathematical programs with complementarity constraints

Oliver Stein, Dept. of Mathematics - C, RWTH Aachen University, Templergraben 55, 52056, Aachen, Germany, stein@mathC.rwth-aachen.de, Daniel Ralph

Recently the approach to solve SIPs by replacing them with MPCCs has received a lot of attention. This talk introduces two homotopy methods for finding stationary points of a MPCC with quadratic objective function and linear complementarity constraints. To analyze a homotopy path we introduce the C-index of a nondegenerate C-stationary point. We show that for generic data the C-index changes exactly at turning points of the C-stationary set. Numerical results illustrate the performance of the methods for randomly generated test problems.

■ TD-31

Tuesday, 14:00-15:30

NONL Adal XI=222

Gradient-based Methods for Machine Learning Applications

Stream: Industrial Application of Nonlinear Programming Algorithms

Invited session

Chair: Gaetano Zanghirati, Department of Mathematics, University of Ferrara, Building B, Scientific-Technological Campus, via Saragat, 1, 44100, Ferrara, Italy, g.zanghirati@unife.it

1 - An Optimisation-based Framework for Data Classification with Multiple Groups

Gang Xu, Dept. of Chemical Engineering, University College London, Torrington Place, WC1E 7JE, London, United Kingdom, g.xu@ucl.ac.uk, Lazaros Papageorgiou

This paper presents a mixed integer optimisation framework for multi-class data classification problems using a hyper-box representation. An iterative solution procedure is also proposed coupled with a feature selection scheme to improve the training and testing performance. Finally, the applicability of the proposed approach is demonstrated through several benchmark datasets from machine learning databases. According to the computational results, our approach is competitive in terms of prediction accuracy when compared with various standard classifiers.

2 - Gradient Descent Learning in Reproducing Kernel Hilbert Spaces

Lorenzo Rosasco, DISI - Department of Computer and Information Science, University of Genova, Via Dodecaneso 35, 16146, Genova, Italy, rosasco@disi.unige.it, Andrea Caponnetto, Yuan Yao

We study a family of gradient descent algorithms to approximate the regression function from Reproducing Kernel Hilbert Spaces (RKHSs), the family being characterized by a polynomial decreasing rate of step sizes (or learning rate). Solving a bias-variance trade-off we obtain an early stopping rule and some probabilistic upper bounds for the convergence of the algorithms. These upper bounds have improved rates where the usual regularized least square algorithm fails. We also discuss connections of these results with classification, boosting and Landweber regularization.

3 - Some properties of gradient-based methods with application to machine learning

Gaetano Zanghirati, Department of Mathematics, University of Ferrara, Building B, Scientific-Technological Campus, via Saragat, 1, 44100, Ferrara, Italy, g.zanghirati@unife.it, Luca Zanni

Gradient methods for smooth unconstrained and constrained optimization are studied since long time. Recent theoretical and computational issues on linesearch techniques and steeplength selection rules largely improve these classical approaches. We investigate some properties of gradient methods related to the Barzilai-Borwein steps and their practical effect in solving problems arising in machine learning applications.

■ TD-32

Tuesday, 14:00-15:30

NONL Adal XIII=218

Optimization over convex cones and variational inequalities

Stream: Convex Optimization Methods

Invited session

Chair: Alfredo Iusem, IMPA, Estrada Dona Castorina 110, 22460-320, Rio de Janeiro, RJ, Brazil, iusp@impa.br

1 - Finite dimensional approximations of general variational inequalities

Susana Scheimberg, COPPE/ Engenharia de Sistemas e Computação-Instituto de Matemática, COPPE/PESC-IM, Universidade Federal do Rio de Janeiro, Caixa Postal 68511, Bloco H/319, 21941-972, Rio de Janeiro, RJ, Brazil, susana@cos.ufrj.br

We study several schemes for finding appropriate finite dimensional approximations of variational inequality problems defined in infinite dimensional Banach spaces.

2 - On the extension of classical methods from scalar to vector optimization

Luis Drummond, FACC, UFRJ, Barao da Torre 445/704, 22411-003, Rio de Janeiro, RJ, Brazil, lm@ondaalta.com.br

We develop the extension of several classical methods for scalar-valued optimization to the setting of vector-valued optimization, with a partial order given by a cone, without going through a scalarization procedure. Methods like steepest descent, projected gradient and Newton will be discussed.

3 - Antipodal pairs, critical pairs and Nash angular equilibria in convex cones

Alfredo Iusem, IMPA, Estrada Dona Castorina 110, 22460-320, Rio de Janeiro, RJ, Brazil, iusp@impa.br

We discuss three related geometric concepts connected to the angular analysis of a convex cone: antipodal pairs, critical pairs and Nash pairs. Antipodal pairs are formed by unit vectors which realize the maximal angle in the cone, critical pairs are stationary points for that maximization problem, and Nash pairs are a new concept in between.

■ TD-33

Tuesday, 14:00-15:30

NONL Adal A=313

Abstract Convexity and Global Optimization

Stream: Global and Local Derivative Free Optimization

Invited session

Chair: Diethard Pallaschke, Statistics and Mathematical Economics, University of Karlsruhe, Kaiserstr. 12, Geb. 11.40, D-76128, Karlsruhe, Germany, lh09@rz.uni-karlsruhe.de

Chair: Alexander Rubinov, School of Information Technology and Mathematical Sciences, University of Ballarat, 1, University Drive, Ballarat, VIC, Australia, 3353, Ballarat, Victoria, Australia, a.rubinov@ballarat.edu.au

1 - The Hahn-Banach-Lagrange theorem

Stephen Simons, Mathematics, University of California, Santa Barbara, 93106, Santa Barbara, CA, United States, simons@math.ucsb.edu

We discuss the Hahn-Banach-Lagrange theorem, a generalization of the Hahn-Banach theorem. We derive results in functional analysis, on Lagrange multipliers for convex problems, with a sharp lower bound on the norm of the multipliers, on a minimax theorem, on subgradients of convex functions, and on the Fenchel conjugate of a convex function. We deduce a generalization of Rockafellar's version of the Fenchel duality theorem, and an explicit lower bound for the norm of the solutions of the Fenchel duality theorem in terms of elementary geometric concepts.

2 - Three criteria of minimality for pairs of compact convex sets

Ryszard Urbanski, Faculty of Mathematics and Computer Science, Adam Mickiewicz University in Poznan, ul. Umultowska 87, Pl-61-614, Poznan, Poland, lh06@rz.uni-karlsruhe.de

For a locally convex vector space the family of all nonempty compact convex subsets is considered. The Radstrom-Hörmander lattice is obtained by introducing an equivalence relation on pairs of compact convex sets by assigning to each pair the difference of its support functions. Two pairs are called equivalent if the differences of their support functions is equal. Of special importance are the inclusion minimal elements in a class of equivalent pairs. We prove three criteria of minimality: a generalized "facets criterion" an "edges criterion" and a generalized "steps criterion".

3 - Pairs of Compact Convex Sets

Diethard Pallaschke, Statistics and Mathematical Economics, University of Karlsruhe, Kaiserstr. 12, Geb. 11.40, D-76128, Karlsruhe, Germany, lh09@rz.uni-karlsruhe.de, *Ryszard Urbanski*

Pairs of compact convex sets arise in the quasidifferential calculus of V.F. Demjanov and A.M. Rubinov as sub- and superdifferentials of quasidifferentiable functions. Of special importance are the inclusion minimal pairs. Different types of sufficient criteria for inclusion minimality are given. Algebraic and geometric characterization of minimality lead to the separation law for convex sets which is equivalent to the order cancellation law. Pairs of compact convex sets are a commutative ordered semigroup with cancellation property, which leads to a fractional arithmetic for convex sets.

■ TD-34

Tuesday, 14:00-15:30

DEC VR II V-138

DDM and inter-organizational coordination

Stream: Distributed Decision Making

Invited session

Chair: *Heike Schenk-Mathes*, Institut für Wirtschaftswissenschaft, Technische Universität Clausthal, Julius-Albert-Str. 2, D-38678, Clausthal-Zellerfeld, Germany, heike.schenk-mathes@tu-clausthal.de

1 - Supply Chain Coordination under Mild Behavioral Assumptions

Mirko Kremer, Logistics, Mannheim Business School, Schloss, S 228, 68131, Mannheim, Germany, Mirko.Kremer@bwl.uni-mannheim.de, *Stefan Minner*

We address bounded rationality in the context of decentralized decision making. This is an issue widely disregarded in the recent model-based research on "optimal" coordination of decentralized supply chains. We provide two motivations for including bounded rationality into supply chain coordination models, review the related literature, support the potential of this research direction by a formal model analysis, and discuss promising paths for future research effort in this field.

2 - Regulatory information, integration and competition in the European network industries

Per Agrell, Louvain School of Management, Université Catholique de Louvain, Cescm, Place des Doyens, 1, 1348, Louvain-la-neuve, Belgium, agrell@poms.ucl.ac.be, *Mathias Lorenz*

We present a model of regulatory competition and integration in the infrastructure industries. Regulators compete for downstream investments by free-riding on complementary regulation regimes in neighboring countries. Consolidating firms can neutralize the regulators through forcing them to costly information acquisition on operating efficiency. A case from the Nordic electricity sector is presented.

3 - Learning preferences in negotiations

Rudolf Vetschera, Dept. of Business Studies, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, rudolf.vetschera@univie.ac.at

It is often argued in the negotiation literature that in order to obtain efficient outcomes, negotiators need to develop an understanding of the other parties' goals and preferences. Yet, so far there is a lack of objective instruments to measure preference information revealed in negotiations. In this paper, we develop such an instrument based on the domain criterion for sensitivity analysis. To test its validity, we apply it to a data set of 3.000 negotiations. Results indicate that our instrument can predict success and efficiency of negotiations better than self-reported measures.

■ TD-35

Tuesday, 14:00-15:30

DEC VR II V-147

From Soft Methods to Soft Processes

Stream: Problem Structuring Methods / Soft OR

Invited session

Chair: *Rene Victor Valqui Vidal*, Informatics and Mathematical Modelling, Technical University of Denmark, Building 305, 2800, Kgs. Lyngby, Denmark, vvv@imm.dtu.dk

1 - Facilitating future ICT developments. The MAGNET case

Lene Sorensen, Center for Information and Communication Technologies, Technical University of Denmark, Building 371, 2 floor, 2800, Kgs. Lyngby, Denmark, lene@cict.dtu.dk

Designing future information and communication technologies demands a mixture between being creative and rational finding the right blend of technology developments and meeting the expected user needs. This paper will focus on facilitation of multi-disciplinary groups involved in technology design. The overall purpose is to discuss a number of issues which are determining for how facilitation can take place and for the type of facilitation that can be carried out. The paper will focus on a case study, the MAGNET project, where creative workshops have been facilitated for new system designs.

2 - The Role of Conflict Management in OR

Carsten Nico Hjortsø, Centre for Forest, Landscape and Planning, The Royal Veterinary and Agricultural University, Rolighedsvej 23, 1958, Frederiksberg C, Denmark, cnh@kvl.dk

Social conflict is a fundamental aspect of human interaction and, consequently, an inevitability element in OR practice regardless whether it places itself within the hard, soft or critical tradition. During the last decades Conflict Management (CM) has emerged as a distinct research discipline and practice. The theoretical foundation and practical methods of CM are characterized and compared to different perceptions and approaches to conflict management found in OR. It is concluded that CM can provide a significant inspiration to future methodological improvement of OR.

3 - The art and science of participative problem solving

Rene Victor Valqui Vidal, Informatics and Mathematical Modelling, Technical University of Denmark, Building 305, 2800, Kgs. Lyngby, Denmark, vvv@imm.dtu.dk

In this paper we will document that real-life problem solving in complex situations demands both rational (scientific) and intuitive (artistic) thinking. First the concepts of art and science will be discussed; differences and similarities will be enhanced. Thereafter the concept of group problem solving facilitation both as science and art will be presented. A case study related to examination's planning will be discussed to illustrate the main concepts in practice. In addition, other case studies will be shortly presented.

■ TD-36

Tuesday, 14:00-15:30

DEC VR7 V-155

Integrated MCDA Applications

Stream: Multicriteria Decision Analysis

Invited session

Chair: *Theodor Stewart*, Statistical Sciences, University of Cape Town, Upper Campus, 7701, Rondebosch, South Africa, tjstew@stats.uct.ac.za

1 - MCDA with Risk, Uncertainty and the Time Value of Money

Cathal Brugha, Management Information Systems, University College Dublin, Quinn School of Business, Belfield, 4, Dublin 4, Ireland, Cathal.Brugha@ucd.ie

We describe a case where a large Irish company spent a year choosing a software producer that will build its web platform. They used the Direct-Interactive Structured-Criteria (DISC) System, firstly with Utility-Satisfaction (DISCUS) to screen candidates down to three, and then Relative-Intensity-Measurement (DISCRIM) to make the choice. The decision constructs were progressively refined in each phase. The final choice used only part of the criteria tree, and focused on issues to do with risk, uncertainty and differences between the alternatives' expected revenue streams over time.

2 - MCDA support of the Dutch defence materiel procurement process

Diederik J.D. Wijnmalen, Systems Support for Decisions Operations, TNO Organisation for Applied Scientific Research, P.O. Box 96864, 2509 JG, The Hague, Netherlands, diederik.wijnmalen@tno.nl

This presentation will illustrate where and how MCDA comes in to support evaluation and selection at various stages of the formalised Dutch defence procurement process. Criteria hierarchy building, weighting and scoring peculiarities, and workshop settings are topics that will be addressed. The presentation will draw on some recent examples.

3 - Multiobjective decision support for land use planning

Ron Janssen, Institute for Environmental Studies, Free University of Amsterdam, De Boelelaan 1115, 1081HV, Amsterdam, Netherlands, ron.janssen@ivm.vu.nl

This paper describes a class of spatial planning problems in which different land uses have to be allocated across a geographical region, subject to a variety of constraints and conflicting management objectives. A goal programming / reference point approach to the problem is formulated, which can be classified as a nonlinear combinatorial optimization problem. A special purpose genetic algorithm is integrated with the algorithm and applied to a specific land use planning problem in The Netherlands.

4 - How to select tools to carry out an integrated assessment?

Marjan van Herwijnen, Institute for Environmental Studies, Vrije Universiteit Amsterdam, De Boelelaan 1087, 1081 HV, Amsterdam, Netherlands, marjan.van.herwijnen@ivm.vu.nl

To carry out an integrated assessment (IA) a policy maker has to decide what tools to use to answer its specific questions. This is a difficult decision. The EU-project SustainabilityA-Test made an inventory of tools and evaluated them on sustainable development and operational aspects and aspects linked to policy processes. All tools are integrated in a webbook (www.sustainabilityA-Test.net). This presentation will first show the role of MCDA linked to the other tools and secondly, give insight in how the webbook makes use of MCDA to find out the most suitable tools to carry out a specific IA

■ TD-37

Tuesday, 14:00-15:30

DEC VR7 V-156

Multicriteria Sorting Methodologies and Applications

Stream: Multiple Criteria Decision Aiding

Invited session

Chair: *Michael Doumpos*, Dept. of Production Engineering and Management, Technical University of Crete, University Campus, 73100, Chania, Greece, mdoumpos@dpem.tuc.gr

1 - TRICLAS: A DSS for Ordinal Classification

José Rui Figueira, Instituto Superior Tecnico, Technical University of Lisbon, Av. Cavaco Silva, Tagus Park, 2780 - 990 Porto Salvo, 2780 - 990, Lisbon, Portugal, figueira@ist.utl.pt, *Juscelino Almeida-Dias*

In this article we present the structure and the functionalities of TRICLAS, a DSS designed for ordinal classification problems with the integration of the coherency analysis on the parameters. It is based in some ordinal classification methods, incorporating inference procedures to develop a sorting model based on the reference actions. TRICLAS is also a useful tool to develop new consistent case studies for helping the decision maker to find relevant answers in a decision process. The software is presented through an illustrative example.

2 - Regularized Estimation for Preference Disaggregation in Multiple Criteria Decision Making

Michael Doumpos, Dept. of Production Engineering and Management, Technical University of Crete, University Campus, 73100, Chania, Greece, mdoumpos@dpem.tuc.gr, *Constantin Zopounidis*

Disaggregation methods have been extensively used in MCDM to infer preferential information from reference examples, using linear programming. This paper proposes simple extensions of existing formulations, based on the concept of regularization which has been introduced within the context of the statistical learning theory. The properties of the new formulations are analyzed for ranking and classification problems and experimental results are presented demonstrating the improved performance of the proposed formulations over the ones traditionally used in preference disaggregation analysis.

3 - Stochastic Multicriteria Acceptability Analysis for Classification with Ordinal Criteria

Iryna Yevseyeva, Mathematical Information Technology, University of Jyväskylä, P.O. Box 35 (Agora), FI-40014, Jyväskylä, Finland, iyevsev@cc.jyu.fi, *Kaisa Miettinen*, *Pekka Salminen*

We suggest a SMAA - Classification method: a variant of stochastic multicriteria acceptability analysis for classification of alternatives measured by ordinal criteria into ordered set of classes. SMAA - Classification explores the criteria weight space and finds such preferences that assign an alternative to a particular class. For each alternative the method calculates a class acceptability index, a vector of criteria weights and a confidence factor of such classification. We demonstrate the method with a neuropsychological diagnostics application.

■ TD-38

Tuesday, 14:00-15:30

DEC VR7 V-157

DEA Methodology I

Stream: DEA and Performance Measurement (c)

Invited session

Chair: *Gerrit Loeber*, Department of Economics, University of Mannheim, L7,3-5, 68131, Mannheim, Baden-Württemberg, Germany, McPenguin@gmx.de

1 - DEAS: Data Envelopment Analysis System, a new software, for the improvement of decision-making

Monique LeMoing, INRA-ESR, 4 allée Adolphe Bobierre, CS 61103, 35011, Rennes cedex, France, Monique.LeMoing@rennes.inra.fr

Version 1.0 of DEAS, is an easy-to-use software to perform productivity and efficiency measurements. DEAS using the technique known as Data Envelopment Analysis (DEA), provides a wide range of basic DEA models. Furthermore, this package implements the most recent developments of the method (Malmquist indexes for panel data, Directional distance function); DEAS is particularly well suited for taking into account joint-production in the presence of undesirable outputs. The kernel for solving Linear Programs takes advantage of one extremely efficient interior-point algorithm.

2 - A DEA model for hierarchical data

Robert Wilken, Economic Department, Institut fuer Anlagen und Systemtechnologien, Am Stadtgraben 13-15, 48143, Muenster, Germany, robert.wilken@uni-muenster.de

We develop a DEA panel data model which refers explicitly to hierarchical data structures. The DMUs' performances of a sequence of time periods are incorporated into the objective functions of both primal and dual linear programs. The solution of these LPs can be used in order to assess efficiency for any period of the aforementioned sequence. We give interpretations of the resulting efficiency scores from both primal and dual programs. Furthermore, we illustrate why our method, from a conceptual point of view, outperforms static-comparative models as well as the DEA-based window analysis.

3 - Multiplier Adjustment in Data Envelopment Analysis

Jorge Santos, Universi. Egora, R. Elina Guimarães 7-4-A, 7-4-a, 1750-095, Lisboa, Portugal, jj66ii@iol.pt, *José Dulá*

Weight restriction is a field of intensive interest in Data Envelopment Analysis. Weights restriction schemes commonly result in concentrations near lower and upper limits. We introduce a non-linear goal programming formulation that allows the adjustment of the multipliers around base values. The proposed technique concentrates the weights around its previously chosen central value. This technique is illustrated by a real world application with a symmetric weights distribution.

4 - A simple trick: categorical variables in non-parametric frontier analysis

Gerrit Loeber, Department of Economics, University of Mannheim, L7,3-5, 68131, Mannheim, Baden-Württemberg, Germany, McPenguin@gmx.de

Since Banker and Morey (1986) introduced the use of categorical variables to non-parametric frontier analysis categorical variables have been widely used, but these are only valid for variable returns to scale (VRS). This paper introduces categorical variables for all convexity assumptions without the necessity of reprogramming the linear program. I will show an easy way to modify the data and bring the information about category in the analysis without skewing the results. As a second step I will give an outlook to the possibility of influencing non-parametric frontier analysis with parametric information.

■ TD-39

Tuesday, 14:00-15:30

DEC VR II V-158

Stochastics Models for DSS

Stream: Decision Support Systems

Invited session

Chair: *James Everett*, School of Business, University of Western Australia, 49 Goldsmith Rd, Nedlands, 6009, Nedlands, Western Australia, Australia, jeverett@ecel.uwa.edu.au

1 - Non-parametric Vertical Box Control Chart For Monitoring The Mean

Mirek Pawlak, Electrical and Computer Engineering, University of Manitoba, 75 Chancellor Circle, R3T 5V6, Winnipeg, Manitoba, Canada, pawlak@ee.umanitoba.ca

The averaging across change points and parametric knowledge of noise process used in classical control charts (CUSUM, EWMA, Shewhart) yield a substantial reduction in their performance. In order to alleviate these shortcomings we propose a non-parametric control chart utilizing the idea of vertically weighted regression which does not average past observations and does not require parametric knowledge of the process. The proposed control chart possesses a uniformly better performance than classical control charts over a large range of shifts and over a wide class of errors distributions.

2 - Vulnerability Analysis of Extreme Events and the Use of Ranked Probabilities

Akkanad Isaac, College of Business and Public Administration, Governors State University, Division Chair, Management, Marketing, and Public Administration, One University Parkway, 60466, University Park, Illinois, United States, a-isaac@govst.edu

Catastrophic natural disasters like Hurricane Katrina usually happen with some advance warning. To mitigate the consequence of the disaster, it is necessary to develop appropriate strategies taking into account the most likely states of nature.

The decision making context is intermediate between pure risk and pure uncertainty. Ranked probabilities, an operational technique pioneered by P.C.Fishburn will help to identify the most effective strategy. It is possible to compute the minimum and maximum expected losses and minimum and maximum expected variance.

3 - Building Enterprise Case-Based Reasoning Systems: A dynamic clustering approach

Georgios Papamichail, National Centre for Public Administration, Piraeus 211 & Thrace 2, 17778, Athens, Greece, papamichail@gmail.com

In enterprise CBR systems the decision makers usually have to retrieve information from organizational resources and transform it into meaningful cases. This paper describes a framework for building such systems incorporating dynamic clustering methods. K-means range clustering is employed to assist the decision maker in filtering vast quantities of information from the enterprise database, CBR is used to transform the data clusters into business cases which are documented, indexed, and inserted into the case base and lastly, the dynamic clustering method ensures the validity of the case base.

4 - Choosing the Daily Ore Blend to Mine - Adjusting Inaccurate Estimates by an Adaptive Regression Model

James Everett, School of Business, University of Western Australia, 49 Goldsmith Rd, Nedlands, 6009, Nedlands, Western Australia, Australia, jeverett@ecel.uwa.edu.au

Iron ore product must be close to target composition, in iron, silica, alumina and phosphorus. The daily mining blend is based on inaccurate samples from blast hole drilling. Accurate composition is not known until it has been mined, railed to port, crushed and assayed. An adaptive regression model compares exponentially smoothed past port assays and mine estimates to adjust the mine estimates. Three years operation of the model, producing over a hundred million tonnes of iron ore, has yielded greatly improved uniformity of product composition. Further improvements to the model are discussed.

■ TD-40

Tuesday, 14:00-15:30

SOC VR II V-257

Environmental Planning with Simulation

Stream: Environmental Planning (c)

Invited session

Chair: *Luís Alcáda-Almeida*, Faculty of Economics, University of Coimbra, Av. Dias da Silva, 199, 3000, Coimbra, Portugal, alcada@dec.uc.pt

1 - Operational Production Planning of Metallurgical Processes - Combining Flowsheet Simulation and Mixed Integer Programming

Magnus Fröhling, Institute for Industrial Production (IIP), University of Karlsruhe, Hertzstraße 16, D-76187,

Karlsruhe, Germany,
magnus.froehling@wiwi.uni-karlsruhe.de, *Otto Rentz*

We present a new approach for the modelling of metallurgical processes in operational production planning. The four steps "process modelling" using flowsheet simulation, to determine input-output functions of the process, "mass and energy flow orientated structuring of monetary parameters", "economic modelling" by means of mixed integer programming, and "implementation in an integrated decision support system" are demonstrated in an industrial case study, the utilisation of ferrous residues from the iron and steel industry in a blast furnace. Further, exemplary application results are given.

2 - Generating Environmental Policy Alternatives Using Simulation-Optimization Methods

Julian Scott Yeomans, OMIS, Schulich School of Business, York University, 4700 Keele Street, Ssb S338, M3J 1P3, Toronto, Ontario, Canada, syeomans@schulich.yorku.ca

Environmental policy formulation can prove complicated when the various system components contain stochastic uncertainty. In addition, it is generally preferable to create several good alternatives that provide different approaches and perspectives to the same problem. This study shows how simulation-optimization (SO) techniques can be used to efficiently generate multiple environmental policy alternatives that satisfy required system criteria. The efficacy of this modelling-to-generate-alternatives approach is demonstrated using several case studies of municipal solid waste management.

3 - Environmental Impacts Over Populations: A Spatial Decision Support System for Scenario Evaluation

Luís Alçada-Almeida, Faculty of Economics, University of Coimbra, Av. Dias da Silva, 199, 3000, Coimbra, Portugal, alcada@dec.uc.pt, *João Coutinho-Rodrigues*

An integrated SDSS, overcoming the analytical limitations of commercial GIS, designed to address general problems and suited to study environmental problems is presented. The system uses a RDBMS that stores quantitative models edited by the user together with the relevant data, and offers a graphical edition/visualization interface. A case study addressing the simulation of impacts over the city of Coimbra due to a planned implementation of a HAZMAT co-incineration is presented. The SDSS allows generating alternative solutions showing the variation of the respective impacts over populations.

■ TD-41

Tuesday, 14:00-15:30
SOC VR11 V-258

Context

Stream: Human Centered Processes

Invited session

Chair: *Patrick Brezillon*, Lip6, Université Paris 6, 8 rue du Capitaine Scott, 75015, Paris, France, brezil@poleia.lip6.fr

1 - An Analytical Comparison of Two Context-driven Intelligence Modelling Paradigms

Patrick Brezillon, LIP6, Université Paris 6, 8 rue du Capitaine Scott, 75015, Paris, France, brezil@poleia.lip6.fr, *Avelino Gonzalez*

This paper describes an investigation comparing Context-based Reasoning (CxBR) and Contextual Graphs (CxG), two paradigms used to represent human intelligence. While both employ the notion of contexts, their similarities and differences are not obvious from a cursory examination. The paper presents the results of a comparison in ten different aspects. It begins with a short description of the paradigms, points out how they are complementary and finishes with a recommendation for a new synergistic approach, followed by an application to tactical agents.

2 - A Context-driven Approach to Emulating Human Behavior in Automated Agents

Hans Fernlund, Computer Engineering, Dalarna University, Rodavagen 3, 78188, Borlange, Dalarna, Sweden, fernlund@mail.ucf.edu, *Avelino Gonzalez*

Building models of automated agents able to control moving platforms is a difficult task. In most cases, there is an element of tactical behavior, as decisions must be made in reaction to unexpected situations in the environment. This paper describes a way to build such models effectively by learning from observation of human performance in a simulation. The use of contexts as a way to decompose the behavior is a critical part of our approach. It synergistically combines Genetic Programming (GP) with Context-based Reasoning (CxBR). This paper describes the process as well as results.

■ TD-42

Tuesday, 14:00-15:30
SOC VR11 V-261

Modelling of Economies and Societies in Transition and Aspects of Markets

Stream: Modelling of Economies and Societies in Transition (c)

Invited session

Chair: *Ante Rozga*, Faculty of Economics, Quantitative methods, University of Split, Matice Hrvatske 31, 21000, Split, Croatia, rozga@efst.hr

1 - Market Attractiveness Ratings of Transition Economies

Zdravka Aljinovic, Faculty of Economics, University of Split, Department of Quantitative Methods in Economics, Matice hrvatske 31, 21000, Split, Croatia, zdravka.aljinovic@efst.hr, *Neli Tomic - Plazibat, Snjezana Pivac*

This study use PROMETHEE method in country risk assessment of the 15 transition countries, from New EU members group and from The Balkans group. Market attractiveness ratings involve the assessment of the performance of countries considering their economic and socio-political characteristics. Namely, the two basic goals of transition are development of market economy and development of democratic society. The purpose of the paper is to answer to which extent these goals have been achieved and to find the comparative position of individual country in the group of all analyzed countries.

2 - Model of Investment under Uncertainties in a Transition Economy

Vaclava Pankova, Dept. of Econometrics, University of Economics Prague, W.Churchill sq. 4, 13067, Prague 3, Czech Republic, PANKOVA@VSE.CZ

Optimizing of investment is constrained by uncertainty about future rewards. Uncertainties of economic environment concerning inflation or exchange rate, tend to have negative effect on foreign investors. Irreversibility of investment decisions and opportunity cost of possibility to wait rather than to invest, imply that an impact of uncertainties depends on type of industry. Mathematical model with investment and output of selected industrial branches and influence of inflation, resp. exchange rate, is formulated. Using panel data, case of Czech Rep. is studied. GACR 402/04/0756.

3 - Forecasting Interest Rates in Transition Economies: Croatian Case

Ante Rozga, Faculty of Economics, Quantitative methods, University of Split, Matice Hrvatske 31, 21000, Split, Croatia, rozga@efst.hr, *eljko Banovic*

The main variables used to forecast interest rates are: money supply, country ranking and the presence of foreign banks. It is particularly interesting for transition countries since they previously had mostly socialist economies without foreign banks. We used econometric model with log transformations both for interest rates and money supply and also presence of foreign banks as a dummy variable. The presence of foreign banks has substantially reduced interest rates. We also compared these results with ARIMA forecasting and seasonal adjustment methods such as X-12-ARIMA and TRAMO/SEATS.

■ TD-43

Tuesday, 14:00-15:30

FIN Endur Room 1

OR Applications of Stochastic Programming

Stream: Stochastic Programming

Invited session

Chair: *Jitka Dupacova*, Probability and Math. Statistics, Charles Univ, Faculty of Math. and Physics, Sokolovska 83, CZ-18675, Prague, Czech Republic, dupacova@karlin.mff.cuni.cz

Chair: *Marida Bertocchi*, Dipartimento di Matematica statistica informatica e applicazioni, Universita Degli Studi di Bergamo, Via dei Caniana 2, 24127, Bergamo, BG, Italy, marida.bertocchi@unibg.it

1 - A stochastic optimization model for the gas retail sector

Marida Bertocchi, Dipartimento di Matematica statistica informatica e applicazioni, Universita Degli Studi di Bergamo, Via dei Caniana 2, 24127, Bergamo, BG, Italy, marida.bertocchi@unibg.it, *Elisabetta Allevi*, *Maria Teresa Vespucci*, *Francesca Maggioni*, *Mario Innorta*

A stochastic optimisation model in gas retail market is described. Uncertainty in consumptions due to temperature changes is modelled by two different approaches. The profit function depends on the number of contracts with the final clients, the typology of clients and the cost supported to meet the final demand while constraints are related to a maximum daily gas consumption, to yearly maximum and minimum consumption in order to avoid penalties and to consumption profiles. The results give clear indication of the amount of losses that may appear in the gas seller's budget.

2 - Unemployment Problem via Stochastic Programming

Vlasta Kankova, Academy of Sciences of the Czech Republic, Prague, Czech Republic, kankova@utia.cas.cz, *Petr Chovanec*

Nowadays unemployment has become one of the main problems in Europe. In this presentation, we introduce the possibilities of stochastic programming in the labor market policies. For this purpose, we briefly mention the basic concepts of labor economics relevant to the unemployment problem and Active Labor Market Policies (ALMP), and we introduce multistage stochastic programming model for regional labor office with ALMPs. At the end, the possible ways of unemployment prediction are presented with the connection to scenario generation, as well as procedures for solving this model.

3 - Analysis of business models for provision of mobile telecom services using stochastic programming

Alexei Gaivoronski, Industrial Economics and Technology Management, Norwegian University of Science and Technology, Alfred Getz vei 1, 7491, Trondheim, Norway, alexei.gaivoronski@iot.ntnu.no

Provision of mobile telecom services of the next generations requires serious study of innovative business models for several reasons - as opposed to traditional services, the advanced data services involve collaboration of several actors - business decisions are made under substantial risk and uncertainty about user response and technological development - service lifecycle can be very limited We apply optimization models under uncertainty, stochastic programming and modern finance methods for evaluation of service platforms, service portfolios and related value chains in this context.

■ TD-44

Tuesday, 14:00-15:30

FIN Endur Room 2

Portfolio Planning and Estimation

Stream: Long Term Financial Decisions

Invited session

Chair: *Thomas Burkhardt*, Campus Koblenz, IfM, Universität Koblenz-Landau, Universitätsstr. 1, 56070, Koblenz, Germany, tburkha@uni-koblenz.de

1 - Long-Term Asset Allocation Advice

Michael Stutzer, Finance, University of Colorado, 419 Ucb, 80309, Boulder, CO, United States, michael.stutzer@colorado.edu

Expected utility maximizing advice is unreliable, because one can't reliably find a client's risk aversion parameter. Target-shortfall probability minimizing advice is reliable, but appears to lack a utility-based foundation. This foundation is provided by maximizing expected power utility of the return-to-target ratio, over both the portfolio and the risk aversion parameter. The latter optimization is surprising and unprecedented, but follows directly from large deviations theory.

2 - Persistence, Predictability and Portfolio Planning

Michael Brennan, UCLA, Anderson, School of Management, 90095, Los Angeles, CA, United States, michael.brennan@anderson.ucla.edu, *Yihong Xia*

We use a model of stock price behavior in which the expected rate of return on stocks follows an Ornstein-Uhlenbeck process to show that levels of return predictability that cause large variation in valuation ratios and offer significant benefits to dynamic portfolio strategies are hard to detect or measure by standard regression techniques.

We propose a new approach to portfolio planning that uses forward-looking estimates of long run expected rates of return from dividend discount models. Simulation results suggest that this approach may be valuable for long horizon investors.

3 - When Do Stop-Loss Orders Stop Losses?

Kathryn Kaminski, Operations Research, MIT, 500 Memorial Dr., 02139, Cambridge, MA, United States, katykam@mit.edu, *Andrew Lo*

Stopping strategies, policies to close out positions after reaching a certain threshold of losses, are commonly used by retail and institutional investors to manage portfolio risks. However, under certain conditions, stop-loss policies can have a substantial negative impact on a portfolio's expected return. We derive analytical and numerical implications of stop-loss policies on portfolio performance when they are applied to common investment strategies. We show that superimposing a stopping policy can alter the underlying strategy and may significantly impact long term portfolio performance.

■ TD-45

Tuesday, 14:00-15:30

FIN Endur Room 3

Optimal Consumption and Investment beyond Merton

Stream: Optimization in Financial Mathematics

Invited session

Chair: *Mogens Steffensen*, Institute for Mathematical Sciences, Universitetsparken 5, 2100, Copenhagen, Denmark, mogens@math.ku.dk

1 - Portfolio optimization for stochastic volatility models and utility indifference pricing

Fred Espen Benth, Centre of Mathematics for Applications, University of Oslo, PO Box 1053 Blindern, N-0316, Oslo, Norway, fredb@math.uio.no

We discuss utility optimization of financial portfolios for a stochastic volatility model with jumps, and consider applications to pricing of options using utility indifference. We base our discussions on the dynamic programming approach, where a Hamilton-Jacobi-Bellman equation with an integral term is solved semi-explicitly via a Feynman-Kac representation. The indifference price of options is given via the solution of a non-linear Black & Scholes type partial-integro differential equation. A special case is analyzed, where the minimal entropy martingale measure plays an important role.

2 - Portfolio Optimization with Default Risk

Holger Kraft, University of Kaiserslautern,
Erwin-Schroedinger-Str., 67663, Kaiserslautern, Germany,
kraft@mathematik.uni-kl.de

We analyze the impact of default risk on the portfolio decision of an investor wishing to invest in corporate bonds. Default risk is modeled via a reduced form approach and we allow for random recovery as well as joint default events. Depending on the structure of the model, we are able to derive almost explicit results for the optimal portfolio strategies. It is demonstrated how these strategies change if common default factors can trigger defaults of more than one bond or different recovery assumptions are imposed. In particular, we analyze the effect of beta distributed loss rates.

3 - Optimal Consumption and Insurance

Mogens Steffensen, Institute for Mathematical Sciences,
Universitetsparken 5, 2100, Copenhagen, Denmark,
mogens@math.ku.dk

We present an overview over some decision problems about consumption and insurance. We approach a problem based on a model in a continuous time multistate Markovian framework. The optimal solution is derived and studied. The model, the problem, and its solution are exemplified by two special cases: In one model the individual takes optimal positions against the risk of dying; in another model the individual takes optimal positions against the risk of losing income as consequence of disability or unemployment.

■ TD-46

Tuesday, 14:00-15:30

FIN Endur Room 4

Forecasting

Stream: Applied Probability/Forecasting (c)

Invited session

Chair: *Zsolt Harnos*, Mathematics and Informatics, Corvinus University of Budapest, Villányi ut 29-43., H-1118, Budapest, Hungary, zsold.harnos@uni-corvinus.hu

1 - Reoptimization under data uncertainty. A two phase approach

Giovanni Sechi, Dept. Of Land Engineering, University of Cagliari, Piazza d'Armi, 09123, Cagliari, Italy,
SECHI@UNICA.IT, *Paola Zuddas*

We propose a scenario analysis approach for systems optimization under uncertainty conditions. A scenario approach may be trustworthy because it allows decision makers to select the bundle of scenarios most appropriate to the situation. Scenario analysis technique has been used to implement a two-phase strategy. The first phase consists in finding a "barycentric decision" with respect to the selected decision variables that is used in the second deterministic optimization phase. Scenario instances are based on a dynamic space-time network flow model with uncertainty on the input parameters.

2 - Forecast Quality and Inflation Targeting: An Empirical Investigation

Heinz Glück, Economic Studies Division, Oesterreichische Nationalbank, P.O.Box 61, A-1011, Vienna, Austria,
Heinz.Glueck@oenb.at, *Stefan Schleicher*

To follow an inflation targeting policy, forecast quality often is not sufficient. We show this by evaluating accuracy and efficiency of OECD and IMF forecasts, paying attention to the sequence of forecasts, serial correlation of forecast errors, data revisions and common bias. We find that considerable policy errors are occurred if simple instrument rules of monetary policy relying on unadjusted real-time data are applied. We suggest methods to correct data inputs for some of the mentioned defects, enabling policymakers to use information available in real time more efficiently.

3 - A method of yield forecasting

Zsolt Harnos, Mathematics and Informatics, Corvinus University of Budapest, Villányi ut 29-43., H-1118, Budapest, Hungary, zsold.harnos@uni-corvinus.hu

The aim of our analysis is to estimate the expected yield in the different weather circumstances. The main steps of the method are to determine the independent data set of agro-technique and genetic, to form data set clusters, to determine that discriminant functions of the meteorological parameters which separates the years having given level yield loss or surplus from the others to estimate the expected yield in the given weather situation by regression analysis. We also used this method to forecast the expected yield in the climatic circumstance predicted by GCMs.

■ TD-47

Tuesday, 14:00-15:30

FIN Endur Room 5

Value

Stream: Financial Modelling (c)

Invited session

Chair: *Silvia Mayoral*, Quantitative Methods, Universidad de Navarra, Universidad de Navarra, Edificio Bibliotecas (Entrada Este), 31080, Pamplona, Navarra, Spain, smayoral@unav.es

1 - An Option-Pricing Approach for the Valuation of Intangible Assets

Takashi Shibata, Economics, Kyoto University,
Yoshida-Honmachi, Sakyo-ku, 606-8501, Kyoto, Japan,
shibata@econ.kyoto-u.ac.jp, *Masaaki Kijima*, *Koji Inui*

This paper examines the valuation of intangible assets of a firm by using the option-pricing theory. It derives closed-form results for the value of intangible assets and endogenous bankruptcy threshold when the tangible asset value follows a diffusion process with constant volatility. It is shown that an increase in the initial value of realizable intangible asset decreases the bankruptcy threshold, while an increase in the value of the unrealizable intangible asset increases the bankruptcy threshold.

2 - Sequential arbitrage measurement and envelopes for the TSIR

Alejandro Balbás, Business Administration, University Carlos III of Madrid, CL. Madrid, 126, 28903, Getafe, Madrid, Spain, alejandro.balbas@uc3m.es

This paper proposes new measures providing us with the level of sequential arbitrage in bond markets. Each measure is generated by a dual pair of optimization problems. Primal problems provide different applications: First, they permit traders and empirical researchers to detect the presence of arbitrage. Second, they yield new strategies to invest and price new bonds. Each dual problem generates a concrete proxy for the Term Structure of Interest Rates. An empirical test of our findings is implemented in the Spanish market

3 - CAPM and imperfections with applications to financial markets integration measures

Silvia Mayoral, Quantitative Methods, Universidad de Navarra, Universidad de Navarra, Edificio Bibliotecas (Entrada Este), 31080, Pamplona, Navarra, Spain,
smayoral@unav.es, *Alejandro Balbás*

The paper provides new methods to test a capital asset pricing model in imperfect markets. The concepts of pseudo-arbitrage and efficiency are used and analyzed by means of both scalar and vector optimization problems. This new approach will permit us to examine the existence of possible recent growths in the degree of integration of European financial markets. Some duality results will permit us to point out that a significant transaction costs reduction is very often feasible in practice, allowing for improvements of the integration level among the new members of the European Union.

■ TD-48

Tuesday, 14:00-15:30

EWG Logberg 102

EWG: OR for Development

Stream: EWG Meetings

Invited session

Chair: *Leroy White*, Management, University of Bristol, Willes Memorial building, Queens Rd, BS8 1RN, Bristol, United Kingdom, leroy.white@bris.ac.uk

Chair: *Maurice Shutler*, Operational research, London School of Economics, 23 Admington Drive, Hatton Park, CV35 7TZ, Warwick, United Kingdom, maurice.shutler@tiscali.co.uk

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, Odtü, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Foundation Meeting of EURO WG "OR for Development"

Leroy White, Management, University of Bristol, Willes Memorial building, Queens Rd, BS8 1RN, Bristol, United Kingdom, leroy.white@bris.ac.uk, *Maurice Shutler*, *Gerhard-Wilhelm Weber*

For this meeting, the foundation of the new EURO Working Group "OR for Development" is planned and closer explanations prepared. Future plans will be discussed.

Participants are cordially welcome, also for membership: to become Founding Members!

■ TD-50

Tuesday, 14:00-15:30

DISCUSS Adal 1

Discussion Presentation (A2)

Stream: Poster - Discussion Presentations

Invited session

Chair: *Valerie Belton*, Dept. Management Science, University of Strathclyde, 40 George Street, G1 1QE, Glasgow, United Kingdom, val.belton@strath.ac.uk

1 - A Cluster Approach Methodology for a Real Location-Routing Problem

Sérgio Barreto, ISCA - Higher Institute for Accounting and Administration, University of Aveiro, Apartado 58, 3811-953, Aveiro, Portugal, sergio.barreto@isca.ua.pt, *Rui Borges Lopes*, *Carlos Ferreira*

In the last two decades Location-Routing Problem (LRP) models have been used to approach distribution network problems. In this paper, mathematical programming formulations for a real LRP are proposed, as well as a cluster approach methodology for solving it. Results obtained using a computer application will be presented and discussed.

2 - Graph algorithms for continuous path planning problems

Ranga Muhandiramge, School of Mathematics and Statistics, University of Western Australia, 35 Stirling Highway, Crawley, 6009, Perth, Western Australia, Australia, ranga@maths.uwa.edu.au, *Natashia Boland*

We use the network weight constrained shortest path problem (WCSPP) to solve continuous path planning problems in which we want to minimise the path integral of a risk function subject to a length constraint on the path.

New techniques in efficiently solving the WCSPP are explained that better use Lagrangean information in both the pre-processing and gap-closing stages of the algorithm. These techniques are compared to other algorithms in numerical experiments.

We also explore the importance of node placement and edge connectivity in improving solution quality.

■ TD-50

Tuesday, 14:00-15:30

DISCUSS Adal 2

Discussion Presentation (B2)

Stream: Poster - Discussion Presentations

Invited session

Chair: *Valerie Belton*, Dept. Management Science, University of Strathclyde, 40 George Street, G1 1QE, Glasgow, United Kingdom, val.belton@strath.ac.uk

1 - Nonlinear Programming for Solving Optimal Control of Natural Resources Exploitation Problems

Joao Lauro Faco, Dept. of Computer Science, Universidade Federal do Rio de Janeiro, Rua Lasar Segall, 100 / 109- A, 22611-100, Rio de Janeiro, RJ, Brazil, jldfaco@acd.ufrj.br

Decision problems as: (i) marine multi-species fishery management, and (ii) electric energy short-term generation scheduling can be represented by coupled sets of discrete-time difference equations describing the interacting dynamics of natural resources and the environment, and optimal control theory can build model structure and parameters estimation. The increase in model complexities as nonlinearities, time delays, supplementary inequality constraints on the state variables imply critical numerical difficulties that can be overcome by reliable Nonlinear Programming methods.

2 - Sustainability evaluation of farm/forest investments: optimising for landuse change and management strategies

Oliver Chikumbo, Ensis Forests, Private Bag 3020, 3201, Rotorua, New Zealand, oliver.chikumbo@ensisjv.com

Sustainability issues on a farm/forestry property involves resolving two problems of a spatial nature in order to meet the desired goal, which are, determining land use change over the planning period, and determining the suite of management options from the conglomeration of management units for the chosen land uses. The optimisation process shown here simultaneously optimises for land use and management strategy changes. By applying appropriate constraints on the financial and environmental outputs, scenarios may be determined that satisfy the goals of sustainability.

3 - Collective causal mapping methodologies: aggregating or filtering?

Tatiana Bouzdine - Chameeva, Bordeaux Ecole de Management, 680, cours de la Liberation, 33405, Talence Cedex, France, tatiana.chameeva@bordeaux-bs.edu

Causal mapping is used to elicit and represent domain knowledge of individuals in the form of a causal map. How to derive a collective causal map basing on individual perceptions? The appropriate level of aggregation or filtering of the individual maps is put forward in the presented methodology which combines the homothetic and idiographic approaches. The in-depth analysis of the results of several management studies is presented and the issues important for a further development of causal mapping techniques are highlighted.

■ TD-50

Tuesday, 14:00-15:30

DISCUSS Adal 3

Discussion Presentation (C2)

Stream: Poster - Discussion Presentations

Invited session

Chair: *Valerie Belton*, Dept. Management Science, University of Strathclyde, 40 George Street, G1 1QE, Glasgow, United Kingdom, val.belton@strath.ac.uk

1 - Knowledge and Information system of Faculty of Transportation Sciences of Czech Technical University

Jana Kalikova, Department of Informatics and Telecommunication, Czech Technical University, Faculty of

Transportation Sciences, Konviktska 20, 110 00, Prague,
Czech Republic, kalikova@fd.cvut.cz, *Drahomír Schmidt,*
Marek Kalika

Knowledge and information system for the university's support of education, administration, and decision making: 1. System for education support - electronic access to documentation, tools for on-line training and testing courses creation. 2. Intranet - active document exchange, meeting planning, registering of students on subjects and exams, ordering IS, etc. 3. Knowledge system - knowledge database, rules defining, creation of application for fulltext searching of knowledge with given topics. Rules defining for K-net as the so called "teaching-from-examples" system, rules for data protection.

2 - Decision Mathematics at the University of Luxembourg

Patrick Meyer, Service de Mathématiques Appliquées,
University of Luxembourg, 162a, avenue de la Faïencerie,
1511, Luxembourg, Luxembourg, patrick.meyer@uni.lu,
Claude Lamboray, *Raymond Bisdorff*, *Jean-Luc Marichal*

This presentation focuses on the research projects which exist in the field of Decision Mathematics in the Applied Mathematics Unit (SMA) at the University of Luxembourg. Two important research topics can be distinguished: methodological issues in decision-making support and aggregation operators. The first theme is in the tradition of the European school of multicriteria decision aid established by Prof. Bernard Roy. The second subject focuses more particularly on nonadditive measures and integrals for aggregation in the framework of information and decision making systems.

Tuesday, 16:00-17:30

■ TE-01

Tuesday, 16:00-17:30

KEY Askja N-132

TUTORIAL: Theoretical advances in nonlinear semi-infinite optimization

Stream: Nonlinear Semi-Infinite Optimization

Invited session

Chair: *Oliver Stein*, Dept. of Mathematics - C, RWTH Aachen University, Templergraben 55, 52056, Aachen, Germany, stein@mathC.rwth-aachen.de

1 - TUTORIAL: Nonlinear SIP: Structural Analysis

Hubertus Th. Jongen, Dept. Mathematics, RWTH Aachen University, Templergraben 55, 52062, Aachen, Germany, jongen@rwth-aachen.de

We present a survey on structural results in standard SIP. In particular, we focus on critical points and topological stability. Then, we describe new challenging features appearing in general SIP.

2 - Augmented Lagrangians in Semi-Infinite Programming

Jan-J. Rückmann, Dept. of Actuarial Sciences and Mathematics, Universidad de las Americas, Puebla, Sta. Catarina Martir, 72820, Cholula, Puebla, Mexico, janj.ruckmann@udlap.mx

We study an augmented Lagrangian approach to semi-infinite problems and present necessary and sufficient conditions for the existence of corresponding augmented Lagrange multipliers. Furthermore, we discuss two particular cases for the augmenting function: the proximal Lagrangian and the sharp Lagrangian. This lecture is based on a joint work with Alexander Shapiro.

■ TE-02

Tuesday, 16:00-17:30

APP Askja N-131

Pharmaceutical Models

Stream: OR in Health Care

Invited session

Chair: *Pascale Crama*, Decision Science, London Business School, Regent's Park, NW1 4SA, London, United Kingdom, pcrama@london.edu

1 - Multicriteria models of structure-activity relationships in pharmacology and toxicology

Jaroslava Halova, Institute of Inorganic Chemistry, Academy of Sciences of the Czech Republic, Research center 1001, CZ 25068, Rez, Czech Republic, halova@iic.cas.cz, *Martin Aust*, *Lucia Austova*

Structure-Activity Relationships (SARs) are dealing with interrelations of chemical structure, characterised by descriptors, and biological criteria, as applied to computer aided drug design. Based on interrelations among these criteria determined by MCDM methods, the prediction of therapeutic properties from characteristics of chemical structure of drugs can be performed. The inverse problem of finding chemical structure of a drug of desired therapeutic properties can be solved with the application to drug tailoring.

2 - Optimization of the Colombian pharmaceutical supply chain including transaction costs

Rafael Guillermo García Cáceres, Productive Processes, Pontificia Universidad Javeriana, Carrera 7 No. 40-62, Facultad de Ingeniería, 1, Bogotá, Colombia, rafael.garcia@javeriana.edu.co, *Ingrid Marcela Monroy Licht*, *Sergio Torres*

The pharmaceutical products in Colombia for human use takes second place of Global National Production. Therefore, the research purpose "Optimization of the strategic elements of the supply chain based on a transaction costs perspective: Bogota's medicine case" is to gather tools to integrate quantitative and qualitative considerations for local enterprises to make better market decisions. We present a research approach to determine the supply chain issues for modelling, find restrictions to take into account, and suggest the methodology in order to analyse the transaction costs.

3 - Milestone payments or royalties? Contract design for R&D licensing

Pascale Crama, Decision Science, London Business School, Regent's Park, NW1 4SA, London, United Kingdom, pcrama@london.edu, *Bert De Reyck*, *Zeger Degraeve*

We study how innovators can optimally design licensing contracts, under incomplete information on the licensee's valuation of the innovation and limited control over the licensee's development efforts. Under adverse selection, the optimal contract structure changes with the licensee's valuation of the innovation. Only a risk-averse licensor should include upfront and milestone payments. Moral hazard alone is not detrimental to the licensor's value, but may create a value loss when combined with adverse selection. The combination of factors explains the contracts observed in practice.

4 - A study on improving the process of filling prescription for pharmacy

Ying-Chyi Chou, Department of Business Administration, Thughai University, 181 Taichung-kang Rd., Sec. 3, Taichung, Taiwan, R.O.C., 407, Taichung., Taiwan, rosechyi@yahoo.com.tw, *Ming-Fen Wu*, *Shuw-Chuan Wang*, *Hui-Shin Lin*, *Wen-Chi Chuang*

In Taiwan after the National Health Insurance was brought into effect in March of 1995, it resulted in an increase in the number of people seeing the doctor's making it hard for the older hospital pharmacy personnel to keep up with the continually increasing number of patients. This research is based on case subjects conducted at Taichung Veterans General Hospital with according to its current manpower of the pharmacy. We use "time studies" to analyze the process of filling the prescription and to propose the improvement program hoping that the waiting time for prescriptions can be shortened.

TE-03

Tuesday, 16:00-17:30

APP Askja N-130

Business and Industry OR - IBM

Stream: Business and Industry OR - Special Track

Invited session

Chair: *Brenda Dietrich*, Mathematical Sciences, IBM TJ Watson Research Center, Route 134, 10598, Yorktown Heights, NY, United States, dietric@us.ibm.com

1 - Optimization of spare parts inventories with multiple ordering modes

Richard Boedi, IBM, Saumerstrasse 4, 8803, Rueschlikon, Switzerland, rbo@zurich.ibm.com, *Ulrich Schimpel*

A manufacturer wanted to optimize their spare parts business. The optimization goals are 1) Determine optimal replenishment strategies to minimize the total costs while achieving a global target service level. 2) There are two different ordering modes available: normal and rush orders. The second goal was to find the mix between normal and rush orders for each SKU that minimizes the total costs. 3) For each SKU it needs to be determined whether to store a SKU in the regional warehouse or only in the central distribution center.

2 - Workforce capacity planning under demand and attrition uncertainty

Gyana Parija, Analytics and Optimization, IBM Research, IBM India Research Laboratory (IRL), Block-1, Indian Institute of Technology, Hauz Khas, 110016, New Delhi, India, gyparija@in.ibm.com

Workload for each client in a business unit (BU) of Business Process Outsourcing (BPO) companies may correspond to several back-end processes each of which has special skills requirements for case handling. Capacity planning in such a setting involves developing monthly hiring (of case handling agents) plans in the face of monthly demand forecasts and uncertain attrition outlook. We present a constrained optimization model to aid in capacity planning in such a setting and discuss the model characteristics and behavior using representative data.

3 - Applying OR to processes in IBM Global Services

Brenda Dietrich, Mathematical Sciences, IBM TJ Watson Research Center, Route 134, 10598, Yorktown Heights, NY, United States, dietric@us.ibm.com

In addition to designing, manufacturing, selling, and supporting information technology hardware and software, IBM operates a large service organization, with offerings ranging from hardware maintenance to business process outsourcing, to IT center operation, business consulting and systems integration. In this talk I will discuss opportunities for the application of OR methodology, some of the challenges, and some early indications of success.

TE-04

Tuesday, 16:00-17:30

APP Askja N-129

Market structure and the longer term

Stream: Electricity Markets

Invited session

Chair: *John Ranyard*, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, jranyard@cix.co.uk

1 - The Value of Reduced Abatement Cost Uncertainty in an Integrated Assessment Model of Climate Change

Stephan Alberth, Judge Business School, University of Cambridge, 80 Chartfield road, CB1 9JY, Cambridge, Cambridgeshire, United Kingdom, sea42@cam.ac.uk

Using a stochastic Integrated Assessment Model of climate change, we have made a first order approximation of the value of reducing the parametric uncertainty of the abatement technology learning parameter. Reduced uncertainty allows the model to optimise more effectively thereby reducing the total costs associated with climate change. The value of reducing uncertainty by half by 2006 was found to be 250 Billion USD (2000), and if the same reduction in uncertainty was to take place for free by 2030, the value remains at 50 Billion USD (2000) discounted to year 2000 values.

2 - Energy mix planning for the French electricity production sector

Nadia Maïzi, Center for Applied mathematics, Ecole des Mines de Paris, Rue C. Daunesse, Bp 207, 06904, Sophia-Antipolis, France, nadia.maizi@ensmp.fr, *Edi Assoumou*, *Gilles Guerassimoff*, *Marc Bordier*

The French electricity sector has the well-known main features that it relies on the highest nuclear share worldwide. As the power sector is characterized by low emission levels, the future generation mix and nuclear energy share constitute a major issue. In order to tackle that central topic, modelling becomes essential in order to describe more precisely energy and technology options and to demonstrate trends concerning the environmental questions. We present some results of a bottom-up French electricity sector model based on the family of Markal models.

3 - Fuel for Thought - Designing an Electricity Generation Policy for the UK

John Ranyard, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, jranyard@cix.co.uk

The UK government is, once again, reviewing its long-term energy policy against a background of changing and conflicting requirements. The aim is to enable a supply of energy at competitive prices that is secure, sustainable and acceptable to stakeholders, whilst also meeting the Kyoto agreement for emissions and government targets for the introduction of renewable sources. This problem has been set as a group exercise to Lancaster MSc(OR) students for the last 10 years and insights into how several OR approaches can help will be described.

■ TE-05

Tuesday, 16:00-17:30

APP Askja N-128

Optimisation and Forest Management I

Stream: OR in Agriculture and Forest Management (c)

Invited session

Chair: *Frederick Garcia*, Unite de Biometrie et Intelligence Artificielle, INRA, Castanet-Tolosan, France, fgarcia@toulouse.inra.fr

1 - A new mixed integer programming model for harvest scheduling subject to maximum area restrictions

Isabel Martins, Department of Mathematics, Instituto Superior de Agronomia, Tapada da Ajuda, 1349-017, Lisbon, Portugal, isabelinha@isa.utl.pt, *Miguel Constantino*, *Jose Borges*

Research on exact methods has been done in order to solve forest management problems with constraints on the clearcut size. Each clearcut may have more than one stand if its area does not exceed the maximum clearcut size. Two main basic integer programming models have been discussed, which one with an exponential number of variables or constraints. In this work, we describe a new integer programming model with a polynomial number of variables and constraints. We use branch-and-bound to solve it and we report on computational experience with real life and test instances.

2 - Heuristic for bilevel olive harvest and olive oil production planning problem

Kristina Soric, Faculty of Economics, Dept. of Mathematics, University of Zagreb, Trg J.F.Kennedy 6, 10000, Zagreb, Croatia, ksoric@efzg.hr, *Visnja Vojvodic Rosenzweig*, *Olivera Koprivnjak*

The problem considered here is a practical problem of a Croatian olive oil producer. The aim is to schedule the harvest of olives and the production of olive oil minimizing overtime cost and setup, storage, waiting and production cost. The problem is modelled as a bilevel integer programming production planning problem and solved using heuristic based on tabu search, Lagrangean and some other relaxations

3 - An experiment with non-industrial private forest owners' preferences in interval and ratio scales

Teppo Hujala, Department of Forest Research Management, University of Helsinki, P.O.Box 27, FI-00014, Helsinki, Finland, Teppo.Hujala@helsinki.fi, *Pekka Leskinen*

We tested direct capturing of preferences in different measurement scales. Altogether 30 NIPP owners were asked to set importances of six predefined forestry goals. The interval scale values were set graphically in a vertical line, and the ratio scale values were elicited numerically as percentages. Those percentages were transformed and compared with the original interval scale values. Interestingly, ratio scale showed significantly bigger contrast than interval scale. In this presentation, we discuss the results and assess the alternative methods in capture of DMs' subjective preferences.

■ TE-06

Tuesday, 16:00-17:30

APP Askja N-121

Location and Transportation

Stream: Optimization in Postal Logistics

Invited session

Chair: *Joachim Wessels*, Managing Director, Mail Operations West, Deutsche Post AG, Postfach 450527, 50880, Köln, Germany, j.wessels@deutschepost.de

1 - Models for Closed Loop Logistics

Mark Daskin, Dept. of IE/MS, Northwestern University, 2145 Sheridan Road, 60208, Evanston, IL, United States, m-daskin@northwestern.edu, *Kristin Sahyouni*, *Canan Rezzan Savaskan*

Postal operations may be thought of as closed loop logistical systems with flows going from customers to consolidation centers and then back out to customers. We formulate simple integrated forward and reverse closed loop models that minimize the facility location and transportation costs. We outline an optimal solution algorithm. The algorithm is dramatically faster than off-the-shelf algorithms, thereby facilitating sensitivity analysis. The models indicate when integrated, as opposed to sequential, planning is critical.

2 - Collaboration in the transportation branch: profit sharing and impediments

Marta Anna Krajewska, Department of Economics, Chair of Logistics, University of Bremen, Wilhelm-Herbst-Strasse 5, 23359, Bremen, Germany, makr@logistik.uni-bremen.de, *Herbert Kopfer*

Enhancement of competitiveness among the freight forwarding enterprises can be achieved if they cooperate in coalitions to balance their request portfolios. We introduce a model for collaboration among freight forwarders that is based on the theoretical foundations in the field of combinatorial auctions and operations research game theory. The assumptions of this model are based on practical experience from our joint project with a freight forwarding company. Next, we analyse the impediments of the collaboration caused by the profit sharing mechanism itself as well as by practical incentives.

3 - IT Systems and Models for Interactive Distribution Network Planning

Tore Grünert, GTS Systems and Consulting GmbH, Raiffeisenstr. 10, 52134, Herzogenrath, Germany, gruenert@gts-systems.de

Postal enterprises usually run a logistics network that consists of sorting centres, hubs, airports, local distribution points and other dedicated locations. These locations are linked by transportation arcs that allow a huge number of shipments (parcels, letters, magazines etc.) to be moved from their origins to their destinations. In this talk we will distinguish different planning situations and discuss how OR models and IT systems can aid users in finding good solutions to the planning problems

■ TE-07

Tuesday, 16:00-17:30

APP Askja N-120

Sports and OR II

Stream: OR in Sports

Invited session

Chair: *James Cochran*, Department of Marketing and Analysis, Louisiana Tech University, PO Box 10318, 71272, Ruston, LA, United States, jcochran@cab.latech.edu

1 - Solution of a nonlinear integer program for a college baseball tournament assignment problem

Cole Smith, Department of Industrial and Systems Engineering, University of Florida, 303 Weil Hall, PO Box

116595, 32611, Gainesville, FL, United States,
cole@ise.ufl.edu

The NCAA College Baseball tournament consists of three rounds: the first two rounds are held at university sites, and the last round is held at a neutral site. We investigate the solution of a team assignment problem in order to minimize travel. In this problem, teams are assigned to first-round locations, and the tournament bracket is set to determine the second-round pairings. Travel costs depend on first-round travel plus expected second-round travel. The resulting problem is a large-scale non-linear integer programming problem, which we address using various optimal algorithms.

2 - Modelling tactical changes of formation in association football as a zero-sum game

Nobuyoshi Hirotsu, School of Health and Sports Science, Juntendo University, 1-1 Hiragagakuendai, Inba-Mura, 270-1695, Inba, Chiba, Japan, nhirotsu@hotmail.com, *Mike Wright*

This paper proposes a game theoretic approach to modelling tactical changes of formation in an association football match. We use a Poisson regression model to evaluate the offensive and defensive strengths of the formations of teams for scoring or conceding a goal by means of the maximum likelihood method. We then develop a mathematical formulation to express quantitatively the tactical changes of formation as a zero-sum game by taking account of both teams' decisions. We demonstrate how the managers' decisions affect the probability of winning the match using real data of the J League.

3 - Scheduling the Brazilian Soccer Championship

Celso Ribeiro, Department of Computer Science, Universidade Federal Fluminense, Rua Bogari 70, 22471-340, Rio de Janeiro, RJ, Brazil, celso@inf.puc-rio.br, *Sebastián Urrutia*

The yearly Brazilian Football Championship is organized by the Brazilian Football Confederation (CBF) and its major sponsor is TV Globo, the largest television network in Brazil. CBF seeks a schedule minimizing the number of breaks, while TV Globo aims to maximize broadcast revenues. The schedule must also satisfy a number of hard constraints. We developed an exact four-phase solution strategy involving complete enumeration, linear programming, and integer programming. Successful numerical results on a real life instance are reported.

4 - The Pitcher or the Batter - Who Has More Influence over the Outcome of a Plate Appearance in Major League Baseball?

James Cochran, Department of Marketing and Analysis, Louisiana Tech University, PO Box 10318, 71272, Ruston, LA, United States, jcochran@cab.latech.edu

We use regression analysis and data for outcomes of individual plate appearances from the 2004 Major League Baseball season to assess the relative influence of the pitcher and the batter. The frequency of occurrence of a particular event (hits, home runs, strikeouts, walks, hit by pitches, etc.) for individual pitcher/batter matchups are regressed on the frequency of occurrence of the event for the individual pitcher and the hitter over the entire season.

TE-08

Tuesday, 16:00-17:30

EDU Oddi 101

TUTORIAL WORKSHOP: Getting started using cases

Stream: OR Education

Invited session

Chair: *Peter Bell*, Richard Ivey School of Business, University of Western Ontario, N6A 3K7, London, Ontario, Canada, pbell@ivey.ca

1 - TUTORIAL WORKSHOP: Getting Started with Cases

Peter Bell, Richard Ivey School of Business, University of Western Ontario, N6A 3K7, London, Ontario, Canada, pbell@ivey.ca

This workshop will cover the basics of teaching OR using cases. Included will be topics such as: The benefits of using a few cases in an OR course, finding OR cases, various methods to incorporate one or more cases in a course, and various styles of conducting a classroom session based around a case.

TE-09

Tuesday, 16:00-17:30

IT Oddi 106

Sampling techniques for clustering large and high dimensional data

Stream: Data Mining

Invited session

Chair: *Zeev (Vladimir) Volkovich*, Ort Braude Academic College, Yehiam 6, 21823, Karmiel, Israel, zeev@actcom.co.il

1 - On clustering via the sampling sequential EM - algorithm

Zeev (Vladimir) Volkovich, Ort Braude Academic College, Yehiam 6, 21823, Karmiel, Israel, zeev@actcom.co.il, *Jacob Kogan*

As a rule iterative clustering algorithms fail to converge to the global optimum of the objective function. Final partitions generated by the algorithms depend on the initial partitions supplied as input. In this paper we present a new method for the construction of initial partitions in the spirit of the Cross-Entropy method. In this approach we apply the sequential sample classification via the EM algorithm instead of the simulation step of the Cross-Entropy method. As a result clustering procedures applied to the obtained initial partitions generate "better" final partitions.

2 - Social Systems Segmentation and Analysis

Michael Haydock, Operations Research, Walden University, 6460 Fox Path, 55317, Chanhassen, MN, United States, haydock@attglobal.net

In the case of an airline attempting to understand a changing relationship with its travel agency channel, an enormous amount of flight records must be cleaned, processed, and mathematically transformed. Utilizing data mining technologies affords the airlines the possibility to develop channel opportunities. A new clustering analysis procedure is proposed and is compared to the k-means method. Pattern classification techniques transform flight records into binned categorical data. This paper also presents a proposed method of unsupervised binning to accomplish complex data transformations.

3 - Dimensionality reduction via block clustering

Mohamed Nadif, LITA, University Paul Verlaine-Metz, Ile du Saulcy, 57045, Metz, France, mohamed.nadif@univ-metz.fr, *Gerard Govaert*

Cluster analysis is one among the statistical learning methods involving dimensionality reduction. Less popular but still very useful the block clustering or two-mode partitioning methods take now an important place in different fields where the data are very large. They offer a good tool to reduce the size of data. We study the block clustering problem in embedding it in the mixture approach and propose block mixture models adapted to different kinds of data. We perform different variants of the EM algorithm and evaluate their performance on simulated and real data.

4 - Semidefinite Programming Approach for Support Vector Clustering

Basak Ozturk, Institute of Applied Mathematics, Middle East Technical University, Scientific Computing, Gisam, Instructional Technologies Support Office, 06531, Ankara, Turkey, bozturk@metu.edu.tr, *Gerhard-Wilhelm Weber*

Semidefinite programming problems have been intensely studied in the last years. The interest is based on the fact that the applicability of such problems is possible to diverse areas and they can be solved very efficiently, both in theory and in practice. Here, we will derive the 0-1 SDP programming model of support vector clusters. The 0-1 SDP model can be applied not only to the support vector clusters, but also to other scenarios of clustering as well.

■ TE-10

Tuesday, 16:00-17:30

OR Oddi 201

Ethical Values and Multi-Criteria Decision Analysis

Stream: OR - The Profession: Ethics in OR

Invited session

Chair: *Marc Le Menestrel*, Department of Economics and Business, University Pompeu Fabra, Ramon Trias Fargas 25-27, 08005, Barcelona, Spain, marc.lemenestrel@upf.edu

1 - Ethical values and well-tempered emotions in multi-criteria decision analysis

Fred Wenstøp, Strategy and Logistics, Norwegian School of Management BI, Nydalsveien 37, 0484, Oslo, Norway, fred.wenstøp@bi.no

This paper discusses the role of emotions in MCDA, and how to elicit well-founded values. It addresses the problem of strong emotions connected to virtues, and discusses whether it is solvable within or outside MCDA. It contends that the determinants of the decision are immediate emotions, which are only weakly influenced by expected emotions caused by expected consequences, as well as strong emotions connected questions of virtue. MCDA needs to heat the expected emotions and temper the strong emotions.

2 - Linking emotions to needs to decision criteria

Felix Rauschmayer, Economics, Sociology and Law, Center for Environmental research, Permoserstr. 15, 04318, Leipzig, Germany, Felix.Rauschmayer@ufz.de

How is it possible to consider emotions in multi-criteria decision analysis? Which normative implications does this have? Emotions arise when needs are fulfilled or not fulfilled. Linking emotions to needs indicates which emotions to include in multi-criteria decision analysis: The fulfilment of needs induced by decision options necessarily evokes emotions within the decision maker. Using needs-based instead of apparently objective decision criteria consequently results in more rational decisions as consequences can then be considered emotionally without remaining in a consequentialist frame.

3 - Ethical Values beyond Multi-criteria Maximization

Marc Le Menestrel, Department of Economics and Business, University Pompeu Fabra, Ramon Trias Fargas 25-27, 08005, Barcelona, Spain, marc.lemenestrel@upf.edu

We raise objections to treating ethical values and emotions within MCDA. Their reduction to an additional criterion or to a constraint of the function that individuals are supposed to maximize leads to models that are theoretically weak, methodologically biased and practically unreliable. We present new theoretical foundations in representational theory of measurement that may provide a separate and distinct account of ethical values and emotional concerns in human behaviour, while still allowing a precise measurement of other values by the objective function.

■ TE-11

Tuesday, 16:00-17:30

TRANS Oddi 202

Environment Impacts Assessment

Stream: Transportation

Invited session

Chair: *Stefano Carrese*, Department of Civil Engineering, University of Roma TRE, Via Vito Volterra 62, 00146, Roma, Italy, carrese@uniroma3.it

1 - Environment oriented transport policies and transit network design

Ernesto Cipriani, Dept. Civil Engineering, University of Roma TRE, Via Vito Volterra 62, 00146, Roma, Italy, ecipriani@uniroma3.it, *Marco Petrelli*, *Stefano Gori*, *Gaetano Fusco*

In recent years, the enormous increase of congestion phenomena, of acoustic and atmospheric pollution in the urban areas has produced important changes for the role reserved to the public transport, which should become the main tool to solve urban transport problem. Based on this observation, the procedure proposed introduces a new heuristic for the bus design problem that explicitly takes into account environmental impacts joined with the adoption of ad hoc transport policies. The procedure is applied to a case study network in order to verify its effectiveness.

2 - Simulation of maritime transit traffic in the Istanbul Channel

Birnur Ozbas, Industrial Engineering Department, Bogazici University, Güney Kampüs Mühendislik Binasi, Bebek, 34342, Istanbul, Turkey, birnur@ozbas.com.tr, *Ilhan Or*

This study involves an investigation based on the Istanbul Channel maritime traffic rules and regulations and tries to obtain most suitable simulation model for the Channel. The model focuses on the transit traffic and provides a platform to analyze the effects of factors such as rules, number of tugboats and pilots, traffic type, density and meteorological conditions on the Straits. By way of this study, analysis of accidents in the Straits, the risk management of these accidents and the results of them in terms of culture, environment and human life will be achievable in further studies.

3 - Validation of parking models with survey data

Borja Beltran, Civil Engineering, University of Roma TRE, Via V. Volterra, 62, 00100, Rome, Italy, beltran@uniroma3.it

Parking and re-entering traffic are a source pollution. This work is focused to improve the assessment of impacts from transport systems. In the proposed methodology a specific effort was dedicated to the modelling of the parking phase and the re-entering traffic phase. The application of this models in a traffic simulation provides useful information about searching time, searching speed, time of warm up and vehicular cold start fraction in a link that allows to properly analyse emissions. The last step of the work concerns the validation of the models with survey data.

4 - Environmental Impacts of Parking in Transport Policy

Stefano Carrese, Department of Civil Engineering, University of Roma TRE, Via Vito Volterra 62, 00146, Roma, Italy, carrese@uniroma3.it, *Emanuele Negrenti*, *Borja Beltran*

Parking policy plays an important role in the traffic system and it affects the level of traffic congestion and environmental quality in most urban centers. This work presents a suit of models aimed to the accurate determination of emissions due to parking inlet and outlet processes within TEE Model framework. TEE is an innovate model of direct impacts that supplies a detailed calculation of the factors influencing the emission of pollutants. The traffic components running along the road is characterized by three flow modes corresponding to transit, parking and inserting vehicles.

■ TE-12

Tuesday, 16:00-17:30

TRANS Oddi 205

Airport Terminal Management

Stream: Transportation

Invited session

Chair: *Ángel Marín*, Matemática Aplicada, Universidad Politécnica de Madrid, E.T.S.Ingenieros Aeronáuticos, Plaza Cardenal Cisneros, 3, 28040, Madrid, Spain, amarin@dmae.upm.es

1 - A Problem-Oriented Decision Support System for Total Airport Performance Assessment

Konstantinos Zografos, Department of Management Science and Technology, Athens University of Economics and Business, Evelpidon 47A and Lefkados 33, 11362, Athens, Greece, translog@aueb.gr, *Michael Madas*

The airport decision making requires advanced modelling capabilities to support airport planning decisions and capture the trade-off aspects between the measures of airport effectiveness. Airport stakeholders lack modelling capabilities to tackle with the airport performance trade-off's. The objective of this paper is threefold: i) to introduce the operational concept for an integrated Decision Support System for total airport performance analysis, ii) to describe the system architecture and implementation features, and iii) to demonstrate the decision support capabilities of the system.

2 - An optimization model for assessing airport's design aspects related to on the ground aircraft's routing

Esteve Codina, Statistics and Operational Research, UPC, Edifici C5, Desp 216 Campus Nord, 08034, Barcelona, Spain, esteve.codina@upc.edu, *Ángel Marín*

The design of airport configurations is considered after the main tactical and aeronautical decisions have already been made. At this point, on ground's routing and scheduling of aircraft play a key role in the airport's performance. The model is focused on decisions regarding the location of several types of dependencies and their relationship with routing of aircraft on the ground. Examples are location of corridors and waiting points for engine's heating, access points to take-off runways etc. They have a remarkable impact on taxiing operations, delays and airport's capacity.

3 - Scheduling on Terminal Manoeuvring Area

Ángel Marín, Matemática Aplicada, Universidad Politécnica de Madrid, E.T.S.Ingenieros Aeronáuticos, Plaza Cardenal Cisneros, 3, 28040, Madrid, Spain, amarin@dmae.upm.es

Scheduling at Terminal Manoeuvring Area (TMA) is studied by modules: Arrival-Departure Management (A-DMAN), Taxi Planning (TP) and Gate Assignment (GA). The modelling coordinates aircrafts on the prefixed routes, using a multiobjective function and airport and operational constraints to approach at A-DMAN. The GA is modelled trying to minimize a multiobjective function with the passenger delay and the gate idle variance. The TP conflicts have been taken account also using scheduling. The computational experience has been realized using simulated and actual data from Madrid-Barajas airport.

■ TE-13

Tuesday, 16:00-17:30

TRANS Oddi 206

Routing and Location Problems (SADERYL2)

Stream: Vehicle Routing

Invited session

Chair: *Jaume Barcelo*, Statistics and Operations Research, Tecnical University of Catalonia, Edifici Omega, Jordi Girona, 1-3, 8034, Barcelona, Catalonia, Spain, jaume.barcelo@upc.es

Chair: *Juan José Salazar González*, Estadística e Investigación Operativa, Universidad de La Laguna (Tenerife), Av. Astrofísico Francisco Sánchez, s/n, 38271, La Laguna, Tenerife, Spain, jjsalaza@ull.es

1 - Combined route capacity and route length models for unit demand vehicle routing problems

Maria Teresa Godinho, Departamento de Matemática, Instituto Politécnico de Beja - CIO, Rua Afonso III,1, 7800-050, Beja, Portugal, mtgodinho@estig.ipbeja.pt, *Luis Gouveia*, *Thomas Magnanti*

We consider two classes of models for the unit-demand asymmetric Capacitated Vehicle Routing problem: (a) capacitated models and (b) hop-constrained models. We show that combining features from (a) and (b) leads to formulations with a tight linear programming bound (LPB). We examine the asymmetric travelling salesman problem, and show that by using the ideas developed for the CVRP we can derive models with a LPB tighter than the LPB of the standard Dantzig, Fulkerson and Johnson (1954) formulation

2 - On a mixed 0-1 separable quadratic program for water irrigation scheduling

Juan Francisco Monge, Centro de Investigación Operativa, Universidad Miguel Hernández, 3202, Elche, Alicante, Spain, monge@umh.es, *Laureano Fernando Escudero*, *Mercedes Landete*, *Almiñana Marc*, *Joaquín Sánchez-Soriano*, *Alejandro Rabasa*

We present a mixed 0-1 separable quadratic program for the optimization of the water resources management for agriculture irrigation usage in a daily basis. Its functionalities are as follows: Dynamic planning of the daily irrigation scheduling for a given land area, by considering the irrigation network topology, water flow technical conditions for optimizing the usage of the available stored water in the reservoirs; and Feasibility analysis of a given daily partial irrigation schedule. Some computational experience on a large-scale real-life problem is reported.

3 - New results with integer formulations for the capacitated location routing problem

Enrique Benavent, Estadística e Investigación Operativa, Universitat de València, c/ Dr. Moliner, 50, 46100, Burjassot, Valencia, Spain, Enrique.Benavent@uv.es, *Jose M. Belenguer*, *Christian Prins*, *Roberto Wolfler Calvo*, *Caroline Prodhon*

Tackling several decision levels when solving a problem may reduce the overall costs. The Location Routing Problem deals with this consideration integrating simultaneously location and routing decisions. This paper presents two formulations of the Location Routing Problem with capacities on routes and depots. Some valid inequalities are introduced and computational results obtained using these formulations are presented.

4 - A simulation based decision support system for city logistics applications

Jaime Barcelo, Statistics and Operations Research, Universitat Politècnica de Catalunya, Campus Nord, Modul C5, Office 215, Jordi Girona Salgado 1-3, 08034, Barcelona, Spain, barcelo@aimsun.com

This paper reports on a modeling framework based on a DSS with a Model Base, with the family of models and algorithms for the related problems, a GUI, for data I/O, select the model for the problem, apply the ad hoc algorithm, visualize problem and results, and a dynamic simulation model (AIMSUN) tracking individually the vehicles, emulating monitoring of vehicles in real time fleet management systems, gathering dynamic data emulating the data collection from equipped vehicles for a "Dynamic Router and Scheduler" to determine which vehicle will be assigned the new service and its new route.

■ TE-14

Tuesday, 16:00-17:30

PROD Arnag 101

Revenue Management Concepts in Manufacturing and Distribution

Stream: Operations Management / Revenue Management

Invited session

Chair: *Moritz Fleischmann*, RSM Erasmus University, PO Box 1738, 3000DR, Rotterdam, Netherlands, MFleischmann@fbk.eur.nl

1 - Maximizing Profits For Products Sold Through Competitive Bids

Mark Ferguson, Georgia Tech College of Management, Georgia Institute of Technology, 800 West Peachtree St. NW, 30307, Atlanta, Georgia, United States, mark.ferguson@mgt.gatech.edu

We investigate the competitive bid arrangement which is a common method for selling products or services in business-to-business environments. By using historical bid information, we show how a firm can build a bid-response curve that can then be used to optimize profits.

2 - Time slot management for e-fulfillment operations

Niels Agatz, Decision and Information Science, RSM University, Burg. Oudlaan 50, 3000DR, Rotterdam, Netherlands, nagatz@rsm.nl, Moritz Fleischmann, Jo van Nunen

More and more grocery retailers are adding an Internet channel to their portfolio. Delivering groceries to customers' homes in a cost-effective manner is one of the major challenges for these retailers. Customers place orders online and can choose from a menu of time windows and corresponding delivery fees for delivery. In this contribution, we address the retailer's decision regarding which delivery time windows to offer to a specific customer. The question is which subset of all windows to make available to the customers in each zip code.

3 - Dynamic Pricing in the Warehouse Scheduling Problem

Sandra Transchel, Department of Logistics, University of Mannheim, Schloss, S233, 68161, Mannheim, Germany, sandra.transchel@bwl.uni-mannheim.de, Stefan Minner

We analyze a joint multiproduct warehouse scheduling inventory and pricing problem with limited storage capacity. Two variants of the problem, static and continuous price adjustments are considered within a common cycle inventory replenishment framework. Customer demand is modelled by a price response function. The problem is to maximize the average profit by choosing the optimal pricing strategy, lot-size, and the optimal ordering sequence. We give structural properties and report on the results of a numerical study to demonstrate differences between dedicating and sharing warehouse capacity.

4 - Revenue Management in a Manufacturing Environment

Moritz Fleischmann, RSM Erasmus University, PO Box 1738, 3000DR, Rotterdam, Netherlands, MFleischmann@fbk.eur.nl, Herbert Meyr, Dave Pyke

Revenue management has been widely and successfully exploited in both service industries and in retailing. Applications by manufacturing firms are yet emerging. In this contribution, we discuss how to tailor revenue management approaches to the particular characteristics of manufacturing environments. Integration of cost and revenue effects is a key requirement. We explain how to achieve this integration in different supply chain settings, notably for different order decoupling points and different planning horizons. We also point out potential links with advanced planning systems.

■ TE-15

Tuesday, 16:00-17:30
PROD Arnag 201

Supply Chain Management III

Stream: Supply Chain Management (c)

Invited session

Chair: Maria Isabel Salema, CMA-FCT, UNL, Monte da Caparica, 2825-114, Caparica, Portugal, isabel.salema@ineti.pt

1 - A single formulation for the design and planning of green supply chains

Maria Isabel Salema, CMA-FCT, UNL, Monte da Caparica, 2825-114, Caparica, Portugal, isabel.salema@ineti.pt, Ana Paula Barbósa-Póvoa, Augusto Novais

Original equipment manufacturers are expected to have active participation in end-of-life management. They have to re-think their supply chains (SC) to account for product return. We propose a model integrating design and planning aspects of green SC in a single formulation. A graph approach is used as modelling methodology. We consider that products may be associated with nodes and arcs. Modeling of time further generalises the model leading to a dynamic multiproduct network with product return. An industrial based example is solved. Model generality is confirmed with good performance results.

2 - Dynamic Decision-Making in a Decentralized Price-Setting Supply Chain

Tamer Boyaci, Faculty of Management, McGill University, 1001 Sherbrooke Street West, H3A1G5, Montreal, Quebec, Canada, tamer.boyaci@mcgill.ca

We study a decentralized two-echelon supply chain operating under a wholesale price contract. We assume a two-period setting with price-sensitive stochastic and correlated demands, non-stationary parameters, and limited, but possibly more than one, pricing, replenishment and wholesale pricing (contracting) opportunities. We develop and analyze five models with increasing degrees of recourse decision possibilities. We offer insights on the value of pricing, ordering and contracting recourse flexibilities from the viewpoint of the two channel partners.

3 - A Markov decision model to evaluate reverse logistics outsourcing

Sarah Ryan, Industrial Mfg. Sys. Engineering, Iowa State University, 2019 Black Engineering Building, 50011-2164, Ames, IA, United States, smryan@iastate.edu, Marco Serrato, Juan Gaytan

Many firms outsource reverse logistics processes for handling returned products. We analyze a Markov decision model to examine the economic justification for this. Under certain cost relationships and depending on patterns of sales and returns over the product lifecycle, it may be optimal to outsource reverse logistics when cumulative returns exceed a threshold level. The model also supports the hypothesis, derived from empirical observation, that outsourcing is more likely to occur for products with short life cycles and highly variable return volumes.

4 - Robust Supply Chain Management

Edric Margono, Centre for Process Systems Engineering, Imperial College London, Prince Consort Road, SW7 2AZ, London, United Kingdom, edric.margono@imperial.ac.uk, Nilay Shah

Stock levels are a key performance measure of supply chains. While computer tools have allowed better understanding of stock level movements and in making better decisions, two problems have persisted: 1) To be a truly generic tool that can be easily used on any system; 2) The generation of demand inputs with similar characteristics to real demand data. This work tackles the problem by capturing key details of a supply chain and using Monte-Carlo simulations created by generating different sets of projected demand data via a cumulative error function between the forecasts and demand.

■ TE-16

Tuesday, 16:00-17:30
PROD Arnag 301

Scheduling in Practice

Stream: Scheduling

Invited session

Chair: Vasilis Friderikos, Centre for Telecommunications Research, King's College London, 26-29 Drury Lane, WC2B 5RL, London, United Kingdom, vasilis.friderikos@kcl.ac.uk

1 - 3D Simulation based Industrial Production Schedule Optimisation

Craig Lybeck, Visual Components Oy, Korppaanmäentie 17 CL 6, 00300, Helsinki, Finland, craig.lybeck@visualcomponents.com, Heike Krug

Rarely do production schedule optimisation tools find there way to the factory managers office where production plan affecting decisions are made on a daily basis. This papers looks at how an intuitive 3D Simulation tool is combined with a multiconstraint schedule optimisation tool to provide the Plant Manager with a simple to use but highly effective planner for daily operations. A case study of the toolset application to an Electronics Contract Manufacturer will highlight the potential to increase production efficiency for all types of businesses from SMEs to large organisations.

2 - A Neural New Network Based Construction Heuristic for the Examination Timetabling Problem

Mark McGreevy, Computer Science, Queens University Belfast, Queens University, Belfast, BT 7 1NN, Belfast,

N.Ireland, United Kingdom, m.mcgreevy@qub.ac.uk,
Patrick Corr, Barry McCollum

Building on the heuristic ordering technique, where events are ordered by decreasing scheduling difficulty, the NN allows a multi-criteria approach to be used. The difficulty of each event is assessed on several characteristics, and the placement order reviewed and modified as each event is scheduled; a necessary step since the timetable and constraints are altered as events are placed. Our approach uses a Kohonen network and is shown to have wide applicability. Results are presented for a range of problems including standard benchmark datasets and the University of Nottingham 1994 dataset.

3 - Cyclical Staff Scheduling And Workforce Allocation Application For A Call Center

Kadir Ertogral, Systems Engineering Department, King Fahd University of Petroleum and Minerals, Box 1420, 31261, Dhahran, Saudi Arabia, ertogral@ccse.kfupm.edu.sa

Staff scheduling problems have been extensively studied in the literature. In this work we present a comprehensive approach in solving staff scheduling and workforce assignment problem of a local call center which belongs to a major telecommunication company. The approach has two main parts. First part is data analysis, queuing approximation, and simulation analysis for finding hourly staff requirements for particular performance measures. Second part involves optimizing workforce assignment and scheduling under different scenarios, given the hourly requirements obtained in the first part.

4 - Joint Scheduling and Routing in Mesh Networks

Vasilis Friderikos, Centre for Telecommunications Research, King's College London, 26-29 Drury Lane, WC2B 5RL, London, United Kingdom, vasilis.friderikos@kcl.ac.uk, Katerina Papadaki

Routing and scheduling in wireline networks is performed independently. Due to the inherent coupling between functionalities on different layers of the protocol stack such an approach is suboptimal for wireless networks. We formulate the joint routing and scheduling problem for wireless mesh networks as a mathematical program. Decentralized approaches for solving this problem are discussed. Numerical investigations that depict the performance improvement of the joint design with respect to baseline solutions, where scheduling and routing are performed independently, are presented.

■ TE-17

Tuesday, 16:00-17:30

PROD Arnag 303

Cutting and Packing IV

Stream: Cutting and Packing

Invited session

Chair: Jose Fernando Oliveira, FEUP / INESC, Universidade do Porto, Rua Dr. Roberto Frias, 4200-465, Porto, Portugal, jfo@fe.up.pt

1 - Solving the Variable Size Bin Packing Problem with Discretized Formulations

Francisco Saldanha-da-Gama, CIO/DEIO, University of Lisbon, FCUL-DEIO, Bloco C6, Piso 4, 1749-016, Lisbon, Portugal, fsgama@fc.ul.pt, Luis Gouveia, Isabel Correia

We study the problem where bins of different capacities and costs are available for packing the items. The objective is to pack all the items minimizing the total cost. We propose/discuss several formulations. One considers explicitly the class of the bins used. The other uses a so-called discretized model reformulation technique. New valid inequalities suggested by the discretized variables are proposed. Computational results are presented showing that the valid inequalities proposed enhance the linear programming relaxation bound and may be extremely helpful solving the problem optimality.

2 - Clique-based facets for the precedence constrained knapsack polyhedron

Christopher Fricke, Dept. of Mathematics and Statistics, University of Melbourne, Parkville, 3010, Melbourne,

Victoria, Australia, fricke@ms.unimelb.edu.au, Natasha Boland, Gary Froyland, Renata Sotirov

We consider a knapsack problem with precedence constraints imposed on pairs of items, known as the precedence constrained knapsack (PCK) problem. This problem has applications in management and machine scheduling, and also appears as a subproblem in decomposition techniques for network design and other related problems. We present a new approach for determining facets of the PCK polyhedron based on clique inequalities. A comparison with existing techniques that use a lifting of cover inequalities for the PCK problem will also be presented, along with some preliminary computational results.

3 - The Prospect Algorithm, an on-line algorithm for bin-covering problems with known item distributions.

Pall Jensson, Engineering Faculty, University of Iceland, Hjardarhagi 4, 107, Reykjavik, Iceland, pall@hi.is, Agni Asgeirsson

The Prospect Algorithm (PA) works on the on-line bin-covering problem, how to create packs of minimum weight with minimal overflow. The idea behind the PA is to use information on the item distribution to estimate how easy it is to fill a bin with small overflow as a function of the empty space left in it. This estimate is then used to determine where to place the items, so that all active bins either stay easily fillable, or are finished with small overflow. Modifications to the PA are also discussed, how it can cope with additional constraints on the type of packs it produces.

■ TE-18

Tuesday, 16:00-17:30

PROD Arnag 304

Planar location

Stream: Locational Analysis

Invited session

Chair: Barbara Pfeiffer, Institute of Applied Mathematics, University of Erlangen-Nuremberg, Martensstr. 3, 91058, Erlangen, Germany, pfeiffer@am.uni-erlangen.de

1 - Solving the uncapacitated multisource Weber problem by neural algorithms

Enrique Dominguez, Computer Science, E.T.S.I.Informatica - University of Malaga, Campus Teatinos s/n, 29071, Malaga, Spain, enriqued@lcc.uma.es, Jose Muñoz

The main difficulty in solving the uncapacitated multisource Weber problem arises from the fact that the objective function is nonconvex and contains a large number of local minima. Many heuristics have been proposed as well as a few exact algorithms. A drawback is that most traditional heuristics give poor results when the number of facilities to locate is large. New heuristics which give consistently best results, on average, in a moderate computing time are needed to solve quickly large problems and to provide good initial solutions for exact algorithms.

2 - A theoretical framework for modeling asymmetric and non-uniform distance functions

Hérica Sánchez, Institute of Engineering, National Autonomous University of Mexico, Edificio 12 del Instituto de Ingeniería, Circuito exterior, Ciudad Universitaria, 04510, Mexico City, Mexico, hsanchezl@iingen.unam.mx, Servio Tulio Guillén

We propose a theoretical framework for modeling distance functions in an n-dimensional Euclidean space such that, for each ordered pair of distinct points there exists at least one "shortest path" connecting them. Our distance function may refer to transportation cost, travel time, energy expended, etc. We introduce two new concepts: arc induced by a distance function, and premetric. A premetric, unlike metrics, can be asymmetric and non-positive definite, and unlike Lp metrics, it can be non-uniform. We show that a premetric can be obtained by solving a problem of the calculus of variations.

3 - Obtaining the efficient set of biobjective competitive facility location and design problems

Jose Fernandez, Estadística e Investigación Operativa, Universidad de Murcia, Campus de Espinardo, 30100, Espinardo - Murcia, Spain, josefdez@um.es, *Boglárika Tóth*

A franchise wants to set up a new outlet in the plane. Both the location and design of the new facility are to be found. We consider two biobjective problems. In the first one, the objectives are O1: maximization of the profit obtained by the franchisor and O2: maximization of the profit obtained by the franchisee. In the second one, O1 and O3: minimization of the cannibalization suffered by the chain-owned facilities. We compare the performance of two interval based methods (which obtain an outer approximation of the efficient set of any biobjective problem) when applied to those problems.

4 - Varying Environment Location Problems

Barbara Pfeiffer, Institute of Applied Mathematics, University of Erlangen-Nuremberg, Martensstr. 3, 91058, Erlangen, Germany, pfeiffer@am.uni-erlangen.de, *Kathrin Klamroth*

The class of varying environment location problems is tailor-made for applications involving regions with heterogeneous travel properties. In particular, it models problems that are characterized by switches between continuous and discrete travel modes. So the class bridges the gap between the typically distinguished continuous and network models. Its advantages are realistic distance functions and reduced storage costs due to a regionally refined discretization. The problem is solvable in polynomial time for Euclidean and block norms. For block norms exact solution methods are derived.

■ TE-19

Tuesday, 16:00-17:30

PROD Arnag 311

Robust Project Scheduling

Stream: Project Management and Scheduling

Invited session

Chair: *Erik Demeulemeester*, Applied Economic Sciences, Katholieke Universiteit Leuven, Naamsestraat 69, B-3000, Leuven, Belgium, erik.demeulemeester@econ.kuleuven.ac.be

1 - Proactive resource allocation heuristics for robust project scheduling

Filip Deblaere, Applied Economic Sciences, Katholieke Universiteit Leuven, Naamsestraat 69, 3000, Leuven, Belgium, filip.deblaere@econ.kuleuven.be, *Erik Demeulemeester*, *Willy Herroelen*

The resource-constrained project scheduling problem (RCPSP) involves the determination of a predictive schedule of the project activities satisfying the precedence relations and the renewable resource constraints while minimizing the project duration. During execution of the project, activity duration disruptions may disturb this schedule. The objective of our research is to develop procedures for allocating resources to activities of a given schedule in order to maximize its stability. We propose IP based heuristics and report on computational results obtained on a set of benchmark problems.

2 - Generating robust project schedules with explicitly inserted idle time

Olivier Lambrechts, Decision Sciences and Information Management, Katholieke Universiteit Leuven, Naamsestraat 69, 3000, Leuven, Belgium, Olivier.Lambrechts@econ.kuleuven.be, *Erik Demeulemeester*, *Willy Herroelen*

We consider resource constrained project scheduling in an environment characterized by unforeseen resource breakdowns. Our objective is to optimize schedule stability. Proactive strategies based on generating a preschedule can be used to guarantee this stability. We propose a metaheuristic to generate these robust baseline schedules. The objective function is substituted with a surrogate measure in order to avoid the computationally intensive evaluation by means of simulation. By allowing the generation of non-active schedules, we encourage the creation of time buffered schedules.

3 - Heuristic procedures for robust project scheduling: a reactive approach

Stijn Van de Vonder, Applied Economics, Katholieke Universiteit Leuven, Naamsestraat 69, 3000, Leuven, Belgium, Stijn.VandeVonder@econ.kuleuven.be, *Francisco Ballestin*, *Erik Demeulemeester*, *Willy Herroelen*

Robust project scheduling creates a baseline schedule that is as much as possible protected against disruptions (proactive scheduling) and deploys reactive scheduling procedures to revise this schedule when necessary. Most existing reactive policies concentrate on minimizing the expected makespan but may result in poor schedule stability. We will introduce several stable heuristic reactive scheduling procedures, including priority list policies, heuristic solutions for the weighted earliness-tardiness problem and a sampling approach.

■ TE-20

Tuesday, 16:00-17:30

HEUR Arnag 422

Metaheuristic methods

Stream: Metaheuristics

Invited session

Chair: *Marc Sevaux*, EU/ME, University of South Brittany, Lester - Cnrs Fre 2734, Centre de Recherche - BP 92116, 56321, Lorient, France, marc.sevaux@univ-ubs.fr

1 - A metaheuristic method for determining cost-efficient inspection strategies for multistage production systems

Sofie Van Volsem, Dept. of Environment, Technology and Technology Management, University of Antwerp, Prinsstraat 13, 2000, Antwerp, Belgium, sofie.vanvolsem@ua.ac.be

An optimal inspection strategy for multistage production systems (MSPS) has to decide on i) inspection location ii) sample size and iii) acceptance limits, in order to minimize total expected inspection costs. Simplified, more and tighter inspection will induce higher product quality, but will also result in higher costs of inspection. Quantifying this trade-off and thus finding an economic optimum is at the heart of this research. Thereto, a metaheuristic solution approach for jointly optimizing i, ii and iii is presented, consisting of an evolutionary algorithm combined with simulation.

2 - A hybrid variable neighborhood search algorithm for a parallel machine scheduling problem

Kenneth Sörensen, Faculty of Applied Economics, University of Antwerp, Prinsstraat 13, 2000, Antwerp, Belgium, kenneth.sorensen@ua.ac.be, *Marc Sevaux*

We study a parallel machine scheduling problem of which the objective function is to minimize the weighted number of late jobs. This problem is NP-hard and appears in several real-life applications and particularly in finance and production management. To date, only a limited number of methods have been proposed for this problem, most of them unable to solve large problems.

To find good solutions of (large instances of) this problem, we develop a variable neighbourhood search (VNS) algorithm, in which a tabu search (TS) algorithm is embedded as a local search operator.

3 - Continuous VNS: comparison with 'Premium Solver Platform' methods

Vera Kovacevic-Vujcic, Faculty of Organizational Sciences, University of Belgrade, Jove Ilica 154, 11040, Belgrade, Serbia, Serbia and Montenegro, verakov@fon.bg.ac.yu, *Nenad Mladenovic*, *Mirjana Cangalovic*, *Milan Drazic*

This paper presents test results of a Variable Neighborhood Search (VNS) metaheuristic for continuous constrained global optimization. The method is based on an exterior point penalty function technique which combines sequential and exact penalty transformations. Results are compared with some solvers from Premium Solver Platform.

■ TE-21

Tuesday, 16:00-17:30

HEUR Arnag 423

Nonlinear Boundary Value Problems II

Stream: Dynamical and Anticipatory Systems

Invited session

Chair: *Irena Rachunkova*, Faculty of Science, Palacky University, Tomkova 40, 77900, Olomouc, Czech Republic, rachunko@inf.upol.cz

Chair: *Milan Tvrdy*, Mathematical Institute, Academy of Sciences of Czech Rep., Zitna 25, CZ 115 67, Prague, Czech Republic, tvrdy@math.cas.cz

1 - Resonance and nonlinearity

Jean Mawhin, Department of Mathematics, Universite Catholique de Louvain, Louvain-la-Neuve, Belgium, mawhin@math.ucl.ac.be

Resonance is one of the most versatile concepts of science. It is present under various aspects in astronomy, physics, technology, musics, and, of course, mathematics. At resonance, the response of a vibrating system to a periodic excitation becomes unbounded; resonance can destroy the stability of a bridge or of the solar system. The mathematical study of resonance is closely linked to the concept of spectrum, a name coined in optics by Newton in 1672. The lecture describes some recent results relating spectra and nonlinearities in differential equations.

2 - Nonlocal Maximum Principles

Ricardo Roque, Área de Matemática, Instituto Superior de Engenharia de Lisboa, Rua Conselheiro Emídio Navarro, 1, 1959-007, Lisbon, Portugal, roque@dec.isel.ipl.pt, *Luis Sanchez*

We show that the Green operator associated with a second order nonlocal singular ODE still works for some special right-hand sides, and prove some maximum principles using this Green operator. Finally, we find solutions for a nonlocal elliptic boundary value problem, using this maximum principles applied to upper and lower solutions.

3 - Periodic solutions of dissipative systems

Jan Andres, Mathematical Analysis, Palacky University, Tomkova 40, 77900, Olomouc, Czech Republic, andres@inf.upol.cz

It is well-known that, in the case of uniqueness, dissipative (in the sense of N. Levinson) systems of ODEs in Euclidean spaces, which are periodic in time, possess (harmonic) periodic solutions. In our talk, we shall present at first an extremely simple proof of this fact. Then we shall also deal with a lower estimate of the number of subharmonics and their localization (e.g. problems with obstacles) by means of various (relative) Nielsen numbers for fixed and periodic points. Finally, we shall consider the situation in the lack of uniqueness.

4 - Singular problems arising in the theory of shallow membrane caps

Irena Rachunkova, Faculty of Science, Palacky University, Tomkova 40, 77900, Olomouc, Czech Republic, rachunko@inf.upol.cz

We investigate solvability of singular nonlinear second order differential equations subjected to mixed boundary conditions at the endpoints of a compact real interval. The nonlinearity in the differential equation can change its sign and it has both time and space singularities. We are interested in solutions positive inside the basic interval. Our approach is based on a construction of a sequence of auxiliary regular problems, on a generalized lower and upper functions method and on limit processes.

■ TE-22

Tuesday, 16:00-17:30

OPT Adal 050

Representation of the Nondominated Set II

Stream: Multiple Objective Optimization

Invited session

Chair: *Ralph E. Steuer*, Terry College of Business, University of Georgia, Department of Banking and Finance, Brooks Hall, 30602-6253, Athens, GA, United States, rsteuer@uga.edu

Chair: *Margaret Wiecek*, Department of Mathematical Sciences, Clemson University, Martin Hall O-208, 29634, Clemson, SC, United States, wmalgor@clemson.edu

1 - Multi-Objective Optimization, the Pareto Front and Beyond: A Practitioner's View

Martina Hasenjäger, Honda Research Institute Europe GmbH, Carl-Legien-Str. 30, 63073, Offenbach am Main, Germany, martina.hasenjaeger@honda-ri.de, *Bernhard Sendhoff*

In practical approaches to multi-objective optimization it is often not possible to obtain the Pareto front in one step. In general also objectives and targets are subject to change based on the experience gained throughout the project. We propose to exploit this kind of project dynamics by constructing a patchwork-style Pareto front built from the complete available data and by providing additional tools for the visualization and further analysis of these Pareto solutions. As a demanding engineering application example, we will discuss the design optimization of a gas-turbine stator blade.

2 - A Hybrid Method For Approximating Pareto Frontier

Yeboon Yun, Kagawa University, 2217-20 Hayashicho, 761-0396, Takamatsu, Kagawa, Japan, yun@eng.kagawa-u.ac.jp, *Hiroataka Nakayama*, *Min Yoon*

Many practical problems such as engineering design need tremendous time and cost in evaluating the value of function. In those problems, it is important to reduce the number of function evaluation for obtaining a solution. And, the problems are formulated as multi-objective optimization problem. In this research, we propose a hybrid technique with prediction and approximation by using computational intelligence method of machine learning algorithm and genetic algorithm for finding Pareto optimal solutions. Also, the effectiveness of our method will be shown through several numerical examples.

3 - Preference-based Modification of the Nondominated Set in Multiobjective Programming

Margaret Wiecek, Department of Mathematical Sciences, Clemson University, Martin Hall O-208, 29634, Clemson, SC, United States, wmalgor@clemson.edu

MCDM has been relying on the concept of Pareto optimality and the resulting Pareto-nondominated set as the set of candidates for a final preferred solution. We propose to elicit preferences from the decision maker (DM) and modify the Pareto set to a nondominated set that is meaningful for the DM. We present preference models such as relative importance of criteria, equitability of outcomes, additive or multiplicative approximate nondominance of outcomes, and motivate their use in decision making. Examples from the area of engineering design are included.

■ TE-23

Tuesday, 16:00-17:30

OPT Adal 051

Approximation Algorithms

Stream: Combinatorial Optimization (c)

Invited session

Chair: *Daniel Vanderpooten*, LAMSADE - Université Paris Dauphine, Place de Marechal de Lattre de Tassigny, 75775, Paris, France, vdp@lamsade.dauphine.fr

1 - Algorithmic approach for obtaining a lower bound on a problem's complexity

Amir Sapir, Dept. of Computer Science, Ben-Gurion University of the Negev, Ben-Gurion rd. 1, 84105, Beer Sheva, Israel, amirsa@cs.bgu.ac.il, *Daniel Berend*

Upper bound analysis of an algorithm yields also a (not necessarily tight) upper bound for the corresponding problem. However, when it comes to lower bound analysis of an algorithm, it is not the case: we cannot infer on a lower bound for the problem.

Despite the above, we present an algorithmic approach establishing a lower bound for a particular problem, by scanning a large set of initial configurations and "undesired" sequences of moves which originate from them.

Eventually, we present considerations avoiding the need to check most of the configurations.

2 - Solving the concave cost supply scheduling problem

Bruce Golden, Decision Information Technologies, University of Maryland, 4339 Van Munching Hall, College Park, MD 20742, 20742, College Park, MD, United States, bgolden@rhsmith.umd.edu, *Edward Wasil*, *Xia Wang*

We consider two cases of the concave cost supply scheduling problem. In case one, there are multiple providers and one manufacturing unit. A genetic algorithm selects a subset of providers. The quantity provided is determined by a greedy algorithm. In case two, there are multiple manufacturing units and multiple providers.

3 - Min-max (regret) versions of some combinatorial optimization problems: complexity and approximation

Cristina Bazgan, LAMSADE, Université Paris Dauphine, Place de Marechal de Lattre de Tassigny, 75775, Paris, France, bazgan@lamsade.dauphine.fr, *Hassene Aissi*, *Daniel Vanderpooten*

We review and extend complexity results for and min-max and min-max regret versions of some combinatorial optimization problems: shortest path, spanning tree, cut, s-t cut, knapsack. Since most of these problems are NP-hard, we investigate, for the first time in the literature, the approximability of these problems.

4 - Polynomial algorithms for some Euclidean TSP and its generalizations

Edward Gimadi, Discrete Analysis and Operations Research, Sobolev Institute of Mathematics, Prospekt Akad. Koptiyuga, 4, 630090, Novosibirsk, Russian Federation, gimadi@math.nsc.ru

We consider Euclidean TSP, which assumes that it is necessary to pass n points in k -dimensional Euclidean space. Polynomial approximation algorithms for solving max ESTP are presented. A generalization of the problem is m -Peripatetic Salesman Problem (when it is necessary to find multiple edge-disjoint Hamiltonian circuits). For this problem performance guarantees of the algorithms are analyzed. The algorithms are shown to be asymptotically optimal for special cases of the problems. The work was supported by projects 05-01-00395 (RFBR) and 04-77-7173 (INTAS).

■ TE-24

Tuesday, 16:00-17:30

OPT Adal 052

Dynamical Systems and Supply Chain Management

Stream: Dynamical and Anticipatory Systems

Invited session

Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, Odtü, 06531, Ankara, Turkey, gweber@metu.edu.tr

Chair: *Daniel M. Dubois*, UER Operations, HEC Management School - University of Liege, Office: Institute of Mathematics, B37, Grande Traverse 12., B-4000, Liège, Belgium, daniel.dubois@ulg.ac.be

1 - Optimal investments in the reduction of production costs

Alberto A. Pinto, Pure Mathematics, Faculdade de Ciências da Universidade do Porto, Rua do Campo Alegre, 687, 4169-007, Porto, Portugal, aapinto@fc.up.pt, *Fernanda A. Ferreira*, *Flávio Ferreira*

We present new deterministic and stochastic dynamics on the production costs of Cournot competitions, based on R&D investment strategies with and without uncertainty. We study the sensitivity of the Nash investment equilibrium to the variation of the initial production costs and also to the differentiation of the goods. We also analyse the loss in the profits of one firm when this firm decides not to invest in R&D projects and the other firm uses the best investment strategy. The uncertainty deviates the mean of the stochastic trajectories from the deterministic trajectories.

2 - Static and Dynamic Transportation Network Equilibrium Reformulations of Electric Power Supply Chain Networks with Known Demands

Anna Nagurney, Department of Finance and Operations Management, University of Massachusetts, Isenberg School of Mgmt, 01002, Amherst, MA, United States, nagurney@gbfin.umass.edu, *Zugang Liu*, *Monica-Gabriela Cojocar*, *Patrizia Daniele*

We consider critical infrastructure networks in the form of electric power supply chains in which the demands are known. We model the behavior of the decision-makers and derive the optimality conditions, along with the equilibrium conditions. We then establish the equivalence between electric power supply chain network equilibrium problems with known demands and transportation network equilibrium problems. We exploit this equivalence and the recent theoretical results in the unification of evolutionary variational inequalities and projected dynamical systems to construct a dynamic model.

3 - Modeling of supply network dynamics

Petr Fiala, Dept. of Econometrics, University of Economics Prague, W.Churchill Sq. 4, 13067, Prague 3, Czech Republic, pfiala@vse.cz

Supply chain management has generated a substantial amount of interest both by managers and researchers. Supply chain management is more and more affected by network and dynamic business environment. The paper is devoted to modeling of supply network dynamics. There are some approaches to model and analyze the supply dynamics. The combination of network structure modeling and simulation of dynamic behavior of units in supply network can be a powerful instrument of performance analysis of supply networks. Multicriteria analysis of supply network performance is proposed.

4 - The Order-Up-To policy using divergence to control the bullwhip problem

Fernanda Strozzi, Quantitative Methods Institute, Cattaneo University-LIUC, Corso Matteotti, 22., 21053, Castellanza, Varese, Italy, fstrozzi@liuc.it, *Jose-Manuel Zaldivar*, *Carlo Noe*

In this work a new control technique based on the divergence of the system is applied to the order policy for reducing the bullwhip effect in the supply chain. The results are then compared with the ones obtained by applying a proportional controller. The advantage in using divergence is in the time in advance in which the actors have the possibility to react. Moreover the reduction of the bullwhip not always correspond to a reduction of the costs we are interested in. The divergence control is also able to be applied as an optimization tool of the management costs of the supply chain.

■ TE-25

Tuesday, 16:00-17:30

OPT Adal I-111

Game Theory and Nash Equilibrium

Stream: Mathematical Programming

Invited session

Chair: *Flip Klijn*, Instituto de Análisis Económico (CSIC), Campus UAB, 08193, Bellaterra (Barcelona), Spain, flip.klijn@uab.es

1 - An Inspection Game with Multiple Inspectees

Ryusuke Hohzaki, Dep. of Computer Science, National Defense Academy, 1-10-20 Hashirimizu, 239-8686, Yokosuka, Kanagawa, Japan, hozaki@cc.nda.ac.jp

This paper deals with a nonzero-sum inspection game with one inspector and several inspectees. Each inspectee country makes a decision from the standpoint of his national interest while the inspector distributes staff to inspectee facilities to detect illegal behavior. We propose a method to find a Nash equilibrium for the game, which could help the inspector make an effective plan about how to assign staff to individual suspect facilities in those countries. This paper extends Avenhaus' two-inspectee model to a multi-inspectee one with a dispatch of inspection staff.

2 - A non-cooperative approach to the multicriteria minimum cost spanning tree problem.

Amparo Mármol, Economía Aplicada III, Universidad de Sevilla, Avd. Ramon y Cajal, 1, 41018, Sevilla, Spain, amarmol@us.es, *Francisco Ramon Fernandez, Miguel A. Hinojosa, Justo Puerto*

Multicriteria minimum cost spanning tree problems concern the construction of a tree which provides a connection with the source for every node of the network in those cases in which the costs associated to the construction are multidimensional. The goal of this paper is to address the sharing cost problems associated to these situations. We associate to each multicriteria spanning tree problem a non-cooperative multicriteria game and we prove that the cost allocation given by the Bird's rule provides a Nash equilibrium for this game.

3 - Bayesian Stackelberg competition

Flávio Ferreira, Mathematics, ESEIG - Instituto Politécnico do Porto, R. D. Sancho I, 981, 4480-876, Vila do Conde, Portugal, flavioferreira@eseig.ipp.pt, *Fernanda A. Ferreira, Alberto A. Pinto*

We consider a dynamic model of duopoly in which a leader firm moves first and a follower firm moves second, supposing that each firm has two different technologies, and chooses one of them following a binary probability distribution. The utilization of one or the other technology affects the unitary production cost. Furthermore, we let the firms produce a differentiated good. We determine the Bayesian Nash equilibrium. In general, the leading firm profits more than the other one, due to its leadership advantage. However, we show that, in our stochastic model, the opposite can happen.

4 - Stable Nash Equilibria in College Admissions with Truncated Preferences

Flip Klijn, Instituto de Análisis Económico (CSIC), Campus UAB, 08193, Bellaterra (Barcelona), Spain, flip.klijn@uab.es, *Guillaume Haeringer*

We consider the allocation of college positions to students through the Deferred Acceptance algorithm (Gale and Shapley, 1962). We study the non-cooperative game in which the students are the only strategic agents and in which students can only submit "short" preference lists. First, we show that Nash equilibrium outcomes may not be stable. Next, we establish conditions to recover stability. Our main result identifies Ergin's (2002) acyclicity condition as a necessary and sufficient condition on the colleges' priorities to assure the stability of the Nash equilibria

TE-26

Tuesday, 16:00-17:30
OPT Adal III=231

From coloring to sequencing

Stream: Combinatorial Optimization

Invited session

Chair: *Dominique de Werra*, Ima, Fsb, Epfl, CH 1015, Lausanne, Switzerland, dewerra.ima@epfl.ch

Chair: *Marie-Christine Costa*, CEDRIC, CNAM, 192 rue saint-Martin, 75003, Paris, France, costa@cnam.fr

1 - Split coloring and cocoloring in some classes of graphs

Marc Demange, SID, ESSEC, avenue B. Hirsch, BP 50105, 95021, Cergy Pontoise, France, demange@essec.fr, *Tinaz Ekim, Dominique de Werra*

Min cocoloring (resp. Min split-coloring) is a natural variation of the usual vertex coloring problem. It is to minimize $(p+k)$ (resp. $\max(p,k)$) such that the vertex set of a given graph can be covered by p cliques and k stable sets. We give a model involving split-coloring and cocoloring of permutation graphs. We then study the complexity status of both problems in some classes of graphs including line graphs, comparability and permutation graphs. We also consider their approximation ability in case of NP-hardness. A key question is to compare both problems from intractability point of view.

2 - Characterization Of Just In Time Sequencing Via Apportionment

Wieslaw Kubiak, Faculty of Business Administration, Memorial University of Newfoundland, Prince Philip Drive, A1B 3X5, St. John's, NL, Canada, wkubiak@mun.ca

The just in time sequencing has recently emerged as a universal tool for a fair allocation of shared resources. Its applications range from just in time supply chains to operating systems and data networks. A number of algorithms have been proposed in the literature to optimize just in time sequencing. This talk characterizes these algorithms via characteristics developed by the apportionment theory.

3 - Discrete Tomography And Graph Coloring

Marie-Christine Costa, CEDRIC, CNAM, 192 rue saint-Martin, 75003, Paris, France, costa@cnam.fr, *Cédric Bentz, Dominique de Werra, Christophe Picouleau, Bernard Ries*

The image reconstruction problem in discrete tomography consists in reconstructing a rectangular array of pixels from the number of occurrences of each color in every column and in every row. Here we consider a generalization of this problem. Given a graph, a collection of subsets of vertices and the number of vertices of each color in each subset, the problem is to find a coloring of V . We classify the problems according to several parameters and for each problem, we propose a polynomial time algorithm or we give complexity results.

TE-27

Tuesday, 16:00-17:30
OPT Adal V=229

COIN-OR I

Stream: COIN-OR: Open Source Software

Invited session

Chair: *Jp Fasano*, TJ Watson Research Center, IBM Research, 1101 Kitchawan Road, 10598, Yorktown Heights, NY, United States, jpfasano@us.ibm.com

1 - COIN-OR: Open-source software for Operations Research

Robin Lougee-Heimer, Mathematical Sciences, IBM Research, T.J. Watson Research Center, 1101 Kitchawan Road, 10598, Yorktown Heights, NY, United States, robinlh@us.ibm.com, *Brenda Dietrich*

The Computational Infrastructure for Operation Research (COIN-OR) is a initiative to promote the use and development of open-source software in Operations Research. In this talk we explain what is open-source software and describe the elements of this open source library, why IBM spearheaded the COIN-OR initiative (and continues to support it today), and how the open-source software freely available on COIN-OR is being used by companies, universities, and researchers. As of November, 2004 COIN-OR has been managed by the nonprofit COIN-OR Foundation, Inc and is on-line at www.coin-or.org.

2 - The ALPS Library for Scalable Parallel Search and Optimization

Matthew Saltzman, Mathematical Sciences, Clemson University, Martin Hall, Box 340975, 29634, Clemson,

South Carolina, United States, mjs@clemson.edu, Yan Xu, Ted Ralphs, Laszlo Ladanyi

ALPS (Abstract Library for Parallel Search) is a framework for implementing high-performance parallel search and optimization algorithms. Building on the ALPS base layer, BiCePS (Branch-Cut-Price Software) implements a data-management layer for Lagrangian duality-based optimization, and BLIS (BiCePS Linear Integer Solver) completes an LP-based MIP solver. We present results of computational tests on large integer programs.

3 - CoinMP: Simple C-API Windows DLL implementation of CLP, CBC, and CGL

Bjarni Kristjansson, Maximal Software, Inc., 2111 Wilson Boulevard, 22201, Arlington, Virginia, United States, bjarni@maximalsoftware.com

The COIN Open Source Initiative has become very popular in the recent years. To make life easier for users that simply want to solve models and not compile C++ applications, we have developed standard C-API Windows DLL CoinMP.DLL that implements most of the functionality of CLP, CBC, and CGL.

■ TE-28

Tuesday, 16:00-17:30

OPT Adal VI=207

Dynamic Programming II

Stream: Dynamic Programming

Invited session

Chair: Seiichi Iwamoto, Department of Economic Engineering, Faculty of Economics, Kyushu University, 812-8581, Fukuoka, Japan, iwamoto@en.kyushu-u.ac.jp

1 - Dynamic Pricing of Look-back and Barrier Option

Takayuki Ueno, Department of Economics, Nagasaki Prefectural University, 858-8580, Sasebo, Japan, ueno@nagasakipu.ac.jp, Kazuyoshi Tsurusaki

In this talk, we consider dynamic pricing of the look-back option and the barrier(knockout) option. The pricing is valuation of options under martingale measure. One useful valuation is direct method, which is discussed on the basis on fundamental probability theory. However, we are concerned with a dynamic option-pricing on the binomial model. Our dynamic pricing comes from dynamic programming without optimization. We use an invariant imbedding method, which expands the original state space by one dimension. We derive backward recursive relations. Finally, numerical illustrations are shown.

2 - Surefire Strategy for Winning a Game

Toshiharu Fujita, Faculty of Engineering, Kyushu Institute of Technology, 1-1 Sensui-cho, Tobata-ku, 804-8550, Kitakyushu, Japan, fujita@comp.kyutech.ac.jp

Nondeterministic dynamic programming is applied to get surefire strategies for winning a game. The game is simple. Initially, vertical bars are arranged like a lower triangular matrix with elements 1 as non-zero elements. Two players erase bars in turn with some rules. Who erases the last bar is loser. In our formulation, state denotes current situation for the lead. The next state depends on unknown decision by the opponent. Thus we need nondeterministic transition. We show that to minimizing maximum criterion under nondeterministic transition gives the shortest surefire strategy.

3 - Is Golden Policy Optimal in Dynamic Programming?

Seiichi Iwamoto, Department of Economic Engineering, Faculty of Economics, Kyushu University, 812-8581, Fukuoka, Japan, iwamoto@en.kyushu-u.ac.jp, Masami Yasuda

This paper introduces a notion of Golden policy in dynamic programming and shows that a Golden policy is optimal in a few of typical dynamic optimization problems. A policy is called Golden if it yields a sequence of states which constitutes the Golden section between current and next states. Then the state sequence is called a Golden trajectory. We show that a Golden policy is optimal both in quadratic control processes and in square-root allocation processes. Further we illustrate two Golden trajectories.

■ TE-29

Tuesday, 16:00-17:30

OPT Adal VII=225

Quadratic Optimization III

Stream: Global Optimization: Deterministic and Stochastic Methods

Invited session

Chair: Immanuel Bomze, ISDS, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, immanuel.bomze@univie.ac.at

1 - A class of nonlinear programming algorithms for semidefinite programming problems

Veronica Piccialli, Dipartimento di informatica e sistemistica, Università di Roma la Sapienza, Via Buonarroti 12, 00185, Rome, Italy, piccialli@dis.uniroma1.it, Laura Palagi, Luigi Grippo

We consider a semidefinite programming program in standard primal form. Using the Gramian representation of the unknown semidefinite positive matrix, the problem can be reduced to the nonlinear programming problem of minimizing a quadratic function with quadratic constraints. For the solution of this problem, we propose efficient unconstrained algorithms based on the definition of continuously differentiable exact merit functions.

This is a joint work with Luigi Grippo and Laura Palagi

2 - Multi-Standard Quadratic Optimization Problems

Immanuel Bomze, ISDS, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, immanuel.bomze@univie.ac.at, Laura Palagi, Werner Schachinger

A Standard Quadratic Optimization Problem (StQP) consists of maximizing a (possibly indefinite) quadratic form over the standard simplex. Likewise, in a multi-StQP we have to maximize a (possibly indefinite) quadratic form over the cartesian product of several standard simplices (of possibly different dimensions). Multi-StQPs occur in Support Vector Machines and also in Box-Constrained QPs. Two converging monotone interior point methods are established, along with a cone programming reformulation useful for establishing rigid bounds and finding improving directions.

3 - The clique algorithm for nonconvex (Standard) Quadratic Programming

Fabio Tardella, Dip. di Matematica - Facoltà di Economia, Università di Roma, Via del Castro Laurenziano, 9, 00161, Roma, Italy, fabio.tardella@uniroma1.it, Andrea Scozzari

We associate a graph to a Quadratic Program (QP) on a polytope and we show that a global optimizer must lie in a face whose vertices form a clique in the graph. We then propose a new active set approach to nonconvex QP that is based on implicit enumeration of all the cliques of the associated graph.

The efficiency of this approach is comparable with that of other methods for general nonconvex QPs, and is particularly remarkable for the Standard Quadratic Programming problem, where it solves to optimality problems of one order of magnitude larger than the ones solved in the literature.

■ TE-31

Tuesday, 16:00-17:30

NONL Adal XI=222

Generalized Newton Methods I

Stream: Generalized Newton Methods

Invited session

Chair: Liqun Qi, Department of Mathematics, The City University of Hong Kong, Department of Mathematics, The City University of Hong Kong, N/A, Kowloon Tong, Kowloon, Hong Kong, maqilq@polyu.edu.hk

Chair: Jérôme Bolte, 4 Place Jussieu, Case 189, UFR 929, Université Paris 6, Equipe Combinatoire et Optimisation, 75252, Paris (Cedex), France, bolte@math.jussieu.fr

1 - Generalized Newton Methods for Semi-infinite Programs

Liqun Qi, Department of Mathematics, The City University of Hong Kong, Department of Mathematics, The City University of Hong Kong, N/A, Kowloon Tong, Kowloon, Hong Kong, maqilq@polyu.edu.hk

In this talk, we will review the progress of generalized Newton methods for solving semi-infinite programs.

2 - An Iterative Method for Solving KKT System of the Semi-Infinite Programming

Soon-Yi Wu, National Cheng Kung University, No. 1, Ta-Hsueh Road, 701, Tainan, Taiwan, soonyi@mail.ncku.edu.tw

We develop an iterative method for solving the KKT system of the semi-infinite programming (SIP) problem. At each iteration, we solve the KKT system of a nonlinear programming problem with finite constraints by a semismooth Newton method. The algorithm either terminates at a KKT point of the SIP problem in finitely many iterations or generates an infinite sequence of iterates whose any accumulation point is a KKT point of the problem. We also analyze the convergence rate of the method. Preliminary numerical results are reported.

3 - Tame mappings are semismooth

Jérôme Bolte, 4 Place Jussieu, Case 189, UFR 929, Université Paris 6, Equipe Combinatoire et Optimisation, 75252, Paris (Cedex), France, bolte@math.jussieu.fr

Superlinear convergence of the Newton method for nonsmooth equations requires a semismoothness assumption. In this talk we discuss the semismoothness of locally Lipschitz functions definable in an o-minimal structure (in particular semialgebraic functions). Semialgebraic, or more generally, globally subanalytic mappings present the special interest of being r -order semismooth, where r is a positive parameter. As an application of this new estimate, we show that the error at the k th step of Newton's method behaves like $2^{-(1+r)k}$.

- Joint work with A. Daniilidis and A.S. Lewis -

TE-32

Tuesday, 16:00-17:30

NONL Adal XIII=218

Topics in Semidefinite and Linear Programming

Stream: Semidefinite Programming

Invited session

Chair: *Miguel Anjos*, Management Sciences, University of Waterloo, 200 University Avenue West, N2L 3G1, Waterloo, Ontario, Canada, anjos@stanfordalumni.org

1 - Application of Linear Programming for Optimization of Response Speed in Lean Manufacturing Environment

Zbigniew Prusak, Engineering Technology, Central Connecticut State University, 1615 Stanley St., 06050-4010, New Britain, CT, United States, prusakz@ccsu.edu

Criteria and methods of production management decision making in Lean Manufacturing environment, as well as use of Linear Programming for optimization from cost efficiency point of view. A range of response speed factors (lean production efficiency factors) helping to quantify performance of various stages for entire production process is described. Results of study conducted at very small to medium size spring manufacturers producing entirely to customer specifications. The significant constraints to lean production were usually not the ones mentioned in literature on Lean Manufacturing.

2 - The Higher-Order Derivatives of Separable Spectral Functions

Hristo Sendov, Department of Math Stats, University of Guelph, NIG 2W1, Guelph, Ontario, Canada, hssendov@uoguelph.ca

Let S_n be the Euclidean space of n by n real symmetric matrices. For X in S_n let $(L_1(X), \dots, L_n(X))$ be its eigenvalues counting multiplicities. A separable spectral function is a function F from S_n to \mathbb{R} that can be expressed as $F(X) = g(L_1(X)) + \dots + g(L_n(X))$, for some function g from \mathbb{R} to \mathbb{R} . The main result is that F is k -times (continuously) differentiable at a matrix X if and only if g is such at each eigenvalue of X . We give a formula for the k -th derivative of F in terms of the function g . An example is the self-concordant barrier on the positive semidefinite cone $-\log \det(X)$.

TE-33

Tuesday, 16:00-17:30

NONL Adal A=313

Derivative free nonsmooth optimization

Stream: Global and Local Derivative Free Optimization

Invited session

Chair: *Bulent Karasozen*, Inst. of Appl. Mathematics, Middle East Technical University, 06531, Ankara, Turkey, bulent@metu.edu.tr

1 - Application of the Global Optimization Methods for Nonconvex Production Optimization Opportunities

Jean van Berkel, EPT Research, Shell International Exploration and Production, Kesslerpark 1, 2280 AB, Rijswijk, Netherlands, jean.vanberkel@shell.com, *Licister Mason*, *Adil Bagirov*

Oil and increasingly gas, will continue to be an important source of energy over the next few decades. Unfortunately, many oil and gas high value optimization opportunities are non-smooth and non-convex. Finding ways to solve such opportunities can be commercially attractive. Based on typical oil and gas optimization opportunities, we present results of a new variant of the DGM and compares these with off-the-shelf LGO and the GlobalPenaltyFn algorithms. The results show that the DGM as well as the LGO and GlobalPenaltyFn are capable of addressing difficult oil and gas optimization.

2 - A new derivative-free method for constrained nonsmooth optimization and its applications

Adil Bagirov, School of Information Technology, Mathematical Sciences, University of Ballarat, University Drive, Mount Helen, P.O. Box 663, 3353, Ballarat, Victoria, Australia, a.bagirov@ballarat.edu.au, *Moumita Ghosh*

We present a new derivative-free method for solving constrained nonsmooth optimization problems which based on the notion of a discrete gradient. An algorithm for the computation of subgradients of a broad subclass of non-regular, nonsmooth functions is described. We report the preliminary results of numerical experiments and compare the proposed algorithm with the nonsmooth optimization solver DNLP from GAMS. We also consider the application of the proposed algorithm to k -plane clustering problem and present results of numerical experiments using real-world data sets.

3 - A derivative free discrete gradient method for nonsmooth optimization

Bulent Karasozen, Inst. of Appl. Mathematics, Middle East Technical University, 06531, Ankara, Turkey, bulent@metu.edu.tr, *Adil Bagirov*, *Meral Sezer*

In this talk a new derivative-free method based on discrete gradients is presented for solving unconstrained nonsmooth optimization. It was demonstrated that the discrete gradients can be used to approximate subgradients of a broad class of nonsmooth functions and to find descent directions of nonsmooth functions. The results of numerical experiments with unconstrained nonsmooth optimization problems are presented. The comparison of the proposed method with nonsmooth optimization solver DNLP from CONOPT-GAMS and derivative-free optimization solver CONDOR is given.

■ TE-34

Tuesday, 16:00-17:30

DEC VR II V-138

DDM Working Group Business Meeting

Stream: Distributed Decision Making

Invited session

Chair: *Rudolf Vetschera*, Dept. of Business Studies, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, rudolf.vetschera@univie.ac.at

1 - DDM Business Meeting

Rudolf Vetschera, Dept. of Business Studies, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, rudolf.vetschera@univie.ac.at

DDM EURO Working Group Business Meeting

■ TE-35

Tuesday, 16:00-17:30

DEC VR II V-147

Models for Strategic Development

Stream: OR and Strategy

Invited session

Chair: *John Morecroft*, London Business School, Regent's Park, NW14SA, London, United Kingdom, jmorecroft@london.edu

1 - Reflecting on the outcomes of empirical research studies of the strategic development process model

Efstathios Tapinos, Aston Business School, Aston University, Economics & Strategy Group, B4 7ET, Birmingham, United Kingdom, e.tapinos@aston.ac.uk, *Robert Dyson*, *Maureen Meadows*

This paper summarises the outcome from three empirical research projects which were framed by a strategic development process model (Dyson, 1998). Combining qualitative and quantitative approaches, we examined the relationship between organisational direction and performance measurement. The outcome of the three research projects shows that organisational learning is ultimately at the core of the relationship between organisational direction and performance measurements. Also, we reflect on the observations made on the strategic development process model itself from the three projects.

2 - Strategy Evaluation in Practice: Preparing the Anvil for Strategy

Abhijit Mandal, Warwick Business School, University of Warwick, ORS Group, Gibbet Hill Road, CV4 7AL, Coventry, United Kingdom, Abhijit.Mandal@wbs.ac.uk, *Don Antunes*

Despite its importance to the practice of strategy, studies of strategy evaluation remain highly under explored. Our study expands Rumelt (1980) original discussion on this subject to complement it with more update views of strategy. Moreover, we highlight the main issues that the evaluation of strategy encounters in practice, and offer three main general principles upon which the evaluation of strategy should be based upon.

3 - Strategic Development, Modelling and System Dynamics

John Morecroft, London Business School, Regent's Park, NW14SA, London, United Kingdom, jmorecroft@london.edu

A framework for strategic development is introduced based on an analogy with feedback control originally devised by Dyson et al. The strengths and limitations of the analogy are discussed. The basic framework is then modified to include strategic rehearsal as a virtual feedback process' at the corporate level to test particular consequences of strategic change. A system dynamics model of easyJet's entry into the European low-cost airline market illustrates the approach. Finally a number of general comments are made on modelling and problem structuring methods for rehearsing strategy.

■ TE-36

Tuesday, 16:00-17:30

DEC VR II V-155

Applications in Decision Analysis I

Stream: Multicriteria Decision Analysis (c)

Invited session

Chair: *Jim Petrie*, Dept. of Chemical Engineering, University of Sydney, Darlington, 2006, Sydney, NSW, Australia, petrie@chem.eng.usyd.edu.au

1 - Selecting Operational Improvements for European Air Traffic Management

Yael Grushka-Cockayne, London Business School, Regents Park, NW14SA, London, United Kingdom, ygrushka.phd2003@london.edu, *Bert De Reyck*, *Zeger Degraeve*

We develop a decision-making framework to support Eurocontrol, the European Air Traffic Management organization, in a multi-stakeholder, multi-objective evaluation of strategic decisions, in effort to cope with forecasted increase in air traffic, while maintaining safety and protecting the environment. The challenge Eurocontrol faces is to select a set of enhancements such that stakeholders will be committed to the decisions. Our methodology combines quantitative and qualitative expert assessments in areas such as capacity, safety and efficiency, for valuing a large number of alternatives.

2 - The governmental use of MCDA -too expensive to be required or too important to be abandoned?

Cathérine Gamper, Institute of Public Finance, alpS Centre for Natural Hazard Management, Grabenweg 3, 6020, Innsbruck, Tyrol, Austria, gamper@alps-gmbh.com, *Catrinel Turcanu*

Unlike other decision supporting techniques, MCDA is rarely required by national laws or directives. Nonetheless, it seems to have gained increasing importance, reflected, among others, by numerous recent applications in which public authorities either directly participated or initiated a MCDA. This paper looks at past studies, their influence, possible future importance and potential of MCDA on governmental decision level. The focus is on real-life case studies carried out in the environmental area and reported during the last decade, for which an insight on stakeholders' feedback is provided.

3 - The complimentary use of value function and outranking methods to screen projects for the Clean Development Mechanism of the Kyoto Protocol

Lauren Basson, Centre for Environmental Strategy (D3), University of Surrey, School of Engineering, GU2 7XH, Guildford, United Kingdom, L.Basson@surrey.ac.uk, *Jim Petrie*

This paper reports on decision support provided to an electrical utility in a developing country to screen projects for consideration under the Clean Development Mechanism of the Kyoto Protocol. It demonstrates the complementary use of value function and outranking methods for the selection of a portfolio of alternatives with due regard to differences in stakeholder preferences and attitudes to compensation. It also demonstrates the use of a variety of techniques to enable the comprehensive consideration of the effects of different types of uncertainties on decision model results.

■ TE-37

Tuesday, 16:00-17:30

DEC VR II V-156

MCDA for Portfolio Analysis and other Applications

Stream: Multiple Criteria Decision Aiding

Invited session

Chair: *Ahti Salo*, Systems Analysis Laboratory, Helsinki University of Technology, P.O. Box 1100, Otakaari 1 M, 02015, Tkk, Finland, ahti.salo@hut.fi

1 - Robust Portfolio Modeling in the Development of National Research Priorities

Ville Brummer, Systems Analysis Laboratory, Helsinki University of Technology, Otakaari 1 M, 02015, Espoo, Finland, ville.brummer@tkk.fi, *Ahti Salo*

We present a foresight process that was conducted to support the development of the Finnish national Strategic Research Agenda (SRA) of the Forest-Based Sector Technology Platform. The process was based on a recently developed multi-criteria method RPM-Screening and consisted of four tasks. In this process, invited experts submitted, assessed and commented research themes in the Internet, whereafter the research themes were analyzed with Robust Portfolio Modeling (RPM). Finally, results from these tasks were validated through a series of workshops.

2 - RPM-Explorer - A Web-based Tool for Interactive Portfolio Decision Analysis

Erkka Jalonen, Systems Analysis Laboratory, Helsinki University of Technology, Otakaari 1 M, 02015, Espoo, Finland, erkka.jalonen@tkk.fi, *Ahti Salo*

Tools for portfolio decision analysis usually offer optimal solutions but little support for broader communication and learning. RPM-Explorer, in turn, is a web-based decision support tool which allows the stakeholders to (i) specify their preferences concerning the relative importance of the evaluation criteria and to (ii) explore interactively what projects can be recommended in view of these preferences. The use of RPM-Explorer is illustrated with a recent case study on the development a research agenda for the Finnish Association of Packaging Technology and Research.

3 - An Optimization Modeling Framework for Maximum Resolution Topology of Internet Data

Sydney Chu, Department of Mathematics, University of Hong Kong, Pokfulam Road, 00000, Hong Kong, Hong Kong, schu@hku.hk

We advocate a general yet topologically driven optimization modeling framework for the intriguing question of what "shape" a set of given internet (market or otherwise) data is in. Our model bases on operational multi-attribute data from sources like GDI (Global Diffusion of Internet) and eBay.com to visualize the dimensions of the data records and determine maximally the resolution of sometimes subtle existence of dichotomy (or market efficiency).

■ TE-38

Tuesday, 16:00-17:30
DEC VR11 V-157

DEA Methodology II

Stream: DEA and Performance Measurement (c)
Invited session

Chair: *Gary Simpson*, Aston Business School, Aston University, Aston Triangle, B4 7ET, Birmingham, United Kingdom, g.p.m.simpson@aston.ac.uk

1 - Aggregation with Reallocation of Inputs in DEA

Elena Pachkova, University of Copenhagen, Universitetsparken 5, DK-2100, Copenhagen, Denmark, elena@math.ku.dk

This presentation investigates reallocation issues among individual units when the efficiency index is calculated for an aggregated unit in the DEA framework.

Moreover, we address the question of the optimal reallocation flow - the optimal flow of inputs among the individual units subject to given transfer costs.

Finally, we'll discuss the trade-off between the maximum cost the managers are willing to pay for a reallocation and the highest efficiency that the aggregated unit can achieve.

2 - Estimation of Allocative Efficiency in DEA: A Cautionary Tale.

Gary Simpson, Aston Business School, Aston University, Aston Triangle, B4 7ET, Birmingham, United Kingdom, g.p.m.simpson@aston.ac.uk

Data Envelopment Analysis models have been used to estimate both cost minimising, Input Allocative Efficiency and Revenue Maximising, Output Allocative Efficiency. In this paper we consider circumstances in which such models fail to correctly disaggregate the technical and allocative aspects of a Decision Making Unit's (DMU's) inefficiency. Monte Carlo Simulation is used to assess the extent of the problems and provide guidance on when the models are likely to produce useful results.

3 - DEA with discrete scoring

Keikichi Osawa, Nihon University, 1-2-1 Izumicho, 275-8575, Narashino, Japan, k7oosawa@cit.nihon-u.ac.jp, *Masaaki Shinohara*

Discrete version of DEA is proposed and its advantage over ordinary continuous DEA is discussed. In order to introduce the discrete version of DEA, we go back to the relative efficiency model via fractional CCR model. Within the proposed discrete DEA framework, various DEA models and evaluation methods, such as CCR, BCC, general returns-to-scale, super efficiency, slackness-based efficiency, cost efficiency, revenue efficiency, positive evaluation, negative evaluation, nonnegative evaluation, and mixed evaluation, can be easily handled.

4 - Variable selection method for efficiency analysis

Clara Simon de Blas, Statistics Operations Research, Rey Juan Carlos University, Departamental II, Desp. 251, C/Tulipan s/n, 28933, Mostoles, Madrid, Spain, clara.simon@urjc.es, *Jose Simon Martin, Alicia Arias*

DEA has been widely applied to measure the efficiency of a set of homogeneous organizations in a given sector. The main advantage of this method is that it does not need any special feature on the input and output. Although it's high flexibility, DEA restricts the number of total used variables respect to the number of DMUs in order to maintain the discrimination power. We propose a variable selection method to apply DEA when the number of input and output variables is high respect to the number of decision making units. The method has been applied on a set of 47 University libraries in Spain.

■ TE-39

Tuesday, 16:00-17:30
DEC VR11 V-158

AI tools for DSS

Stream: Decision Support Systems

Invited session

Chair: *Zied Loukil*, Data Processing, CRIL - CNRS Fre 2499, CRIL CNRS - Université d'Artois, Rue Jean Souvraz - SP 18, 62307, Lens, France, zied.loukil@laposte.net

1 - Explanation of exceptional values in multidimensional databases

Emiel Caron, Department of Information and Decision Sciences, Erasmus University Rotterdam, Burg. Oudlaan 50, P.O.Box 1738, 3000 DR, Rotterdam, Netherlands, ecaron@rsm.nl, *Hennie Daniels*

In this paper, we describe an extension of the datamining framework with causal explanation, offering the possibility to automatically generate explanations and diagnostics to support analysts. This functionality can be built into conventional OLAP (On-Line Analytical Processing) databases using a generic explanation formalism, which mimics the work of managers in diagnostic processes. The central goal is the identification of specific knowledge structures and reasoning methods required to construct computerized explanations from multidimensional data and business models.

2 - Inductive Learning from Incomplete Data under Maximum Entropy

Wilhelm Rödder, Operations Research, University of Hagen, Profilst. 8, 58097, Hagen, NRW, Germany, wilhelm.roedder@fernuni-hagen.de

Bayes' theorem for the conjugate pair Dirichlet/Multinomial enables the construction of probability distributions on a knowledge domain's attribute space, after observing data. The situation becomes more difficult when the respective observations are incomplete or even come from different subdomains. The Principle of Maximum Entropy is shown to be the correct tool for processing incomplete data. For the consumer credit business of a German bank we build a decision support model from 60,000 historical incomplete data and relate on its implementation in the expert system shell SPIRIT.

3 - Improvement of an optimal temporal planner by giving it the ability to manage resources

Zied Loukil, Data Processing, CRIL - CNRS Fre 2499, CRIL CNRS - Université d'Artois, Rue Jean Souvraz - SP 18, 62307, Lens, France, zied.loukil@laposte.net, Pierre Marquis, Vincent Vidal

In this paper, we decided to give modifications in a parallel optimal temporal planner, CPT, which does not manage the resources in its original version, to give it the capacity to manage both consumable and renewable resources.

For the case of the consumable resources, we fixed branching and pruning methods and rules to improve research of valid plans. For the renewable resources, we introduced the concept of resource link used to detect the conflicts generated by the actions consuming the same resource, and we proposed different methods to solve this overlap.

4 - Cognitive Techniques in Understanding Based Managing Support Systems

Marek Ogiela, Institute of Automatics, AGH University of Science and Technology, 30 Mickiewiczza Ave, 30-059, Krakow, Poland, mogiela@agh.edu.pl, Lidia Ogiela, Ryszard Tadeusiewicz

This paper presents new concept of IT systems based on cognitive resonance techniques. It supports the strategic decision-making processes based on cognitive analysis methods. The essence of this approach is in that the automatic understanding methods will be used to develop new generation business IT systems. Paper proposes a holistic concept of a new IT economy system UBMS (Understanding Based Managing Support Systems). Cognitive methods copy the psychological processes of understanding the analysed data, as they take place in the brain of a competent and particularly gifted man.

■ TE-40

Tuesday, 16:00-17:30

SOC VR7 V-257

Complex Societal Issues in general

Stream: Complex Societal Problems

Invited session

Chair: *Dorien DeTombe*, Methodology of Societal Complexity, Chair Euro Working Group, P.O.Box 3286, 1001 AB, Amsterdam, Netherlands, detombe@lri.jur.uva.nl

1 - Global Safety: The COMPRAM Method - Handling Local Natural Disasters the Katrina hurricane

Dorien DeTombe, Methodology of Societal Complexity, Chair Euro Working Group, P.O.Box 3286, 1001 AB, Amsterdam, Netherlands, detombe@lri.jur.uva.nl

Threats as flu pandemic, earthquakes, can be categorized in global or local natural and man made threats. These dangers threaten people, the economy and the stability of states. Handling global safety belongs to the field of methodology for societal complexity and should be handled according to the directions of this field; for instance by the COMPRAM method. Analyzing and discussing the threats in a multi disciplinary way; including power differences and emotions. The Katrina hurricane USA 2005 will be discussed as an example of mitigating the dangers of a local natural caused threat.

2 - Broadband diffusion in remote and rural Scotland: modelling the impact of policy initiatives

Susan Howick, Dept of Management Science, University of Strathclyde, 40 George Street, G1 1QE, Glasgow, United Kingdom, susan.howick@strath.ac.uk, *Jason Whalley*, *Andrew Tookey*

There is considerable interest worldwide in broadband diffusion. This paper identifies the initiatives used to encourage broadband awareness, availability and adoption in remote and rural Scotland and how, if at all, these complement one another. Causal loop diagrams are then developed to identify the main factors that influence broadband diffusion. From these diagrams and empirical data collection, a system dynamics model is derived. This model is used to investigate the impact of initiatives on take-up rate and total adoption.

3 - The Complexity Paradigm in Management Reconceptualizing

Slavica P. Petrovic, Faculty of Economics, University of Kragujevac, D. Pucara 3, 34000, Kragujevac, Serbia, Serbia and Montenegro, pslavica@ptt.yu

Through treating organizations as complex, nonlinear systems, complexity theory is aimed at research of their erratic nature. When an organization is in a state of bounded instability, order and disorder are intertwined, its behaviour is unpredictable but has some pattern. According to the complexity paradigm, as a functionalist systems approach to management, organizations have to strive to avoid states of stability and instability, and they have to strive to stay in a state of bounded instability, at the edge of chaos, where they can display their potential for creativity and innovation.

■ TE-41

Tuesday, 16:00-17:30

SOC VR7 V-258

Human centered decision-making and support

Stream: Human Centered Processes

Invited session

Chair: *Raymond Bisdorff*, Applied Mathematics Unit, University of Luxembourg, L-1511, Luxembourg, Luxembourg, raymond.bisdorff@uni.lu

1 - Toward a naturalistic decision making paradigm

Raymond Bisdorff, Applied Mathematics Unit, University of Luxembourg, L-1511, Luxembourg, Luxembourg, raymond.bisdorff@uni.lu

In this communication we would like to review the recent feature issue in EJOR on HCP following the last Conference on Distributed decision-making and man-machine cooperation (2003). From our general intention to better take into account natural cognition in DSS, we moved onward the description of human knowledge and more precisely expertise in real decision context. The last meeting completed the cycle by focusing on complex decision-making and man-machine cooperation in naturalistic settings, with a focus on critical decision-making, where human decision-makers appear to be essential.

2 - Dynamic programming for planification in critical situations

Alexandre Szytkgold, ENST Bretagne, Brest Cedex 3, France, al.sz@free.fr, *Gilles Coppin*

Our concern is the definition of a DSS devoted to military decision makers dealing with tactical strategies on battlefields. The main idea is to compute decision strategies with guaranteed safety and coherence, that remain coherent with methods used by the military. Our model is based on a mathematical description of the current tactical situation with the assistance of some multivalued graphs. The approach relies on viability theory, probabilistic dynamic programming (with technics like Temporal difference methods) and a cognitive model of the military expert.

3 - Cognitive approach to distributed decision making

Frédéric Cadier, LUSI / TAS, GET/ENST Bretagne / THALES, Technopôle Brest-Iroise, Cs 83818, 29238, Brest Cedex 3, France, frederic.cadier@enst-bretagne.fr, *Philippe Lenca*, *Gilles Coppin*, *Gabriel Marchalot*

Situations of distributed decision making are usually characterized by the existence of different points of view, expressed by multiple kinds of agents along different temporal scales. In most DDSS, the observable dynamics of the process is handled through the workflow of information between the agents. Our approach tries to extend this classical one while taking into account, beyond this observable information, the individual mental representations and process models. Our application support is an Airborne Maritime Surveillance System.

4 - Efficient Shift Scheduling Through 2-Stage Optimization in the Retail Sector

Özgür Kabak, Industrial Engineering Dept., Istanbul Technical University, Isletme Fakültesi Maçka, 34357, Istanbul, Turkey, kabak@itu.edu.tr, Fusun Ulengin, Emel Aktas, Sule Onsel Sahin, Ilker Topcu

Personnel scheduling has become one of the primary means by which service organizations remain competitive. Management's goal is to find the best mix of hourly employees so that demand is satisfied at minimum cost. This paper proposes a two-stage computer-supported, scheduling model. Initially, a sales-response model is used, by which hourly demands for staff are determined. The outputs of this model become the input for a mixed integer optimization model to find the total number of staff necessary as well as the assignment of the staff to the required daily shifts of the week.

■ TE-42

Tuesday, 16:00-17:30

SOC VR11 V-261

Modelling of Economies and Societies in Transition: Analysis, Indicator and Measurement Aspects

Stream: Modelling of Economies and Societies in Transition (c)

Invited session

Chair: *Vladimir Kascelan*, Finance, Central Depository Agency of Montenegro /Faculty of Economics, Novaka Miloseva bb /Jovana Tomasevica 37, 81 000, Podgorica, Montenegro, Serbia and Montenegro, v.kascelan@cg.yu

1 - Integration of Economic Activity between the Euro Area and Croatia: Empirical Analysis

Natasa Erjavec, Faculty of Economics, Dept. of Statistics, University of Zagreb, Trg J.F.Kennedy 6, 10000, Zagreb, Croatia, nerjavec@efzg.hr, *Boris Cota*

The paper analyses correlation of short-term business cycles in the euro area and Croatia as EU accession country. The degree of economic integration is estimated by the similarity of monthly indices for industrial production for the euro area and Croatia, since industrial production is probably more accurately measured than any other indicators of economic activity in Croatian economy. The data sample excludes the period associated with the change of the economic system, which should make the results more reliable. The issue is assessed using vector autoregressive methodology.

2 - Some Modifications of Composite Indicators for Croatian Business Survey

Mirjana Cizmesija, Faculty of Economics, Dept. of Statistics, University of Zagreb, Trg J.F.Kennedy 6, 10000, Zagreb, Croatia, mcizmesija@efzg.hr, *Vlasta Bahovec*

Business surveys in Croatia are based on the harmonized EU methodology adjusted for some specific characteristics of Croatian economy. They are carried out quarterly in manufacturing industry, construction and trade. Confidence indicators which are derived from business survey results can be used to forecast developments of the national economy. In this paper we would like to modify some Confidence indicators with the aim to create Confidence indicators with the better predictive properties.

3 - On Solvency Measurement of Insurance Companies in Montenegro

Vladimir Kascelan, Finance, Central Depository Agency of Montenegro /Faculty of Economics, Novaka Miloseva bb /Jovana Tomasevica 37, 81 000, Podgorica, Montenegro, Serbia and Montenegro, v.kascelan@cg.yu

This paper deals with different models (such as: fixed ratio, RBC-risk based capital, risk and ruin theoretic approaches and scenario based approach) and experiences of solvency margin determination for insurance companies all over the world. These models are used to propose appropriate model for Republic of Montenegro.

We have to face with specific conditions of undeveloped market, such as insurance market in Montenegro, and it is offered adequate methodology for solvency measurement in this case.

■ TE-43

Tuesday, 16:00-17:30

FIN Endur Room 1

Stochastic Optimization for Capital Growth

Stream: Stochastic Programming

Invited session

Chair: *William Ziemba*, Sauder School of Business, University of British Columbia, 2053 Mail Mall, V6T 1Z2, Vancouver, BC, Canada, ziemba@interchange.ubc.ca

1 - Risk Control in a Speculative Financial Market

Leonard MacLean, School of Business Administration, Dalhousie University, 6100 University Avenue, B3H 3J5, Halifax, Nova Scotia, Canada, l.c.macleam@dal.ca, *William Ziemba*

We consider the problem of downside risk control in a financial market where a price bubble may arise. The price dynamics are defined by a Cox process, with jumps following a non-homogeneous Poisson process. The jump intensity depends a yield differential. The risk control is based on upper and lower limits on accumulated capital. When the wealth path reaches a control limit, the pricing model and investment strategy are evaluated. The path control approach is compared to risk control methods which focus on capital accumulation at a fixed planning horizon.

2 - On Growth Optimality Versus Security Against Underperformance

Michael Stutzer, Finance, University of Colorado, 419 Ucb, 80309, Boulder, CO, United States, michael.stutzer@colorado.edu

The expected log portfolio criterion results in the highest asymptotic growth of wealth. Risk-control suggests alternative criteria that stress security against underperformance over finite horizons. Large deviations theory is used to generalize log utility's asymptotic analysis to incorporate security concerns. The resulting power utility criterion is free of a risk aversion parameter as the latter is endogenously determined by expected utility maximization.

3 - Capital Growth: Theory and Practice

William Ziemba, Sauder School of Business, University of British Columbia, 2053 Mail Mall, V6T 1Z2, Vancouver, BC, Canada, ziemba@interchange.ubc.ca, *Leonard MacLean*

We survey capital growth theory in discrete and continuous time. Performance and feasibility criteria are related using expected utility. There is a growth-security trade-off with the fraction invested in an optimal growth portfolio determined by the risk aversion index of a negative power utility function. Models calculating the optimal fractional Kelly investment with alternative criteria are formulated and the effects of estimation and modeling error are discussed. Applications include futures trading, asset allocation, lotto games, horseracing, and great investors use of such strategies

■ TE-44

Tuesday, 16:00-17:30

FIN Endur Room 2

Long Term Time Optimal Financial Decision Making

Stream: Long Term Financial Decisions

Invited session

Chair: *Ursula Walther*, Fakultät für Wirtschaftswissenschaften, TU Bergakademie Freiberg, Lessingstr. 45, 09596, Freiberg, Germany, ursula.walther@bwl.tu-freiberg.de

1 - Time Optimal Decision Making and Portfolio Choice

Thomas Burkhardt, Campus Koblenz, IfM, Universität Koblenz-Landau, Universitätsstr. 1, 56070, Koblenz, Germany, tburkha@uni-koblenz.de

Time Optimal Decision Making (TODM) is concerned with choice situations in which time is the decisive random variable, so that risks are best characterized in the dimension of time. Investment or financing decisions are important examples, e.g. if an investor is interested to reach a predefined level of wealth by risky investments. The concept of TODM, which is new to the literature, is exposed, a rational model of TODM is developed in the spirit of von Neumann/Morgenstern, and a time optimal portfolio selection model which is build thereupon is presented.

2 - Preferences over Uncertain Investment Horizons

Martin Bouzaima, Institute for Management / AG Finance, University of Koblenz-Landau, Universitaetsstrasse 1, 56075, Koblenz, Germany, bouzaima@uni-koblenz.de

This research proposes and discusses notions and properties of risk and risk aversion for the analysis of choice situations that feature goals like reaching a given future wealth level and uncertainty with respect to the time until this goal is reached. The new notions are derived based on a rational model of choice that allows an expected utility representation. The properties and the economic appeal of our notions are further investigated using demand for insurance coverage and the division of wealth between a risky and a riskless asset as touchstone examples.

3 - Estimating Barrier Options by Adaptive Control Variables

Klaus Poetzelberger, Department of Statistics and Mathematics, Wirtschaftsuniversität Wien, Augasse 2-6, A-1090, Vienna, Austria, klaus.poetzelberger@wu-wien.ac.at

To estimate the boundary crossing probability (BCP) by adaptive control variables, approximate the boundary b by b_m , which is linear on m intervals and estimate its BCP by a MC method. Let b_k be a further approximation of b . The BCP for b_k as control variable improves the MSE, the improvement depending on the difference of the (exact) BCP's for b and b_m . We show that iterating control variables leads to a convergence rate which is typical for finite-dimensional problem.

4 - Interest Rate Risk in a Time Oriented Perspective

Ursula Walther, Fakultät für Wirtschaftswissenschaften, TU Bergakademie Freiberg, Lessingstr. 45, 09596, Freiberg, Germany, ursula.walther@bwl.tu-freiberg.de, Thomas Burkhardt

We analyse time aspects of savings- and financing processes. If a predefined financial target is strived for various risks might affect the time span needed until the goal is reached. With the example of private house building we define interest rate and inflation risk in a time oriented perspective and analyse their impact on the total process length. A model that allows to clearly specify and calculate the process length is developed. As the process design influences the saver's risk exposure we explore how the process can be organised favourably with respect to risk sensitivity.

TE-45

Tuesday, 16:00-17:30

FIN Endur Room 3

Models and Tools for Financial Planning

Stream: Models and Tools for Financial Planning (c)

Invited session

Chair: Peter Letmathe, FB 5: Wirtschaftswissenschaften, University of Siegen, Chair of Value Chain Management, Hoelderlinstr. 3, 57068, Siegen, Germany, peter.letmathe@uni-siegen.de

1 - An Approach of Dynamic Optimization Model to Evaluation of Stocks Portfolios from Warsaw Stock Exchange

Bartosz Sawik, Department of Systems Analysis and Computer Modelling, AGH University of Science

Technology, Al. Mickiewicza 30, PL-30-059, Kraków, Poland, B_sawik@yahoo.com

This paper presents dynamic optimization model based on the Markowitz Problem with a modified objective function and additional constraints. Computations have been made for selected portfolio structures. Model includes market commissions and income tax calculated from investment profit. The average level of risk aversion for portfolio was calculated. Selected 65 months investment period was considered in compliance with the total risk of investment. Data sets for the analysis come from Warsaw Stock Exchange from December 2000 to April 2006.

2 - A Tractable Probabilistic Approach to Value-at-Risk Optimization

Dessislava Pachamanova, Mathematics and Sciences, Babson College, 319 Babson Hall, 1 Forest Street, 02457, Babson Park, MA, United States, dpachamanova@babson.edu, Melvyn Sim, Karthik Natarajan

Value-at-Risk (VaR) is the most popular and accepted risk measure in the financial and insurance industries, yet efficient optimization of VaR remains a very difficult problem. We propose an approximation method for optimizing the VaR of a portfolio based on robust optimization techniques. Numerical experiments with real market data indicate not only that our probabilistic approach is computationally tractable, but also that it results in better portfolio performance than alternative approaches for quantile-based portfolio risk minimization.

TE-46

Tuesday, 16:00-17:30

FIN Endur Room 4

Stochastic Models in Reliability

Stream: Applied Probability/Forecasting (c)

Invited session

Chair: Lidia Filus, Mathematics, Northeastern Illinois University, 5500 N. St. Louis Ave., 60625, Chicago, Illinois, United States, L-Filus@neiu.edu

1 - Forecasting both time varying MTBF of fighter aircraft module and expected demand of minor parts

Yoon Kyung Bok, Dept. of Information and Industrial Systems Engineering, Yonsei University, Shichondong 134, 120-749, Seoul, Korea, Republic Of, ykb@yonsei.ac.kr, So Young Sohn

Most of the existing inventory models do not take into account the time varying characteristics of modules composed of minor parts even though the demand rate of minor parts is sensitive to the conditions of module. In this paper, we propose random effects regression models to forecast the MTBF of modules and the expected demand for the minor parts in the module based on time varying characteristics of modules. Subsequently, we show how they can be applied to find necessary seasonal demand of minor parts.

2 - Top event probability of a fault tree with priority AND gates

Tetsushi Yuge, Dept. of Electrical and Electronics, National Defense Academy Japan, Hashirimizu 1-10-20, 2398686, Yokosuka, Japan, yuge@nda.ac.jp, Shigeru Yanagi

A method for calculating the exact top event probability of a fault tree with priority AND gates (PAG) and repeated basic events, is proposed when the minimal cut sets are given. S-independent, exponentially distributed, non-repairable basic events are assumed for the analysis. The output probability for a single PAG is derived by Markov analysis. The top event probability is given by cut set approach and inclusion-exclusion formula. The logical product which composed of a PAG having at least one repeated basic event is transformed into the sum of disjoint events which are equivalent to PAG.

3 - A stochastic model for reliability of systems with repair

Lidia Filus, Mathematics, Northeastern Illinois University, 5500 N. St. Louis Ave., 60625, Chicago, Illinois, United States, L-Filus@neu.edu, *Jerzy Filus*

An "extended Weibullian" stochastic process is constructed and applied as a model for system maintenance. The process (which entries are considered to be times between successive failures) is defined by a common pattern for sequences of new n -variate pdfs of corresponding r . vectors as n grows to infinity. New, relatively simple, description of underlying stochastic dependencies between the modeled life times allows to relax the usual Markovianity assumption, while analytical tractability is still preserved. Thus a gain in prediction accuracy is anticipated.

■ TE-47

Tuesday, 16:00-17:30

FIN Endur Room 5

Options

Stream: Financial Modelling (c)

Invited session

Chair: *Vesna Bogojevic Arsic*, Fakultet Organizacionih Nauka, Jove Ilica 154, 11000, Belgrade, Serbia and Montenegro, arsicp@yahoo.com

1 - Optimizing Omega

Stephen Kane, School of Physics, Astronomy and Mathematics, University of Hertfordshire, College Lane Campus, AL10 9AB, Hatfield, Herts, United Kingdom, s.s.kane@herts.ac.uk, *Michael Bartholomew-Biggs*

OPTIMIZING OMEGA

S.J. Kane and M.C. Bartholomew-Biggs

School of Physics Astronomy and Mathematics, University of Hertfordshire

The Omega Function, proposed by Cascon, Keating and Shadwick, is a performance evaluation measure for comparison between assets. Its use in portfolio optimization has been discussed by Favre-Bulle & Pache and the present paper reports computational experience of portfolio selection based on Omega compared with the use of more traditional approaches. The paper pays particular attention to numerical issues in the calculation and optimization of Omega.

2 - Option and Risk Pricing with Markovian Trees

Sergio Ortobelli, MSIA, University of Bergamo, Via dei Caniana, 2, 24127, Bergamo, Italy, sol@unibg.it, *Gaetano Iaquinta*

In this paper we propose to use a Markov chain in order to model the behaviour of asset returns in option pricing and risk management. In particular, we describe markovian trees to price risk and contingent claims. First, we analyze the problem of pricing American and European options with homogeneous Markov chains and we discuss the extension to non homogeneous Markov chains. Secondly, we discuss the problem of pricing risk of a given portfolio using markovian trees. Finally, we propose an ex post comparison among the different models and the Black and Scholes one.

3 - Leasing as a Put Option for Entrepreneur Firms

Tsutomu Mishina, Systems Science and Technology, Akita Prefectural University, 84-4 Tsuchia-Ebinokuchi, J-015, Akita, Japan, mishina@akita-pu.ac.jp

As leasing offers the right for economic use of an asset without obtaining ownership and provides various favorable features for the user, the leasing contract is particularly beneficial to newly formed firms. Those firms mostly face financial difficulties in acquiring high-priced assets, and they have fragile management bases. This paper focuses on the option which the firm holds against the leasing company as a put option. In this option based evaluation context, various types of leasing contracts significantly affect the total value of the firm.

Wednesday, 8:30-10:00

■ WA-01

Wednesday, 8:30-10:00

KEY Askja N-132

KEYNOTE: Optimization in Postal Logistics

Stream: Optimization in Postal Logistics

Invited session

Chair: *Hans-Jürgen Sebastian*, Deutsche Post Endowed Chair of Optimization of Distribution Networks, RWTH Aachen University, Templergraben 64, 52062, Aachen, Germany, sebastian@or.rwth-aachen.de

1 - KEYNOTE: Optimization in postal logistics

Hans-Jürgen Sebastian, Deutsche Post Endowed Chair of Optimization of Distribution Networks, RWTH Aachen University, Templergraben 64, 52062, Aachen, Germany, sebastian@or.rwth-aachen.de

The presentation will start with a brief introduction to the area of Postal Logistics for letter, parcel and express mail. We will discuss the distribution networks consisting of mail collection, sorting centers, long-haul transportation, delivery stations and the last mile. This will be followed by a description of the main classes of optimization problems which arise in the strategic, tactical and operational planning phases of the postal logistics network: problems of Facility Location, Service Network Design, Location Routing and Vehicle Routing and Scheduling.

Following this preparatory information, we will present an outline of the Stream "Optimization in Postal Logistics", which contains the four sessions Postal Logistics, Location and Transportation, Optimization of the Last Mile and IT Systems in Postal Logistics.

The core part of the presentation consists of selected state-of-the-art optimization models, their solution using combinatorial optimization and their implementation with the help of a decision-support types of software systems. We will also show what the research challenges in the field are, and what progress has been made in joint projects with the Deutsche Post World Net.

2 - New modelling and solution techniques for very large-scale routing problems

Stefan Irnich, Deutsche Post Endowed Chair of Optimization of Distribution Networks, RWTH Aachen University, Templergraben 64, 52062, Aachen, Germany, sirnich@or.rwth-aachen.de

One of the challenges of planning postal logistics transportation networks is handling their enormous size with thousands of collection or delivery points. Another type of complexity is implied by non-standard side constraints, e.g., limited sorting capacities at mail processing centers forcing vehicles to arrive staggered over the planning period. New techniques to efficiently handle large-scale VRPs with non-standard constraints are presented. The kernel of the solver is a highly-efficient local search framework that can be integrated into any type of controlling meta-heuristic.

■ WA-02

Wednesday, 8:30-10:00

APP Askja N-131

Resource Allocation

Stream: OR in Health Care

Invited session

Chair: *Roger Beech*, Centre for Health Planning and Management, University of Keele, Darwin Building, ST5 5BG, Keele, Staffordshire, United Kingdom, r.beech@hpm.keele.ac.uk

1 - A decision support system to improve the efficiency of resource allocation in healthcare management

Emel Aktas, Industrial Engineering Department, Istanbul Technical University, ITU Isletme Fakultesi, Macka, 34357,

Istanbul, Turkey, aktasem@itu.edu.tr, *Fusun Ulengin, Sule Onsel Sahin*

A decision support model is proposed to assist health system managers in improving the efficiency of utilizing resources. First, key variables affecting system efficiency and their causal relationships are identified through causal maps. Second, a Bayesian Belief Network is used to represent the conditional dependencies and uncertainties of the key variables. Third, a sensitivity analysis is performed to determine the most critical variable(s). Finally, strategies to improve system efficiency are proposed. The proposed model is applied to the tomography section of a private hospital in Turkey.

2 - Resource Requirements for Screening and Treatment for Diabetic Retinopathy

Ruth Davies, Warwick Business School, University of Warwick, Gibbet Hill Road, CV4 7AL, Coventry, United Kingdom, Ruth.Davies@wbs.ac.uk, *Sally Brailsford*

Screening and treatment can prevent blindness. The continuing increase in the prevalence of Type 2 diabetes associated with diet and obesity. Furthermore, the NHS has introduced guidelines that all patients with diabetes must be screened annually. An MSc student has used an existing simulation program, developed by Davies, Brailsford and Canning, to show the escalating demands on screening and clinic resources. A further student has extended this work to a clinic in Warwick, using Simul8, to explore the hospital resource use and bottlenecks in more detail.

3 - Comparison of meta-heuristic procedures for the nurse scheduling problem

Mario Vanhoucke, Management Information, Operations Management and Technology Policy, Ghent University and Vlerick Leuven Gent Management School, Hoveniersberg 24, 9000, Ghent, Belgium, mario.vanhoucke@ugent.be, *Broos Maenhout*

The nurse scheduling problem (NSP) assigns nurses to shifts in order to maximize the overall schedule quality. Up to now, various meta-heuristic procedures were proposed to solve the NSP in various guises. In this research, we compare the algorithmic design of different population-based meta-heuristic procedures proposed in literature. To that purpose, different algorithms, using a unifying approach, will be tested on a standard dataset and extensive computational results will be presented.

■ WA-03

Wednesday, 8:30-10:00

APP Askja N-130

Business and Industry OR - ORTEC

Stream: Business and Industry OR - Special Track

Invited session

Chair: *Bart Veltman*, ORTEC Products, ORTEC, PO Box 490, Groningenweg 6K, NL 2800 AL, Gouda, Netherlands, bveltman@ortec.nl

1 - OR in Practice: lessons from 25 years of experience at ORTEC

Gerrit Timmer, Board, ORTEC, PO Box 490, NL 2800 AL, Gouda, Groningenweg 6K, NL 2800 AL, Gouda, Netherlands, gtimmer@ortec.nl

25 years ago, 5 (PhD-)students in Operations Research in Rotterdam started applying OR techniques in practice. Now their company ORTEC employs over 500 professionals that operate from 10 offices around the globe. In the presentation one of the founders will speak about lessons learned and on issues that determine the success or failure of OR applications. Moreover, attention will be given to social and economic trends that have contributed to the success of ORTEC and that will further effect the possibilities for OR applications in the future.

2 - OR in practice: ORTEC's business model, aimed to sustainable growth

Bart Veltman, ORTEC Products, ORTEC, PO Box 490, Groningenweg 6K, NL 2800 AL, Gouda, Netherlands, bveltman@ortec.nl

ORTEC started as a Dutch consulting firm specialised in the practice of MS/OR. Nowadays, ORTEC is a consulting firm as well as a producer and international supplier of standard Advanced Planning & Scheduling software products (the ORTEC Logistics and ORTEC Finance product families). The product manager for the ORTEC Logistics product family will present the business model ORTEC implemented to realise this expansion. Attention will be given to the simultaneous marketing of consulting services and APS-products, and to the organisational structure to produce and distribute APS-products.

3 - OR in practice: APS in the (security) service industry

Bart Veltman, ORTEC Products, ORTEC, PO Box 490, Groningenweg 6K, NL 2800 AL, Gouda, Netherlands, bveltman@ortec.nl

Advanced Planning & Scheduling software (APS) has its history mainly in the logistics industry, e.g. planning and scheduling of production, transport, and distribution processes. The Service Industry is a relatively new but growing domain of the Enterprise Resource Planning (ERP) and Advanced Planning & Scheduling (APS) practice. The presentation will present a model that explains the added value of APS to the Service Industry, especially the Security Industry. Attention will also be given to the enterprise wide implementation of APS at Group 4 Seuciror in the Netherlands.

■ WA-04

Wednesday, 8:30-10:00

APP Askja N-129

Understanding electricity market behaviour

Stream: Electricity Markets

Invited session

Chair: *Eddie Anderson*, Australian Graduate School of Management, University of New South Wales, Unsw, 2052, Sydney, NSW, Australia, eddiea@agsm.edu.au

1 - A market-calibrated approach to modelling behaviour in the New Zealand Electricity Market

James Tipping, Department of Management, University of Canterbury, Private Bag 4800, 8004, Christchurch, New Zealand, james.tipping@canterbury.ac.nz, *Don McNickle*, *Grant Read*

The dominant form of generation in the New Zealand Electricity Market (NZEM) is hydro, with limited seasonal storage. As a result, spot prices are heavily influenced by reservoir levels, which determine the amount of generating capacity available. Rather than operating under assumptions requiring marginal costs and dispatch priorities, this paper presents a stochastic simulation model for NZEM spot prices and storage levels calibrated with observed data. The model therefore mimics market behaviour remarkably well, and offers an additional perspective to the traditional market-clearing models.

2 - Hourly Electricity Forward Price Curve Generation with a Calendar-based Linear Regression Model

Otso Ojanen, -, Process Vision Ltd., Melkonkatu 18, 00210, Helsinki, -, Finland, otso.ojanen@processvision.fi, *Sami Niemelä*

We present a method for constructing hourly-level seasonal forward price curves on electricity markets by fitting realized electricity spot prices to forward prices. The hourly electricity forward price curve is not known explicitly due to the limited number of forward contracts traded in the market but it is crucial for pricing sales contracts and for risk management. The method uses a calendar-based linear regression model with optional external factors to explain variations in the generated spot price profile. We apply and analyze the model with realized prices on the Nordic power exchange.

3 - Customers' Satisfaction and Loyalty to Electric Power Suppliers under Liberalized Competitive Market in Japan

Hisanori Goto, Socio-economic Research Center, Central Research Institute of Electric Power Industry, 2-11-1, Iwado

Kita, 201-8511, Komae-shi, Tokyo, Japan,
hisanori@criepi.denken.or.jp, Toshio Ariu

In Japan, retail electricity liberalization has been expanded to cover more than 60 per cent customers in the electricity demand basis. In this competitive market, it is increasingly important for electric power suppliers to understand customer satisfaction, loyalty and choice behavior in order to maintain and increase their market shares. In this study, we surveyed customer satisfaction and loyalty to electric power suppliers by questionnaire to residential and business customers in Japan. Based on this survey, we analyzed the relationship between the loyalty, satisfaction and other factors.

4 - Residential Customers' Satisfaction and Brand Value of Electric Power Suppliers

Toshio Ariu, Socio-economic Research Center, Central Research Institute of Electric Power Industry, 2-11-1 Iwado Kita, 201-8511, Komae-shi, Tokyo, Japan,
ariu@criepi.denken.or.jp

We surveyed various customer needs and residential customers' satisfaction of electric power suppliers through telephone interviews in G.B., the US and Japan. By using the contingent valuation method, we estimated that 6.2% of the British customers would change power suppliers if they were given a 5% price reduction per month, for instance. We could calculate customer value of power suppliers, based on 1) the electricity monthly payment, 2) the management factors for customer switching, 3) the price reduction rate for switching, and 4) the duration of the price difference for switching.

■ WA-05

Wednesday, 8:30-10:00
APP Askja N-128

OR in Agric.and Forest Management II

Stream: OR in Agriculture and Forest Management (c)

Invited session

Chair: *LluisM Pla*, Mathematics, University of Lleida, JaumeII,73, 25001, Lleida, Spain, lmpa@matematica.udl.es

1 - Manure management and spreading land use by using a shortage function

Isabelle Piot-Lepetit, Economie, INRA, 4 allée Adolphe Bobierre, CS 61103, 35011, Rennes cedex, France,
Isabelle.Piot@rennes.inra.fr

The Shortage function (Luenberger, 1992) provides a useful framework to implement theoretical models. It allows for studying the impact of various environmental policy instruments on the partial equilibrium costs borne by regulated entities (firms, households, government), including both pecuniary and no pecuniary expenses, when the market price system is held constant. It is illustrated in the particular case of manure management in European countries. It provides information on the optimal land allocation for spreading activities. It is implemented by using DEA techniques.

2 - Consolidation of farming by means of quadratic optimization

Andreas Brieden, Bundeswehr University, Munich, Werner-Heisenberg-Weg 39, 85579, Neubiberg, Germany,
andreas.brieden@unibw.de

For various reasons today's farmers may cultivate a number of small sized lots that are distributed over a wide range leading to high production costs. Due to a high percentage of leased land classical forms of land consolidation based on change of ownership become less and less suitable for the farmers. The voluntary lend-lease based exchange of agricultural acreage might be an alternative. In order to fully exploit the potential of the method a mathematical optimization model is required and presented in this talk. The speaker reports also on the method's application in practice.

3 - Achieving optimal production in agricultural holdings of Montenegro

Miomir Jovanovic, Agro-economic research, Biotechnical Institute, kralja Nikole bb, 81000, Podgorica, Montenegro, Serbia and Montenegro, miomir@cda.cg.yu

The paper analyses the issues related to achieving optimum production capacities on individual households in Montenegro. Limited land area, inadequate appliance of agro-technological measures, lack of specialized production etc., significantly influence competitiveness and financial results achieved by domestic producers.

In order to achieve optimal production in these circumstances and with the abovementioned limitations of agricultural holdings, the paper analyses the appropriate model using multiple production lines. Software SOLVER was used for reaching optimum results.

■ WA-07

Wednesday, 8:30-10:00
APP Askja N-120

Sports and OR III

Stream: OR in Sports

Invited session

Chair: *Michael Trick*, Tepper School of Business, Carnegie Mellon University, Tepper Room 243, 15213, Pittsburgh, PA, United States, trick@cmu.edu

1 - Tabu search techniques for the Traveling Tournament Problem

Luca Di Gaspero, Dept. of Electrical, Mechanical and Management Engineering, University of Udine, via delle Scienze 206, I-33100, Udine, Italy, l.digaspero@uniud.it,
Andrea Schaerf

The TTP is a combinatorial problem that combines features from TSP and the tournament scheduling problem. We present a family of tabu search solvers for the solution of TTP that make use of a complex combination of many neighborhood structures, which have been thoroughly analyzed and experimentally compared. We evaluate the solvers on three sets of publicly available benchmarks and we show a comparison of their outcomes with previous results presented in the literature.

2 - A Systematic Simulated Annealing Approach to the Traveling Tournament Problem

Yannis Vergados, Computer Science, Brown University, Brown University Box 1910, 02912, Providence, RI, United States, vi@cs.brown.edu, Pascal Van Hentenryck

Automated sports scheduling has received a lot of attention given the significant revenues and the challenging optimization problems involved. We propose a simulated annealing algorithm for the traveling tournament problem, which abstracts on the US major league baseball. It uses a large neighborhood structure, and includes advanced techniques such as strategic oscillation and reheats. It matches the best known solutions on small instances and significantly improves on larger instances. We also show how it can be extended to handle important variants of the problem for a variety of data sets.

3 - Referee assignment

Celso Ribeiro, Department of Computer Science, Universidade Federal Fluminense, Rua Bogari 70, 22471-340, Rio de Janeiro, RJ, Brazil, celso@inf.puc-rio.br,
Sebastián Urrutia, Alexandre Duarte

A common problem in sports management is the assignment of referees to games. There are a number of rules and objectives that should be taken into account when referees are assigned to games. We address a simplified version of a referee assignment problem common to many amateur leagues. We propose a three-phase solution strategy: construction of an initial solution, a repair heuristic to make the initial solution feasible, and a local search heuristic to improve solution quality. Preliminary computational results on realistic instances are presented and further extensions are discussed.

■ WA-08

Wednesday, 8:30-10:00

EDU Oddi 101

Incorporating Excel in MBA courses

Stream: OR Education

Invited session

Chair: *Nils Rudi*, Technology and Operations Management, INSEAD, Blvd de Constance, 77305, Fontainebleau, France, nils.rudi@insead.edu

1 - Teaching Business Statistics to MBAs: The Role of Excel

Kristin Fridgeirsdottir, Decision Sciences, London Business School, Regent's Park, NW1 4SA, London, United Kingdom, kristin@london.edu

Business Statistics is a core course taught in MBA programmes at London Business School. In this popular course Excel plays a large role both in the classroom as well as in computer lab sessions when students solve cases. This talk will illustrate how a rather dry subject can be taught in an interesting way with, e.g., the use of Excel.

2 - Teaching the Sof-Optics case using QMacros

Nils Rudi, Technology and Operations Management, INSEAD, Blvd de Constance, 77305, Fontainebleau, France, nils.rudi@insead.edu

The Sof-Optics case (HBS case #681052) involves the analysis of both short term and long term decisions of a call center, and it is suggested by the case teaching note (HBS case #683031) to use the M/M/s/N queuing system (i.e., a multi-server system with limited wait space). I will describe how students first use QMacros to do a case analysis of Sof-Optics, and how I use it in the case discussion which follows.

3 - Simulation Applications using Crystal Ball and OptQuest

Sergei Savin, Decision, Risk and Operations, Columbia Business School, Columbia University, 10027, New York, NY, United States, sv30@columbia.edu

Treatment of simulation occupies a significant place in many MBA Management Science courses. This presentation will focus on the classroom use of two popular Excel add-ins designed to analyze a wide variety of stochastic problems in financial, marketing and operations settings.

■ WA-09

Wednesday, 8:30-10:00

IT Oddi 106

Data Mining and Logic Models

Stream: Data Mining

Invited session

Chair: *Giovanni Felici*, Istituto di Analisi dei Sistemi ed Informatica, Consiglio Nazionale delle Ricerche, Viale Manzoni 30, 00185, Roma, Italy, felici@iasi.cnr.it

1 - Logic Mining of non-logic data: Some Extensions of Box Clustering

Bruno Simeone, Dept. of Statistics, University of Rome La Sapienza, Piazzale Aldo Moro 5, 00185, Rome, Italy, bruno.simeone@uniroma1.it, *Maurizio Maravalle*, *Federica Ricca*, *Vincenzo Spinelli*

Box Clustering derives classification logic formulas from data described by continuous and discrete variables. It is based on the search of a number of multi-dimensional intervals, or boxes, that contain all data points and are homogeneous with respect to the classification variable. We discuss some combinatorial and algorithmic issues, as well as refinements of the implementation of the algorithm, such as the classification of records with missing values and, more generally, statistical preprocessing of the input data. Experimental results will be reported.

2 - A Swift Algorithm for the Market Basket Analysis

Luis Cavique, ESCS - IPL, Campus de Benfica do IPL, 1549-014, Lisbon, Portugal, lcavique@escs.ipl.pt

The market basket is defined as an itemset bought together by a customer on a single visit to a store. Although some algorithms can find the market basket, they can be inefficient in computational time. Firstly, the input data set is transformed into a graph-based structure and then the maximum-weighted clique problem is solved using a meta-heuristic approach in order to find the most frequent itemsets. The computational results show accurate solutions with reduced computational times and good scalability properties.

3 - Parallel computing and refinement of DNF in Logic Data Mining

Giovanni Felici, Istituto di Analisi dei Sistemi ed Informatica, Consiglio Nazionale delle Ricerche, Viale Manzoni 30, 00185, Roma, Italy, felici@iasi.cnr.it, *Edgardo Ambrosi*

In this work we propose a method to compute logic formulas from training data and assemble them starting from a large set determined by applying mining methods to distributed data in a parallel computing environment. We use graph and integer programming models to solve the problem and to build a separating DNF with the desired properties. The approach is particularly convenient for large data bases or for data that is distributed on different sites. We describe the method and its implementation using the logic miner Lsquare and evaluate its performances on data bases of relevant dimension

■ WA-10

Wednesday, 8:30-10:00

OR Oddi 201

Ethics for OR and OR for Ethics

Stream: OR - The Profession: Ethics in OR

Invited session

Chair: *Erik Pruyt*, MOSI, Vrije Universiteit Brussel, Pleinlaan 2, 1050, Brussels, Belgium, eruyt@vub.ac.be

1 - Multi-criteria analysis and the resolution of ethical dilemmas in decision-making

Klaas De Brucker, Department of Business Economics - Section Economics and Policy, VLEKHO Business School - Associated to Catholic University of Leuven, Koningstraat 336, BE-1030, Brussels, Belgium, kdebrucker@vlekho.wenk.be, *Cathy Macharis*, *Alain Verbeke*

We demonstrate that some MCA methods address adequately a number of ethical dilemmas, when applied to complex project evaluation. We show that under specific conditions, an MCA approach that embodies a multi-stakeholder perspective can be used to foster the resolution of societal conflicts and the pursuit of the public good. We contrast the value added - in terms of resolving ethical dilemmas - of these stakeholder-oriented with more conventional MCA approaches and cost-benefit analysis. We suggest that the stakeholder-oriented MCA is consistent with the neo-institutional economics paradigm.

2 - How OR assists the discovery of ethical values

Pierre Kunsch, MOSI, Vrije Universiteit Brussel, Pleinlaan 2, 1050, Brussels, Belgium, pkunsch@vub.ac.be, *Michel Theys*

When talking about Ethics in OR', it is usually assumed that a well-defined ethical framework, deontological aspects or other prescriptive guidelines for practitioners are available. In the paper a different point of view is chosen: ethical values are namely strongly influenced by the context: it is why they have first to be discovered and developed in each specific case. Quantitative OR techniques like multi-criteria analysis, agent-based modelling, system dynamics, archetypes in soft system modelling, etc., provide in any situation adequate instruments for this discovery process.

3 - Ethics implicitly and explicitly within MS/OR/S theories, method(ologie)s, techniques, tools and models

Erik Pruyt, MOSI, Vrije Universiteit Brussel, Pleinlaan 2, 1050, Brussels, Belgium, epruyt@vub.ac.be

Many MS/OR/S practitioners are aware of the importance of ethics in the profession, processes and final products. However, the importance of ethics within MS/OR/S theories, method(ologie)s, techniques, and models is less well acknowledged and/or supported. This will be the focus here. First, I will discuss ethics implicitly within MS/OR/S (e.g. world-views and basic assumptions, limits, value and technical choices), followed by ethics explicitly within MS/OR/S. And finally, some (dis)advantages and guidelines for dealing with ethics in MS/OR/S will be discussed.

■ WA-11

Wednesday, 8:30-10:00

TRANS Oddi 202

Freeway Traffic Control

Stream: Transportation

Invited session

Chair: *Markos Papageorgiou*, Production Engineering and Management, Technical University of Crete, Technical University Campus, 73100, Chania, Greece, markos@dssl.tuc.gr

1 - Improvement of a feedback ramp metering strategy

Eric van Berkum, Civil Engineering, University of Twente, PO Box 217, 7500 AE, Enschede, Netherlands, e.c.vanberkum@utwente.nl, *Martijn Ruijters*

In this contribution a modification of the ALINEA local on-ramp control strategy is presented. In this modification, as in ALINEA, the metering rate is determined by a feedback mechanism where the occupancy rate downstream of the merge area is used, yet an adjustment procedure is added, where the stability of the flow upstream of the merge area is used in order to fine-tune the metering rate. Microscopic simulation shows that this improved strategy may yield a significant higher throughput of on-ramp without deteriorating freeway operations.

2 - A simple model for arterial progression

Giuseppe Bellei, Dipartimento di Idraulica Trasporti e Strade, Università degli Studi di Roma, Via Eudossiana 18, 00184, 00184, Rome, Italy, giuseppe.bellei@uniroma1.it, *Fiorella Biondi*

Traffic lights coordination along urban corridors is one of the most frequently utilized tools to manage traffic flows and has been extensively studied. Nevertheless it is possible, by means of a rather simple approach to the problem of optimal coordination, based on the assumption that progression speed has a maximum value, to show that, if oversaturation doesn't take place within the corridor, optimal offsets are such that a direction has maximum speed progression.

3 - Optimal coordinated ramp metering for freeway networks

Markos Papageorgiou, Production Engineering and Management, Technical University of Crete, Technical University Campus, 73100, Chania, Greece, markos@dssl.tuc.gr, *Ioannis Papamichail*, *Ioannis Margonis*, *Apostolos Kotsialos*

A nonlinear rolling-horizon (model-predictive) hierarchical coordinated ramp metering scheme is presented. The hierarchical control structure consists of three layers: the estimation/prediction layer, the optimization layer and the direct control layer. The previously designed optimal control tool AMOC is incorporated in the second layer while the local feedback strategy ALINEA is used in the third layer. Simulation results are presented and it is shown that control of all on-ramps including freeway intersections leads to the optimal utilization of the available infrastructure.

■ WA-12

Wednesday, 8:30-10:00

TRANS Oddi 205

Airplane Boarding

Stream: Transportation

Invited session

Chair: *Eitan Bachmat*, Computer Science, Ben-Gurion U., 1 Ben Gurion Ave, 84105, Beer Sheva, Israel, ebachmat@cs.bgu.ac.il

1 - How to board a 150 seat airplane in less than 15 minutes?

Menkes van den Briel, Department of Industrial Engineering, Arizona State University, PO Box 875906, 85287-5906, Tempe, AZ, United States, menkes@asu.edu, *Rene Villalobos*

One of the key elements that determines the turn time of an airplane is passenger boarding. Several commercial airlines have implemented zone or group boarding in order to speed up the boarding process. We present an integer programming formulation for the airplane boarding problem. The problem is formulated as a nonlinear assignment problem where the objective is to minimize the total expected number of passenger interferences. Our results have successfully been implemented by a major commercial airline in the United States.

2 - On the Optimal Boarding Policy Problem

Luba Sapir, Industrial Engineering and Management, Ben-Gurion University of the Negev, Ben-Gurion Rd. 1, 84105, Beer Sheva, Israel, lsapir@bgu.ac.il, *Eitan Bachmat*, *Daniel Berend*, *Steven Skiena*

We deal with the problem of seating an airplane's passengers optimally, namely in the fastest way. Under several simplifying assumptions, whereby the passengers are infinitely thin and react within a constant time to boarding announcements, we are able to rewrite the asymptotic problem as a calculus of variations problem with constraints. This problem is solved in turn using elementary methods. While the optimal policy is not unique, we identify a rigid discrete structure which is common to all solutions.

3 - Airplane boarding and space-time geometry

Eitan Bachmat, Computer Science, Ben-Gurion U., 1 Ben Gurion Ave, 84105, Beer Sheva, Israel, ebachmat@cs.bgu.ac.il

We provide an analytical model for the airplane boarding process via space-time (Lorentzian) geometry. We show that calculated boarding times match well with results of more detailed event driven simulations.

■ WA-13

Wednesday, 8:30-10:00

TRANS Oddi 206

Routing Problems (SADERYL4)

Stream: Vehicle Routing

Invited session

Chair: *Angel Corberan*, Estadística e Investigación Operativa, Universitat de Valencia, Facultat de Matemàtiques, Avda. Dr. Moliner, 50, 46100, Burjassot, Valencia, Spain, angel.corberan@uv.es

Chair: *Juan José Salazar González*, Estadística e Investigación Operativa, Universidad de La Laguna (Tenerife), Av. Astrofísico Francisco Sánchez, s/n, 38271, La Laguna, Tenerife, Spain, jjsalaza@ull.es

1 - On warehouse routing with capacities and due dates

Antonio Alonso-Ayuso, Statistics Operations Research Department, Rey Juan Carlos University, c/Tulipan s/n, 28933, Mostoles, Madrid, Spain, antonio.alonso@urjc.es,

Maria Albareda Sambola, Elisenda Molina, Clara Simon de Blas

In a warehouse, several orders are received every day. They can be grouped and picked simultaneously by one worker. An assignment problem appears: to decide which orders should be assigned to each worker. This decision should take into account different restrictions (due date.). Different strategies have been used in real situations, but usually, the problem is solved in a two stage process: firstly, orders are grouped and, secondly, the routes are built. Assignment decision does not take into account the routing problem. A model that includes the two decisions simultaneously is presented.

2 - Solving a school bus routing problem

Jorge Riera-Ledesma, Estadística, Investigación Operativa y Computación, DEIOC-Universidad de La Laguna, C/ Astrofísico Francisco Sánchez s/n, 38271, La Laguna, Spain, jriera@ull.es, Juan José Salazar González

This work models a vehicle routing problem arising in the context of transporting students to schools. In this problem one must decide the stop where each student must wait for a bus, and which route each bus must follow. We present two models and implement approaches for finding optimal solutions. Computational results are analyzed on instances adapted from benchmark VRP instances in the TSPLIB.

3 - New results on the windy postman problem

Angel Corberan, Estadística e Investigación Operativa, Universitat de Valencia, Facultat de Matemàtiques, Avda. Dr. Moliner, 50, 46100, Burjassot, Valencia, Spain, angel.corberan@uv.es, Isaac Plana, Gerhard Reinelt, Jose Maria Sanchis, Dirk O. Theis

Given an undirected graph with two costs associated with each edge, representing the cost of traversing it in each direction, the WPP consists of finding the shortest tour traversing at least once every edge. The Zigzag inequalities are among the few families known to induce facets of the polyhedron associated with this NP-hard problem. We show in this talk that the Zigzag inequalities are mod-2 cuts and we also present a new family of facet-inducing inequalities. Finally, some preliminary computational results using new separation procedures for the Zigzag inequalities are reported.

4 - Efficient planning of sales territory design with multiple balancing requirements

Elena Fernandez, Estadística i Investigació Operativa, Universitat Politècnica de Catalunya, Campus Nord, C5-208, Jordi Girona, 1-3, 08034, Barcelona, Spain, e.fernandez@upc.edu, Roger Rios

In this work we present a GRASP approach for a sales territory design problem. The problem, motivated by a real-world application from a soft-drink distribution firm, considers multiple balancing requirements among territories, and a distance-based measure of compactness as an objective function to be minimized. The work includes a preliminary computational evaluation, which shows the effectiveness of the proposed approach when compared to current industry practices.

■ WA-14

Wednesday, 8:30-10:00

PROD Arnag 101

Capacity and Revenue Management

Stream: Operations Management / Revenue Management

Invited session

Chair: *Cornelia Schoen*, Institute for Operations Research and Economic Theory, University of Karlsruhe, Kollegium am Schloss, Geb. 20.14, 76128, Karlsruhe, Germany, schoen@wior.uni-karlsruhe.de

1 - Stochastic capacity allocation using a revenue management approach

Mehdi SharifYazdi, Department of Industrial Engineering, Sharif University of Technology, Azadi Ave., -, Tehran,

Iran, Islamic Republic Of, sharifyazdi@mehr.sharif.edu, Mohammad Modarres

The concept of revenue management is applied in this research to formulate a capacity allocation problem in a manufacturing system. Production capacity is assumed to be stochastic. There are two groups of frequent and one time customers. Price of each unit of capacity is different for each group as well as order cancellation penalty. The model is developed mathematically and we proposed an analytical solution method. We took advantage of unimodality and other properties of the objective function to determine the optimal solution.

2 - Capacity Management and Contract Engineering

Marc Reimann, Institute for Operations Research, ETH Zurich, 8092, Zurich, Switzerland, marc.reimann@ifor.math.ethz.ch

Both product portfolio planning and management of production capacity face new challenges in order to cope with the risks stemming from increasing demand volatility. Moreover, in medium term planning these two areas interact strongly and it is the aim of this work to explore problems at this interface. Using extensions of the newsvendor model, issues like optimal allocation of own capacity, optimal utilization of outsourcing options and valuation and design of product portfolios under varying capacity are studied. Specifically, guidelines for accepting/rejecting certain products are derived.

3 - Integrating Revenue Management and Service Design Decisions

Cornelia Schoen, Institute for Operations Research and Economic Theory, University of Karlsruhe, Kollegium am Schloss, Geb. 20.14, 76128, Karlsruhe, Germany, schoen@wior.uni-karlsruhe.de

Customer choice for flights is mainly influenced by availability, price, schedule and ticket restrictions. While the decisions about which products to offer at which price are usually made at the operational revenue management (RM) level, service design (SD) decisions like fare product and schedule design are more strategic. However, as the revenue impact of the SD is ultimately determined at the operational level, SD and RM decisions are highly interdependent calling for integration of these problems typically treated in isolation. We propose several approaches to integrate SD and RM.

■ WA-15

Wednesday, 8:30-10:00

PROD Arnag 201

Supply Chain Management IV

Stream: Supply Chain Management (c)

Invited session

Chair: *Marco Semini*, SINTEF, S.P. Andersensvei 5, 7465, Trondheim, Norway, marco.semini@ntnu.no

1 - Combined optimization of production, inventory and distribution

Mourad Boudia, ICD-GSI, University of Technology of Troyes, 12 Rue Marie Curie BP 2060 Cedex, 10010, Troyes, France, boudia@utt.fr, *Christian Prins*

A multi-period, multi-item production-distribution problem is studied to minimize a total cost including production setups, storage and delivery. The iterative method proposed uses linear programming to get a first production plan and tabu search to deduce a distribution plan (set of vehicle trips in each period). The production plan is then rebuilt, taking the amounts delivered as input data, and a new distribution plan is computed. This process stops when the two plans become stable. This approach is compared to a classical two-phase method and significant savings are obtained.

2 - Joint Economic Procurement -Production-Delivery Policy for Multiple Items in a Supply Chain

Yushin Hong, Mechanical Industrial Engineering, POSTECH, San 31, Hyoja, 790-784, Pohang, Korea, Republic Of, yhong@postech.ac.kr

We propose an analytical model to integrate procurement, production and delivery activities in a supply chain consisting of multiple raw material suppliers, a manufacturer and multiple retailers. Each retailer places orders based on an EOQ policy. The manufacturer procures the raw materials, produces the items under a common rotation cycle policy, and delivers them to the respective retailers. We determine the optimal common production cycle length, delivery and procurement frequencies that minimize the average total cost. Numerical test shows that the approach gives good solutions.

3 - Pushing Quality Improvement along Supply Chains

Rachel Zhang, IELM, Hong Kong UST, Clear Water Bay, 00000, Kowloon, Hong Kong, rzhang@ust.hk

In this paper, we consider a buyer who designs a product and owns the brand, yet outsources the production to a supplier. Since both the buyer and the supplier incur quality costs, e.g., costs of customer goodwill and future market share loss at the buyer and warranty related costs at the supplier whenever a nonconforming item is sold to a customer, both parties have an incentive to invest in quality improvement efforts. This paper explores the roles of different parties in a supply chain in quality improvement as functions of the quality level and the quality cost born by each party.

4 - Applicability of quantitative models to logistics decision-making in manufacturing supply chains

Marco Semini, SINTEF, S.P. Andersensvei 5, 7465, Trondheim, Norway, marco.semini@ntnu.no, *Haakon Fauske*

A variety of different types of quantitative models have been used to address logistics decision problems in manufacturing supply chains, such as facilities design, inventory management and manufacturing planning and scheduling. This research explores how successfully the models have been applied to different real-world decision problems. Such research provides practitioners with indications about when to use what type of model, and it can direct further research towards practically relevant modeling issues. Over 200 successful real-world applications described in literature are reviewed.

■ WA-16

Wednesday, 8:30-10:00

PROD Arnag 301

Scheduling under Uncertainty

Stream: Scheduling

Invited session

Chair: *Sanja Petrovic*, School of Computer Science and Information Technology, University of Nottingham, Jubilee Campus, NG8 1BB, Nottingham, United Kingdom, sxp@cs.nott.ac.uk

1 - A Generalized FMS Control System with Operations of Random Durations.

Aharon Gonik, Head of Logistics Studies Department, Sapir Academic College, D.N. Hof, Ashkelon, 79165, Sderot, Israel, aharong@sapir.ac.il

The problem is to determine and control both optimal capacity value for every operation and an optimal feeding-in resource schedule in a FMS comprising random durations. This control system stands in the interface between optimal planning and optimal production control. A two-level control system including n different operations which are operated in a definite technological sequence and have a completion deadline are considered. The FMS has a central store of different renewable resources.

2 - Controlling flexible manufacturing systems in real-time

Thomas van Brackel, University of Paderborn, Warburger Straße 100, 33098, Paderborn, Germany, tvb@upb.de

A new approach controlling flexible job-shop systems in real-time is introduced. This approach is capable of handling occurring disturbances in order to ensure an efficient execution of the production plan. Known models are expanded by the integration of disturbance scenarios, installing a flexible production structure and lotsizing aspects. To solve this new optimization problem, an efficient parallel genetic algorithm is developed which is able to conduct a rescheduling simultaneous to the execution of the production processes.

3 - Sensitivity Analysis Of Production Scheduling Problems With Uncertain Job Processing Times

Sanja Petrovic, School of Computer Science and Information Technology, University of Nottingham, Jubilee Campus, NG8 1BB, Nottingham, United Kingdom, sxp@cs.nott.ac.uk, *Carole Fayad*, *Dobrila Petrovic*

This paper deals with the sensitivity analysis of a class of complex job shop scheduling problems, which are characterized by large number of jobs and machines, uncertain job processing times that are modelled by fuzzy numbers, and multiple measures of schedule performance. The base schedule is generated by applying a fuzzy multiobjective genetic algorithm. The aim of the sensitivity analysis is to investigate the consequences of changes to job processing times, and to determine those jobs and machines that are critical with respect to the performance measures of a schedule.

4 - Improving Packaging Operations at GE Advanced Materials

Rajesh Tyagi, GE Global Research, One Research Circle, 12309, Niskayuna, NY, United States, tyagi@research.ge.com, *Srinivas Bollapragada*

The Crystalline Polymer Products division of GE Advanced Materials commissioned a simulation study to increase the capacity of its packaging operations. The packaging facilities for 13 extrusion lines were causing a major bottleneck that was impacting the plant throughput. GE Global Research simulated the plant operations to show that the packaging capacity could be increased through better scheduling without additional equipment and manpower. We then developed and implemented a novel scheduling system that increased throughput capacity by 20 percent and yielded significant productivity gains.

5 - Stochastic Single Machine Scheduling With Early-tardy Penalties

Umar Al-Turki, Systems Engineering Department, KFUPM, Dhahran 31261, Saudi Arabia, Dhahran, Saudi Arabia, alturki@ccse.kfupm.edu.sa, *Mohamed Seliama*

We consider the single machine scheduling problem, in which the machine is subject to random breakdowns and all jobs have a given fixed common due window. No penalty is incurred for jobs that are completed within the window. The objective is find the optimal sequence and optimal due window location to minimize the expected weighted sum of earliness, tardiness, and due window location penalties. The v-shaped nature of the optimum schedule is investigated for Poisson process describing the number of breakdowns.

■ WA-17

Wednesday, 8:30-10:00

PROD Arnag 303

Parallel Machine Scheduling

Stream: Scheduling

Invited session

Chair: *Giorgio Romanin-Jacur*, Management and Engineering, University of Padova, Stradella San Nicola, 3, 36100, Vicenza, Italy, romjac@dei.unipd.it

1 - Customer Order Scheduling to Minimize the Weighted Number of Late Orders

Hsiao-Lan Huang, Institute of Information Management, National Chiao Tung University, 1001, University Road, 300, Hsinchu, Taiwan, lan0903@gmail.com, *Bertrand Lin*

Abstract: In this paper, we consider the scheduling of a set of orders, each of which consists of several jobs. The jobs in an order can be processed in parallel on their dedicated machines. The completion time of an order is the moment the jobs belonging to it are all completed. The problem is to minimize the weighted number of tardy jobs. We formulate time-indexed, position-indexed and interval-indexed mathematical programs and then develop lower bounds. Approximation algorithms are also proposed. Computational experiments are conducted to assess the performance of our results.

2 - Tabu Search for discrete-continuous scheduling problems with heuristic continuous resource allocation

Grzegorz Waligora, Institute of Computing Science, Poznan University of Technology, Piotrowo 2, 60-965, Poznan, Poland, gwaligora@cs.put.poznan.pl

A problem of scheduling non-preemptable, independent jobs on parallel, identical machines under an additional continuous resource is considered. The problem is to find a sequence of jobs on machines and, simultaneously, a continuous resource allocation that minimize the makespan. A heuristic approach to allocating the continuous resource is proposed. The tabu search metaheuristic to solve the problem is presented, as well as simple search methods - multi-start iterative improvement and random sampling. The algorithms are compared on the basis of a computational experiment.

3 - Approximate algorithms for high-multiplicity parallel machine scheduling problems

Giorgio Romanin-Jacur, Management and Engineering, University of Padova, Stradella San Nicola, 3, 36100, Vicenza, Italy, romjac@dei.unipd.it, Carlo Filippi

In many scheduling applications, a large number of jobs are grouped into comparatively few lots of identical jobs. High-Multiplicity problems result, for which standard models and methods must be suitably modified. We use a fluid relaxation of a parallel-machine, H-M scheduling problem, where every lot may be continuously split and processed on different machines, also simultaneously. We study problems with identical, uniform, and unrelated machines, and different objectives. We develop simple algorithms that are asymptotically exact for increasing lot size, and we evidence some open problems.

■ WA-18

Wednesday, 8:30-10:00

PROD Arnag 304

Public facility location

Stream: Locational Analysis

Invited session

Chair: Daniel Serra, Economics and Business, Universitat Pompeu Fabra, Trias Fargas 25-27, 08005, Barcelona, Spain, daniel.serra@upf.edu

1 - Optimization of Kindergarten location in Akureyri

Gudmundur Oskarsson, Faculty of Business Administration, University of Akureyri, Solborg, 600, Akureyri, Iceland, bjarnihjardar@hotmail.com, Bjarni Hjardar

In Akureyri, Northern-Iceland, approximately 1000 children attend approximately 15 kindergartens. The paper describes the current status, that is location and placement of each children, expected demand after five years, and presents two methods of optimization of the problem of least traveling distance, first a simple center of gravity method and secondly a comprehensive p-median near-optimal solution. Moreover, recommendations for future facility planning in Akureyri municipality is presented.

2 - The use of sustainability metric in Locational Analysis

José L. Pino, Estadística e Investigación Operativa, Universidad de Sevilla, Avenida Reina Mercedes s/n, 41012, Sevilla, Spain, jlpino@us.es, M^a Teresa Cáceres

Locational Analysis is a scientific subject of interest for a wide range of disciplines. Geography, Economics, Statistics, O.R. and Computer Science are areas with research about location problems. The frontier-like condition implies advantage for the potential range of applications. Optimally locating a facility in a network is an important problem in several fields. Some researchers have pointed out the necessity of including approaches of sustainability in facility location problems. In this paper a first approximation to the use of sustainability metric in location problems is made.

3 - A DSS for locating public facilities in Barcelona

Daniel Serra, Economics and Business, Universitat Pompeu Fabra, Trias Fargas 25-27, 08005, Barcelona, Spain, daniel.serra@upf.edu

In this paper we present a decision support system to locate fire stations in Barcelona. The model uses modern heuristics such as ant-colony and tabu search methods. It has an easy interface with the planner to decide which facilities have to be removed and where to open new ones. The software can also be used to locate any type of public or private facility in the network of Barcelona.

■ WA-19

Wednesday, 8:30-10:00

PROD Arnag 311

Managing Development Projects

Stream: Project Management & Scheduling (c)

Invited session

Chair: Eduardo Guillén Solorzano, Economic Analysis and Business Administration, University of La Coruña, E.U. Diseño Industrial. Dr. Vazquez Cabrera S.N., 15403, Ferrol, Spain, edugs@udc.es

1 - The Optimal Resource Allocation in Stochastic Activity Networks via the Electromagnetism Approach: A Platform Implementation in Java

Anabela Pereira Tereso, Systems and Production Department, Minho's University, Campus de Azurém, 4800-058, Guimarães, Portugal, anabelat@dps.uminho.pt, Maria Madalena Araújo, Rui Novais

An optimal resource allocation approach to stochastic multimodal projects had been previously developed by applying a Dynamic Programming model, which proved to be very demanding computationally. A new approach, the Electromagnetism Algorithm, has also been adopted and implemented in Matlab, to solve this problem. This paper presents the implementation of the Electromagnetism Algorithm using an Object Oriented language, Java, in order to take advantage of available computational resources.

2 - Simulation Based Control of Project Duration under Risk

Brigitte Werners, Wirtschaftswissenschaft, Ruhr-University Bochum, Universitätsstr, 44780, Bochum, Germany, or@rub.de

For projects, a contracted completion-date has to be met or else delay penalties fall due. If during project realisation delays occur, it must be decided on interventions. The presented decision support system for project control under risk increases the quality of planning data, such as the probability of meeting deadlines or the estimation of costs. Past or future deviations from the planned project schedule are identified in time and corrective control actions are suggested. Not only crash costs and penalty costs are taken into account but also the decision maker's risk attitude.

3 - Planning For Product Design Projects: Comparing Industry Practices To Theoretical Project Planning Methods

Eduardo Guillén Solorzano, Economic Analysis and Business Administration, University of La Coruña, E.U. Diseño Industrial. Dr. Vazquez Cabrera S.N., 15403, Ferrol, Spain, edugs@udc.es, Susana Barbeito, Manuel Martinez

In this research we aim to compare the reality existing in different industries in North Western Spain and the theoretical models to be applied to product design projects. The research was conducted by developing Design Audits in more than 50 industrial companies. The outcomes of the research show that whereas the theoretical models stand for explicit, non sequential, multidisciplinary processes, companies do apply implicit and sequential models for managing product design, reducing the opportunities for the company, and losing control of the process.

4 - AVALGES - A Methodology for Project Evaluation and Management

Aldora Fernandes, Timbermade- Industria de Madeira, LDA, Parque Industrial de Laundos lote 41, 4900-063,

Póvoa de Varzim, Portugal, g.fernandes@madeicavado.pt,
 Maria Madalena Araújo, Fernnado Correia

Project Management is a well developed and accepted science, both at the professional and the academic level. Numerous methods, techniques and tools have been developed. However, it remains a problematic area. Many projects exceed their budgets, suffer delays and fail to attain their objectives. We believe that there is some lagging between the development of the techniques and their application. In order to help to overcome this difficulty we developed a methodology (AVALGES) that integrates all project's processes, from the conception phase until the closing down, incorporating ten phases.

5 - Constraint-Based Rostering

Gilles Pesant, CRT, École Polytechnique de Montréal, CP 6079 succ. Centre-ville, H3C 3A7, Montreal, Quebec, Canada, pesant@crt.umontreal.ca

Solving real-life rostering problems remains a challenging task. Constraint programming (CP) has to its advantage a rich modeling language that makes it easy to express complex regulations and to use them to guide the search for a solution. This talk will show how realistic rostering problems may be modeled in CP, using some of the latest research. Experimental results on benchmark problems will be given to support the efficiency and robustness of this approach.

■ WA-20

Wednesday, 8:30-10:00

HEUR Arnag 422

Metaheuristics II

Stream: Metaheuristics (c)

Invited session

Chair: Ole Brodersen, Abteilung 1, Institut für Wirtschaftsinformatik, Platz der Göttinger Sieben 5, 37073, Göttingen, Germany, obroder@gwdg.de

1 - A hierarchical optimization method for planning a surveillance

Cecile Simonin, DGA - CNRS, DGA / CEP Arcueil / GIP, 16 bis avenue Prieur de la côte d'or, 94110, Arcueil, France, cecile.simonin@gmail.com, Le Cadre Jean-Pierre, Dambreville Frédéric

An optimisation based on Cross-Entropy will be used to solve a hierarchical problem (high complexity). The hierarchical problem described in this paper is inspired by the intelligence procedures for searching clues. The aim is to find a motionless target hidden in a large space, by means of scarce sensors. It is made of 2 leveled interconnected problems: (1) sensors allotment to search zones (CE), (2) finding the best spatial sharing for a sensor allotted to a given search zone (de Guenin, Brown optimizations). Cases studied: simple cases (to validate CE), detection-confirmation problems...

2 - Selection of views to materialize in data warehouse. A hybride solution

Abdelmadjid Boukra, Computer science, USTHB, Faculty of electronic and computer science, Laboratory LSI, P.Box 32 ElAlia Bab ezzouar, 16111, Algiers, Algeria, amboukra@yahoo.fr

The idea of a data warehouse was introduced so as to make decisions efficiently. One of the determining parameters in this effectiveness is the response time to the requests. One of the techniques used to reduce this time span is to select a set of views and materialize them. Then, a difficulty arises. It is that choosing the set of views to materialize to minimize the total response time while respecting certain constraints related to the resources. In this paper, we propose a new algorithm, based on the evolutionary and the ants colonies algorithms.

3 - First steps of Particle Swarm Optimization in management applications – optimizing a 2-product warehousing

Ole Brodersen, Abteilung 1, Institut für Wirtschaftsinformatik, Platz der Göttinger Sieben 5, 37073,

Göttingen, Germany, obroder@gwdg.de, Andreas Lackner, Maik Günther, Andrea Höhn, Jörg Biethahn

Particle Swarm Optimization (PSO) is a global optimization technique which has formerly mainly been applied to engineering problems and training of neural networks. Within this line of research we are introducing a warehousing problem as an example of a management application and compare the solutions provided by different parameterized PSO versions. We found that classical PSO and PSO with inertia weight can be used to receive optimal solutions for this optimization problem. Comparing the effectiveness of different parameterizations PSO with inertia weight tends to find solutions quicker.

4 - Balance versus Cost when Redesigning Web Communities

Margarida Pato, Dept. Matemática, ISEG (Univ. Técn. Lisboa), Centro de Investigação Operacional, FC (Univ. Lisboa), Rua do Quelhas, 6, 1200-781, Lisboa, Portugal, mpato@iseg.utl.pt, Susana Colaço

The linking structure within a web community is usually very unbalanced. To democratise information access or even for marketing purposes, new links must be created and controller domains selected. In the light of this situation, the Web Balancing Problem was modelised in the context of hub location. Two different, contradictory objectives were targeted: linking structure balance and cost minimisation. Exact and heuristic methods for generating solutions of the problem will be presented and the results of their application to real web communities discussed.

■ WA-22

Wednesday, 8:30-10:00

OPT Adal 050

Recent Developments in Multiple Objective Optimization

Stream: Multiple Objective Optimization

Invited session

Chair: Oliver Schütze, Institute for Industrial Mathematics, University of Paderborn, Warburger Str. 100, 33095, Paderborn, Germany, schuetze@upb.de

1 - A new label technique for the multiobjective shortest path problem

José Pinto Paixão, DEIO, University of Lisbon, CIO, Bloco C6 - Piso 4, 1749-016, Lisbon, Portugal, apaia@fc.ul.pt, José Santos

The multiobjective shortest path problem (MSPP) is defined in a vector valued network. As usually, the resolution of the MSPP turns into finding nondominated (ND) paths. In the proposed method, the lexicographic shortest path is selected and the search tree is then developed from the nodes involved in the path. This algorithm computes sequentially deviation shortest paths until all ND paths are obtained. Consequently, it finds ND s-t paths at a very early stage. Computational results are presented comparing the performance of the new technique with the classical ones.

2 - A Continuation Method for the Numerical Treatment of (High-Dimensional) Multi-Objective Optimization Problems

Oliver Schütze, Institute for Industrial Mathematics, University of Paderborn, Warburger Str. 100, 33095, Paderborn, Germany, schuetze@upb.de

We will present new set oriented continuation method for the computation of implicitly defined manifolds and will pay special attention to multi-objective optimization. In order to obtain a good spread of the obtained solutions we use boxes for the representation of the computed parts of the solution set. The data structure in combination with a novel predictor-corrector variant allow for the efficient computation of solution sets, in particular in higher dimensions ($n_i \leq 1000$). We conclude the talk with some numerical results indicating the strength of our method.

■ WA-23

Wednesday, 8:30-10:00

OPT Adal 051

Applications of Combinatorial Optimization

Stream: Combinatorial Optimization (c)

Invited session

Chair: *Martin Gavalec*, Department of Information Technologies, Faculty of Informatics and Management, University of Hradec Kralove, Rokitanskeho 62, 50003, Hradec Kralove, Czech Republic, Martin.Gavalec@uhk.cz

1 - Evaluation of integer programming discriminant function by 20,000 cases

Shuichi Shinmura, Faculty of Economics, Seikei University, Kichijoji Kitamachi 3-3-1., 180-8633, Musashinoshi, Tokyo, Japan, shinmura@econ.seikei.ac.jp

Revised IP-OLDF that minimizes misclassification number (MMN) proves its usefulness by Internal and External Check. Internal Sample (IS) is real data with 200 cases and 6 variables. 20,000 cases as same means and variance-covariance matrices as IS are generated. This is used as External Sample(ES). This method is applied for IS, and 63 discriminant functions are obtained. Next, these models are applied for ES. One of three-variable model is best because its MMN is 7, nevertheless MMN of other three-variable models are over than 183.

2 - On the order of partitions of an integer

Sadek Bouroubi, Faculty of Mathematics, Dept of Operations research, USTHB University, BP32 Bab ezzour 16111, 16111, Algiers, Algeria, bouroubis@yahoo.fr

In this work we are interested in the order of the partitions of an integer n , noted $Pi(n)$, ordered by refinement. As the graphic representation of any problem makes it simpler and easier, we showed some new properties of this order, based on the representation of its Hasse diagram, and we stated some conjectures.

3 - On-line Service Scheduling

Bo Chen, Warwick Business School, University of Warwick, Gibbet Hill Road, CV4 7AL, Coventry, United Kingdom, b.chen@warwick.ac.uk

This paper is concerned with a scheduling problem in service systems, in which customers arrive dynamically over time and are classified as "ordinary" and "special". While ordinary customers can be served on any service facility, special customers need to be served only on the flexible service facilities. We study the worst-case performance of service policies used in practice. In particular, we evaluate three classes of service policies: policies with priority, policies without priority, and their combinations. We obtain tight worst-case performance bounds for all service policies considered.

4 - Eigenspace dimension of a Monge matrix

Martin Gavalec, Department of Information Technologies, Faculty of Informatics and Management, University of Hradec Kralove, Rokitanskeho 62, 50003, Hradec Kralove, Czech Republic, Martin.Gavalec@uhk.cz, *Jan Plavka*

The steady states of discrete event processes correspond to eigenvectors of max-plus matrices, hence characterization of the eigenspace structure is of great importance for the applications. If the considered matrix has some special properties, then the investigation is often more efficient. The aim of this contribution is to give a complete description of the eigenspace structure for a given Monge matrix. The presented algorithm for computing the eigenspace dimension works in better time than the previous ones. This work was supported by GACR #402/06/1071 and VEGA #1/2168/05.

■ WA-24

Wednesday, 8:30-10:00

OPT Adal 052

Systems Optimisation

Stream: Dynamical and Anticipatory Systems

Invited session

Chair: *Ryszard Klempous*, Faculty of Electronics, Wrocław University of Technology, 27 Wybrzeze Wyspianskiego Street, 50370, Wrocław, Poland, klempous@yahoo.com

Chair: *Dan Butnariu*, Department of Mathematics, University of Haifa, Mount Carmel, 31905, Haifa, Israel, dbutnaru@math.haifa.ac.il

1 - An Algorithm of Schedule Planning for Tanker Drivers

Jerzy Kotowski, Institute of Computers, Control and Robotics, Wrocław University of Technology, ul. Zygmunta Janiszewskiego 11/17, 50-372, Wrocław, Poland, jerzy.kotowski@pwr.wroc.pl

A modification of an evolutionary algorithm is characterized. It is intended for planning a schedule for tanker drivers. The modification is based on the Baldwin Effect. The most important element of the algorithm is the procedure of projection of the genotype on the set of phenotypes. In the considered case it is a set of feasible solutions to a problem. Two kinds of tests were conducted. The conclusion resulting from all the tests performed is as follows: In evolutionary computation the Baldwin Effect leads to very effective optimization algorithms.

2 - Middleware for dynamic and resource constrained sensor network.

Zenon Chaczko, Faculty of Engineering, University of Technology, Sydney, Broadway, PO Box 123, 2007, Sydney, NSW, Australia, zenon@eng.uts.edu.au, *Sourendra Sinha*

The notion of the proposed middleware solution (MAGNA) is to bring about context-based processing and intelligent data capture and/or filter right up to the sensor nodes through the use of powerful "sub-net" controllers. The paper will explore the application of MAGNA as a platform capable of offering ambient intelligence in a typical sensor network environment, integrating everyday appliances and our life-style together. In doing so, two primary methodologies will be discussed on which MAGNA is essentially based, namely the Soft Systems Methodology and the Banking Model approach.

3 - A Method of Solving Variational Inequalities With Data Perturbations

Dan Butnariu, Department of Mathematics, University of Haifa, Mount Carmel, 31905, Haifa, Israel, dbutnaru@math.haifa.ac.il

Problems which can be solved as variational inequalities often involve inexact and/or perturbed data. Can such data be used for computing solutions of the original, unperturbed, variational inequality? We present an iterative method which allows to do just that. Under quite mild conditions for the perturbed data it produces approximations of minimal-norm solutions for monotone variational inequalities.

4 - On-line nonlinearity amendment in Hammerstein&Wiener systems by wavelets

Ryszard Klempous, Faculty of Electronics, Wrocław University of Technology, 27 Wybrzeze Wyspianskiego Street, 50370, Wrocław, Poland, klempous@yahoo.com, *Przemyslaw Sliwinski*, *Jerzy Rozenblit*, *Michael Marcellin*

Existing nonlinear dynamic models (e.g. based on Hammerstein, Wiener or Uryson systems) applied in, e.g., modeling of financial processes, transmission channels, or eye movement, usually employ finite size polynomial models (Hermite, Laguerre or Legendre). Thus, if the genuine nonlinearity is, e.g., piecewise smooth, they provide with rough approximation only. We propose an algorithm improving existing nonlinearity models by using wavelet add-on modules. Convergence of the assembly to the genuine nonlinearity of arbitrary shape and the optimal convergence rate are both established.

5 - Multimodel approach to Human Motion Identification

Ryszard Klempous, Faculty of Electronics, Wrocław University of Technology, 27 Wybrzeże Wyspiańskiego Street, 50370, Wrocław, Poland, klempous@yahoo.com

The main problem solved is partition set of primitive motions according to similarity between motions. The motion models are constructed to easier extract features of given motions. Using these models the measure of discrepancy between motions is proposed. Moreover, it normalizes length of motions and decreases high dimension of considered motion data, so clustering may take place in dimensionally reduced space. Human motion is a complex process and its various characteristics may be used in biometric analysis. Different motion representations is also considered .

■ WA-25

Wednesday, 8:30-10:00

OPT Adal I-111

Multiobjective Optimization

Stream: Mathematical Programming

Invited session

Chair: Ana Viana, ISEP/INESC PORTO, Campus da FEUP, Rua Dr. Roberto Frias, 4220-465, Porto, Portugal, aviana@inescporto.pt

1 - Multiobjective Genetic Algorithms in Plate Design Optimization

Lino Costa, Dept. Production and Systems Engineering, University of Minho, Campus de Gualtar, 4710-057, Braga, Portugal, lac@dps.uminho.pt, Isabel Maria Narra de Figueiredo, Rogério Leal, Pedro Oliveira

Real-world problems often impose (by both natural and technological reasons) the consideration of integer variables that lead to mixed integer nonlinear problems, lacking the properties of differentiability and convexity. In this work, the application of a multiobjective genetic algorithm to laminated plate design problems is described. The results show the appropriateness of the algorithm and of the mathematical model for the solution of these optimization problems, as well as the superiority of the multiobjective approach.

2 - Multiobjective genetic algorithm to set covering problem

Andre Santos, Computer Science Department, Universidade Federal de Minas Gerais, Rua Princesa Isabel, 373 / 201, 35300074, Caratinga, MG, Brazil, andre@dcc.ufmg.br, Marco Carvalho, Geraldo Mateus

Crew-scheduling problem builds schedules, minimizing operational costs, but should maximize crew satisfaction and the possibility to re-schedule to cover a crew delay. Its solution is based on set covering problem (SCP). There is not a single solution that optimizes those conflicting objectives. Genetic algorithms (GA) fit well on this case, as it works with a set of potential solutions. We solve the multicriteria SCP by a GA adding, among others, a round-robin priority in the select phase, to spread the solutions around the pareto optimal curve, resulting a bigger and best set of solutions.

3 - Extended dominance relations in dynamic programming

Daniel Vanderpooten, LAMSADE - Université Paris Dauphine, Place de Marechal de Lattre de Tassigny, 75775, Paris, France, vdp@lamsade.dauphine.fr, Cristina Bazgan, Hadrien Hugot

Dominance relations in dynamic programming are used to discard at any stage states representing partial solutions. For some classes of combinatorial optimization problems, e.g. for the approximation versions, the preference relation used to compare solutions is not necessarily transitive and may even admit cycles. We extend the concept of dominance relations in order to handle such classes and provide a generalized dynamic programming framework. We illustrate our approach on single or multi-objective combinatorial optimization problems.

4 - Multiobjective Constraint Oriented Neighbourhoods

Ana Viana, ISEP/INESC PORTO, Campus da FEUP, Rua Dr. Roberto Frias, 4220-465, Porto, Portugal, aviana@inescporto.pt, Jorge Pinho de Sousa, Manuel Matos

We propose a new multiobjective metaheuristic (mCON) that considers several neighbourhood structures to be applied in the search process, according to the type of problem constraints that are violated and to the objective that one is willing to improve the most.

mCON was applied to the Unit Commitment problem in power systems management, considering two objectives - operating costs and emissions. The results obtained were compared with MOSA and PSA, the comparison showing that the method is effective at solving the problem, and more robust to variations in the metaheuristic parameters.

■ WA-26

Wednesday, 8:30-10:00

OPT Adal III=231

QUBO: Quadratic Unconstrained Binary Optimization

Stream: Combinatorial Optimization

Invited session

Chair: Peter L. Hammer, Rutgers, The State University of New Jersey, 640 Bartholomew Road, 08854, Piscataway, NJ, United States, hammer@rutcor.rutgers.edu

1 - Network approaches for QUBO

Endre Boros, Rutgers University, United States, boros@rutcor.rutgers.edu, Peter L. Hammer, Gabriel Tavares

We present two network formulations to compute bounds for QUBO. The first formulation provides an efficient method to compute the so called roof-dual bounds, provides the maximum possible set of variables which can be fixed by strong persistency at their optimal values, and provides a natural decomposition of the residual problem. The second, more symmetric formulation provides a generalization of roof-duality, and an improved iterated variant of these bounds. We present an extensive computational evaluation of these bounds.

2 - Preprocessing QUBO Problems

Peter L. Hammer, RUTCOR, Rutgers, The State University of New Jersey, 640 Bartholomew Road, 08854, Piscataway, NJ, United States, hammer@rutcor.rutgers.edu, Endre Boros, Gabriel Tavares

We present applications of roof-duality and other techniques for determining optimal values of subsets of variables, finding binary relations between optimal values of pairs of variables, and decomposing problems into pair-wise disjoint smaller ones. Applications include optimal solutions of stability problems in planar graphs with up to 500,000 vertices.

3 - Probabilistic based heuristics for QUBO

Gabriel Tavares, RUTCOR, Rutgers University, 640 Bartholomew Road, 08854-8003, Piscataway, NJ, United States, gtavares@rutcor.rutgers.edu, Endre Boros, Peter L. Hammer

We propose a family of heuristics for QUBO based on local optimality conditions, their randomization and rounding procedures. We consider several probability distributions for both standard local search variants, and guaranteed polynomial time one-pass versions. Comparative computational studies on typical problems (including MAX-CUT, MAX-2-SAT and MAX-CLIQUE) involving up to tens of thousands of variables and millions of terms indicate both the efficiency and effectiveness of the proposed methods.

■ WA-27

Wednesday, 8:30-10:00

OPT Adal V=229

COIN-OR II

Stream: COIN-OR: Open Source Software

Invited session

Chair: *John Tomlin*, Yahoo! Research, 701 First Avenue, 94089, Sunnyvale, CA, United States, johntomlin@acm.org

1 - OSiL: An Open Standard for Expressing and Using Optimization Problem Instances

Robert Fourer, Industrial Engineering and Management Sciences, Northwestern University, 2145 Sheridan Road, 60208-3119, Evanston, IL, United States, 4er@iems.northwestern.edu, *Jun Ma*, *Kipp Martin*

Distributed modeling environments necessitate an open standard for exchanging optimization problem instances. For this purpose we present OSiL, an XML-based instance representation for large-scale linear and nonlinear optimization. OSiL uses the object-oriented features of XML to efficiently represent nonlinear expressions. Its schema maps directly to an in-memory representation that provides a robust application programming interface, facilitates reading and writing a range of data formats, and makes the nonlinear expression tree readily available for function and derivative evaluations.

2 - Stochastic Modeling in COIN-OR: Next Steps

Alan King, IBM Research, PO Box 218, 10598, Yorktown Heights, NY, United States, kingaj@us.ibm.com

We discuss the basic infrastructure of COIN-OR and outline the requirements we wish to meet: (1) incorporate probabilistic modeling concepts, including stochastic programming and robust optimization, (2) support solution concepts, including modeling distributions and implementing solvers, and (3) interfaces to modeling languages.

3 - The COIN Open Solver Interface

Jp Fasano, TJ Watson Research Center, IBM Research, 1101 Kitchawan Road, 10598, Yorktown Heights, NY, United States, jpfasano@us.ibm.com

The COIN-OR Open Solver Interface (OSI) is a uniform C++ API (Application Program Interface) for calling math programming solvers. Programs written to the OSI standard may be linked to any solver with an OSI interface and should produce correct results. This talk will cover using the OSI to create an LP formulation, modify the formulation by adding rows/columns, modify the formulation by adding cutting planes provided by the COIN Cut Generation Library (CGL), solving the formulation (and resolving after modification) and extracting the solution.

■ WA-28

Wednesday, 8:30-10:00

OPT Adal VI=207

Stochastic Dynamic Programming

Stream: Dynamic Programming

Invited session

Chair: *Suresh Sethi*, School of Management, SM30, University of Texas at Dallas, P.O. Box 830688, 75083, Richardson, TX, United States, sethi@utdallas.edu

Chair: *Metin Cakanyildirim*, Operations Management, University of Texas at Dallas, School of Management, Po Box 75083-0688, 75083, Richardson, TX, United States, metin@utdallas.edu

1 - A Partially Observed Markov Decision Process for Dynamic Pricing of Finite Inventory

Yossi Aviv, Olin School of Business, Washington University, Campus Box 1133, 1 Brookings Drive, 63130, Saint Louis, MO, United States, aviv@wustl.edu

We develop a partially observed Markov decision process (POMDP) framework for dynamic pricing of fashion-like goods. We propose an Information State Modification (ISM) relaxation method that results in a relatively simple dynamic program, which also serves as a rigorous and impressively tight upper bound on the optimal expected revenues.

2 - An Approximate Dynamic Programming Approach for making R&D Investment Decisions

Joseph Hartman, Industrial and Systems Engineering, Lehigh University, Mohler Lab, 200 W. Packer Ave., 18015, Bethlehem, PA, United States, jch6@lehigh.edu

Growth in the pharmaceutical industry is driven by the research and development (R&D) of drugs. With limited resources, a company must periodically consider which drugs to pursue and fund in the R&D process. We model this process with stochastic dynamic programming. As the state space is of high dimension, the recursion can only be solved over a few periods. Thus, we employ approximation techniques to extend the horizon of analysis and ensure good time zero decisions. We illustrate our approximation scheme, computational results, and insights gained for the decision-making process.

3 - Optimal Ordering Policies for Inventory Problems with Dynamic Information Delays

Suresh Sethi, School of Management, SM30, University of Texas at Dallas, P.O. Box 830688, 75083, Richardson, TX, United States, sethi@utdallas.edu, *Alain Bensoussan*, *Metin Cakanyildirim*

Information delays exist when the most recent inventory information available is dated. We introduce dynamic information delays as a Markov process into the standard multi-period stochastic inventory problem. We develop a reference inventory position. This position is a part of a sufficient statistic for the optimal order quantities.

■ WA-29

Wednesday, 8:30-10:00

OPT Adal VII=225

Algorithms and Software for Global Optimization

Stream: Global Optimization: Deterministic and Stochastic Methods

Invited session

Chair: *Mirjam Duer*, Department of Mathematics, Darmstadt University of Technology, Schlossgartenstr. 7, D-64289, Darmstadt, Germany, duer@mathematik.tu-darmstadt.de

1 - Worst case analysis of mechanical structures

Arnold Neumaier, Fakultät fuer Mathematik, University of Vienna, Nordbergstr. 15, A-1090, Vienna, Austria, Arnold.Neumaier@univie.ac.at

A method is described for computing worst case bounds on the solution of finite element calculations for structures with uncertain material properties or loads, with a computable overestimation factor that is frequently quite small. Excellent bounds are computed for some large, uncertain truss structures with up to about 10% input uncertainty.

This permits a true worst case analysis of the influence of such uncertainties, which was previously possible only for very small systems or very small uncertainties.

2 - An Adaptive Radial Basis Algorithm (ARBF) for Expensive Black-Box Mixed-Integer Constrained Global Optimization

Nils-Hassan Quttineh, Department of Mathematics and Physics, Mälardalen University, Mälardalens högskola, Box 883, 721 23, Västerås, Sweden, nisse.quttineh@mdh.se, *Kenneth Holmström*, *Fredrik Hellman*

The new Adaptive Radial Basis Algorithm (ARBF) for expensive black-box mixed-integer nonlinear problems is presented. The costly objective function is approximated with radial basis function interpolation using all sampled points. Dependent on the stochastic experimental design, convergence is sometimes slow. Methods to improve convergence are discussed. The algorithm relies on good mixed-integer nonlinear solvers, e.g. the constrained DIRECT implementations in TOMLAB (<http://tomlab.biz>). We discuss benchmark results comparing ARBF with standard RBF and other global methods.

3 - LaGO - a Branch and Cut framework for nonconvex MINLPs

Stefan Vigerske, Mathematics, Humboldt University Berlin, Unter den Linden 6, 10099, Berlin, Germany, stefan@math.hu-berlin.de, *Ivo Nowak*

We present an extended Branch and Cut algorithm of the software package LaGO to solve nonconvex mixed integer nonlinear programs. A linear outer approximation is used to generate solution candidates and to compute lower bounds. It is constructed by replacing nonconvex functions by convex quadratic underestimators and linearization. The relaxation is further improved by interval-gradient based cuts. Interval arithmetic applies also for boxreduction. Numerical results on medium size problems from the GAMS MINLPLib and the optimization of the design of a energy conversion system are presented.

■ WA-30

Wednesday, 8:30-10:00

NONL Adal X=220

Interval methods in semi-infinite optimization

Stream: Nonlinear Semi-Infinite Optimization

Invited session

Chair: *Paul I. Barton*, Department of Chemical Engineering, Mit, Room 66-464, 02139, Cambridge, MA, United States, pib@mit.edu

1 - Introduction to Interval Analysis with Applications in Semi-infinite Programming

Paul I. Barton, Department of Chemical Engineering, MIT, Room 66-464, 02139, Cambridge, MA, United States, pib@mit.edu

The techniques of interval analysis provide a computationally tractable way of estimating the image of multi-dimensional intervals under most mappings that can be implemented as computer programs. This paper will present an introduction to some elementary notions in interval arithmetic and analysis. These notions will be used to develop the interval-constrained reformulation (ICR) of a semi-infinite program (SIP). The ICR of a SIP is a finitely constrained optimization problem the feasible set of which is guaranteed to be a subset of the feasible set of the original SIP.

2 - Global Solution of Nonlinear Semi-infinite Programs

Binita Bhattacharjee, Global PTA, BP, BP Research Center, 150 W. Warrenville Rd, MC D-4, 60563, Naperville, IL, United States, binita@alum.mit.edu

An interval-constrained approach to generating a finitely-constrained upper-bounding problem for a semi-infinite program has previously been introduced. Here, the interval-constrained reformulation is combined with a convex relaxation of a discretized approximation to yield the upper and lower-bounding problems for a branch-and-bound framework to solve SIPs. This B&B algorithm is shown to converge finitely to global optimality under mild assumptions when the subdivision and discretization procedures used to formulate the node subproblems are known to have certain convergence characteristics.

3 - Interval Methods for Generalized Semi-Infinite Programming

Panayiotis Lemonidis, Department of Chemical Engineering, MIT, 25 Ames St, 66-363, 02139, Cambridge, MA, United States, plemonid@MIT.EDU, *Paul I. Barton*

This paper will present a branch-and-bound methodology for the global solution of generalized semi-infinite programs (GSIP). Interval extensions of the inner problem constraints are used to construct relaxations and restrictions of the inner problem, which creates restrictions and relaxations, respectively, of the outer problem. The resulting bounding problems are ordinary semi-infinite programs (SIP). The lower bounding SIP is further relaxed with discretization and convexification while the upper bounding SIP is further constrained using the interval-constrained reformulation (ICR).

■ WA-31

Wednesday, 8:30-10:00

NONL Adal XI=222

Generalized Newton Methods II

Stream: Generalized Newton Methods

Invited session

Chair: *Francisco Facchinei*, Universita' di Roma "La Sapienza", DIS - Via Buonarroti 12, 00185, Roma, Italy, facchinei@dis.uniroma1.it

1 - Generalized Newton Methods with Pseudo-Smooth NCP function

Pu Dingguo, Tongji University, No. 1239, Siping Lu, 200092, Shanghai, China, madpu@mail.tongji.edu.cn

We propose an inexact generalized Newton algorithm and prove that the method is implementable and globally convergent, superlinearly convergent under some mild conditions. On the other hand, we give some new weak regular pseudo-smooth NCP functions and reformulate the problem for finding KKT points of nonlinear constrained optimization problems or complementarity problems as a system of semismooth equations by using the new NCP functions the solve it by the inexact generalized Newton algorithm. Some preliminary numerical results indicate that this new method is quite promising.

2 - Proximal point algorithms for vector optimization

Henri Bonnel, ERIM, University of New Caledonia, B.p. R4, F98851, Noumea, New Caledonia, bonnel@univ-nc.nc, *Alfredo Iusem*, *Benar F. Svaiter*

We consider a convex vector optimization problem with the objective map from a Hilbert space to a partially ordered Banach space. We propose an algorithm which generalizes the proximal algorithm for scalar optimization. We prove weak convergence to a weakly efficient point assuming order completeness of the initial section. If this last assumption fails, we still establish that the generating sequence is a minimizing one. We also exhibit a particular instance of the algorithm when the weak limit of the generated sequence is an efficient point, rather than a weakly efficient one.

3 - Generalized Nash Equilibrium Problems and Newton Methods

Francisco Facchinei, Universita' di Roma "La Sapienza", DIS - Via Buonarroti 12, 00185, Roma, Italy, facchinei@dis.uniroma1.it

We consider the generalized Nash equilibrium problem, where the feasible sets of the players may depend on the other players' strategies. This problem is emerging as an important modelling tool but its use is limited by its great analytical complexity. We consider several Newton methods, analyzing their features and comparing their range of applicability. We illustrate in detail the results obtained by applying them to a model for internet switching. This is a joint work with Veronica Piccialli and Andreas Fischer

■ WA-32

Wednesday, 8:30-10:00

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Topics in Semidefinite Programming I

Stream: Semidefinite Programming

Invited session

Chair: *Etienne de Klerk*, Tilburg University, Warandelaan 2, 5000 LE, Tilburg, Netherlands, E.deKlerk@uvt.nl

1 - Exact semidefinite representations for genus zero curves

Pablo Parrilo, Electrical Engineering and Computer Science, Massachusetts Institute of Technology, 77

Massachusetts Ave., Room 32D-726, 02139, Cambridge, MA, United States, parrilo@MIT.EDU

The characterization of sets that admit an exact representation in terms of SDP constraints (perhaps with additional variables) is of great interest in optimization. There have been a few recent results, pointing out specific obstructions for (the interior of) a plane curve to be SDP representable. In this talk we discuss a procedure to explicitly construct exact representations of convex hulls of arbitrary segments of genus zero plane curves. In particular, it is shown that the new method enables the computation of representations for curves for which the generic SOS-based construction fails.

2 - An Algorithm for Solving Nonlinear SDP

Renata Sotirov, Department of Econometrics and Operations Research, Tilburg University, Warandelaan 2, 5000, Tilburg, Netherlands, rsotirov@ms.unimelb.edu.au, *Christopher Anand*, *Tamas Terlaky*

We formulate a nonlinear, nonconvex semidefinite optimization problem to compute the Magnetic Resonance Imaging design variables. To solve the problem we use a mixture of grid search and our sequential, semidefinite, trust-region algorithm. The computed design variables allow imaging tissue types which have not been separated up to date.

3 - On the complexity of optimization over the simplex

Etienne de Klerk, Tilburg University, Warandelaan 2, 5000 LE, Tilburg, Netherlands, E.deKlerk@uvt.nl

, to appear.

We review complexity results for minimizing polynomials over the standard simplex and unit hypercube.

In addition, we show that there exists a polynomial time approximation scheme (PTAS) for minimizing some classes of functions (including Lipschitz continuous functions) over the standard simplex. The main tools used in the analysis are Bernstein approximation and Lagrange interpolation on the simplex combined with an earlier result by De Klerk, Laurent and Parrilo [A PTAS for the minimization of polynomials of fixed degree over the simplex, Theoretical Computer Science

■ WA-34

Wednesday, 8:30-10:00

DEC VR II V-138

Cooperative Games

Stream: Systems and Game Theory

Invited session

Chair: *Carles Rafels*, Economic and financial mathematics, University of Barcelona, Av Diagonal, 690, 08034, Barcelona, Spain, crafels@ub.edu

1 - Managing Knowledge by the Information Systems and Game-theoretic Approach

Peter Tumbas, Department for Business Informatics, Faculty of Economics, Segedinski put 9-11, 24000, Subotica, Serbia and Montenegro, ptumbas@eccf.su.ac.yu

Knowledge is a source of competitive advantage. In small enterprises there is simultaneous cooperation and competition. Knowledge management research is focused on large firms. Information systems and information technology play a paramount role in coordinating and controlling joint ventures. Information system is a key tool in the management of knowledge sharing. This paper offer game-theoretic approach to answer the questions under cooperation and competition, the role of information system in managing knowledge in small enterprises.

2 - Equity Core: non-emptiness and connectivity

Francesc Llerena, Gestio d'Empreses, Universitat Rovira i Virgili, Av. Universitat, 1, E-43204, Reus, Spain, francesc.llerena@urv.net, *Carles Rafels*, *Cori Vilella*

We characterize the non-emptiness and the connectivity of the Equity Core, an extension of the core introduced by Selten (1972). A payoff vector is in the Equity Core if no coalition can divide its value proportionally to a given weight system among its members and, in this way, give more to each member than the amount he receives in the payoff vector. Moreover, considering the particular case in which the players have the same weight, a proper characterization result of the non-emptiness and the connectivity of the Equal Division Core or the Strong Lorenz Core (Dutta and Ray, 1989) is given.

3 - Minimal large sets for cooperative games

Javier Martinez de Albeniz, Matematica Economica, Financera i Actuarial, Universitat de Barcelona, Av. Diagonal, 690, 08034, Barcelona, Spain, javier.martinezdealbeniz@ub.edu, *Carles Rafels*

We analyze the concept of large set for a coalitional game v , introduced in Martinez-de-Albeniz and Rafels (2004). An aspiration is a claim for each player that is an upper bound on each coalition's worth. For each aspiration we study the determination of an allocation of the grand coalition's worth below it. Sets that can represent any aspiration are called large. We give some examples and identify some of these sets. Existence of such sets for any game is proved and several properties of largeness are provided. We focus on minimality of such sets and prove its existence using Zorn's lemma.

4 - The Aggregate-Monotonic Core

Carles Rafels, Economic and financial mathematics, University of Barcelona, Av Diagonal, 690, 08034, Barcelona, Spain, crafels@ub.edu, *Pedro Calleja*, *Stef Tijs*

We study the locus of all point solutions in cooperative T.U. games satisfying core selection and aggregate monotonicity: the aggregate-monotonic core. This set is characterized by means of aggregate monotonicity for set solutions. Furthermore, we characterize the class of games for which the core and the aggregate-monotonic core coincide. Finally, the behaviour of special classes of games (convex games and assignment games) and classical point solution concepts (Shapley value, (pre)nucleolus, (pre)PCnucleolus) with respect to the aggregate-monotonic core is studied.

■ WA-35

Wednesday, 8:30-10:00

DEC VR II V-147

Strategic Modelling

Stream: OR and Strategy

Invited session

Chair: *Fernando Oliveira*, Warwick Business School, University of Warwick, Gibbet Hill Road, CV4 7AL, Coventry, United Kingdom, fernando.oliveira@wbs.ac.uk

1 - A Triangulation Approach to the Measurement of Comparative Efficiency

Rupert Booth, Warwick Business School, University of Warwick, Gibbet Hill Road, CV4 7AL, Coventry, United Kingdom, Rupert.Booth03@phd.wbs.ac.uk

There are a range of techniques to measure comparative efficiency, with quantitative approaches divided between top-down (eg Data Envelopment Analysis and Statistical Frontier Analysis) and bottom-up (eg process benchmarking and efficiency metrics). There are also qualitative approaches, so offering three distinct approaches to efficiency estimation. This paper examines the factors to be considered on whether to apply each technique and how the techniques might complement each other. The theoretical points are illustrated by case study material with which the author was involved.

2 - Fishing for Strategy: Frameworks and Models

Maureen Meadows, Open University Business School, The Open University, Walton Hall, MK7 6AA, Milton Keynes, United Kingdom, m.meadows@open.ac.uk, *Jim Bryant*, *John Morecroft*

This paper will describe an innovative piece of teaching undertaken on a specialist Masters programme, as part of on-going research activity exploring the role of frameworks and models in strategy development. The teaching brought together three varied modelling approaches - Drama Theory, System Dynamics and Scenario Planning - and considered the complementarity of their application in a common problem context. A model of the strategic development process will be introduced, as well as the context for the teaching, the teaching experience itself and the student responses.

3 - Bottom-up Design of Strategic Options as Finite Automata

Fernando Oliveira, Warwick Business School, University of Warwick, Gibbet Hill Road, CV4 7AL, Coventry, United Kingdom, fernando.oliveira@wbs.ac.uk

In this paper we look at the problem of strategic decision making. We start by presenting a new formalisation of strategic options as finite automata. Then, we show that these finite automata can be used to develop complex models of interacting options, such as option combinations and product options. Finally, we also analyse real option games, presenting an algorithm to generate option games (based on automata), and analysing the equilibrium solution of real option games

■ WA-36

Wednesday, 8:30-10:00

DEC VR7 V-155

Applied Decision Analysis III

Stream: Multicriteria Decision Analysis (c)

Invited session

Chair: *Kim Allan Andersen*, Department of Business Studies, Aarhus School of Business, Fuglesangs Alle 4, 8000, Aarhus C, Denmark, kia@asb.dk

1 - An application of Chang's fuzzy AHP, combined with different ranking methods

H. Dilek Kaptanoglu, Systems Engineering Dept., Yeditepe University, 26 Agustos Campus, Kayisdag Cad., 34755, Istanbul, Turkey, dilekk@yeditepe.edu.tr

Analytic Hierarchy Process (AHP) of Saaty, is the most commonly used multi attribute decision making method. Many researchers also used the fuzzy extension of Saaty's priority theory. Chang's approach for fuzzy AHP was the use of some synthetic extent values of the pairwise comparisons. In this study Chang's fuzzy AHP is applied to the academic performance evaluation problem and the problem is also solved by combining Chang's method with different fuzzy ranking methods and their effects on the results are discussed.

2 - The Bicriterion Multi Modal Assignment Problem: Introduction, Analysis and Experimental Results

Kim Allan Andersen, Department of Business Studies, Aarhus School of Business, Fuglesangs Alle 4, 8000, Aarhus C, Denmark, kia@asb.dk, *Lars Relund Nielsen*

We consider the bicriterion multi modal assignment problem which is a new generalization of the classical linear assignment problem. A two-phase solution method using an effective ranking scheme is presented. The algorithm is valid for generating all nondominated criterion points. Extensive computational results are conducted on a large library of test instances to test the performance of the algorithm and to identify hard test instances. Also, test results of the algorithm applied to the bicriterion assignment problem is given.

3 - Leakage management strategy of water distribution network: A Group Decision Making

Danielle Morais, Dept. of Production Engineering, UFPE, R. Cons. Portela, 169/apt. 701, Espinheiro, 52020-030, Recife, Pernambuco, Brazil, dcmorais@ufpe.br, *Adiel Teixeira de Almeida*

Leakage problem is complex and requires actions from different aspects of water network management. Inadequate maintenance has serious consequences, not only financial but also environmental. This paper proposes a multicriteria model applying the PROMETHEE V method to aim a leakage management strategy based on the points of view of four influence groups, selecting feasible options, considering the available budget as constraint. Thus, this strategy is the combination of options that will efficiently meet technical, socio-economic and environmental criteria to achieve sustainable development.

■ WA-37

Wednesday, 8:30-10:00

DEC VR7 V-156

MCDM and Artificial Intelligence

Stream: Multiple Criteria Decision Aiding

Invited session

Chair: *Roman Slowinski*, Institute of Computing Science, Poznan University of Technology, Laboratory of Intelligent Decision Support Systems, Street Piotrowo 2, 60-965, Poznan, Poland, roman.slowinski@cs.put.poznan.pl

1 - Modelling and Analysis of Uncertainties in Multi-Criteria Decision Making Problems Using the Evidential Reasoning Approach

Dong-Ling Xu, Manchester Business School, The University of Manchester, 502 Harold Hankins Building, M15 6PB, Manchester, United Kingdom, L.Xu@mbs.ac.uk, *Jian-Bo Yang*

This paper summarises how various types of uncertainties in different parameters of multiple criteria decision making problems are modelled and aggregated using the Evidential Reasoning approach. Using concepts from the evidence theory and utility theory, the combined effects of the uncertainties on decision outcomes are then modelled in the formats of probability distributions, lower and upper bounds of different performance and risk measures. The methods and procedures for analysing the effects are described and illustrated using a numerical example.

2 - Rough set approach to time preferences under uncertainty

Salvatore Greco, Department of Economics and Quantitative Methods, University of Catania, Corso Italia 55, 95129, Catania, Italy, salgrec@unict.it, *Benedetto Matarazzo*, *Roman Slowinski*

We consider decision under uncertainty with effects distributed over time. We propose a rough set model based on a combination of time dominance and stochastic dominance. We consider the case of traditional additive probability distribution over the set of states of the world, however, the model is rich enough to handle non-additive probability distributions and even qualitative ordinal distributions. The rough set approach gives a representation of decision maker's preferences in terms of "if, then" decision rules induced from rough approximations of sets of exemplary decisions.

3 - Case-based reasoning using dominance-based rough set approach

Roman Slowinski, Institute of Computing Science, Poznan University of Technology, Laboratory of Intelligent Decision Support Systems, Street Piotrowo 2, 60-965, Poznan, Poland, roman.slowinski@cs.put.poznan.pl, *Salvatore Greco*, *Benedetto Matarazzo*

We propose a new approach to case-based reasoning, based on Dominance-based Rough Set Approach, which is particularly useful for its ability of handling monotonic relationships between different aspects of a phenomenon described by data. In case-based reasoning, we consider monotonicity of the type: "the more similar is y to x , the more credible is that y belongs to the same set as x ". We show that rough approximations and decision rules induced from these approximations can be redefined in this context and that they satisfy the fundamental properties of classical rough set theory.

■ WA-38

Wednesday, 8:30-10:00

DEC VR7 V-157

DEA Applications I

Stream: DEA and Performance Measurement (c)

Invited session

Chair: *James Weatherall*, Social Policy, SFI, Herluff Trolles 12, 1052, Copenhagen, Denmark, jweathera@yahoo.com

1 - Application of DEA models in a small service enterprise

Josef Jablonsky, Dept. of Econometrics, University of Economics Prague, W.Churchill sq. 4, 13067, Prague 3, Czech Republic, jablon@vse.cz

The paper describes a simple case study - the evaluation of efficiency of works contracts in a small Czech service enterprise. The employees of the firm are financially rewarded for the participation in contracts depending on their efficiency. The paper discusses the current way of evaluation of efficiency of the contracts and the approach based on the DEA models. All the computational experiments were realised by original DEA support system built in MS Excel environment. This system offers a simple tool for solving basic DEA models including super-efficiency models.

2 - Testing the female underperformance hypothesis: a data envelopment analysis approach

Otilia Driga, Departament d'Economia de l'Empresa, Universitat Autònoma de Barcelona, Edifici B, Campus de la UAB, 08193, Bellaterra (Cerdanyola del Vallès), Barcelona, Spain, otília.driga@uab.es

Using a sample of 1077 Spanish SMEs we perform a comparison of the business performance between male- and female- controlled businesses from six industrial sectors, between 1997 and 2001. Instead of the traditional ratio-analysis approach, we employ Data Envelopment Analysis, which allows us to compare male- and female- controlled businesses through the lens of their productive efficiency. Contrary to previous empirical research, some empirical findings of our study indicate that the best performing female-controlled businesses outperform the best performing male-controlled ones.

3 - Decomposition of Management Efficiency of Vertically Integrated Electric Utilities: Application of Network DEA model

Miki Tsutsui, Socio-economic Research Center, Central Research Institute of Electric Power Industry, 2-11-1 Iwado Kita, Komae-shi, 2018511, Tokyo, Japan, miki@cripi.denken.or.jp, *Kaoru Tone*

This study examines management efficiency of vertically integrated electric utilities, which consist of several divisions, such as generation, transmission and so on. Previous studies mainly focused on efficiency of only a specific division. However, we should evaluate firm-level management efficiency based on divisional efficiencies, because these divisions are closely linked each other. For measuring firm-level efficiency, we apply a network DEA model that reflects streamlined relationship among divisions under vertical integration. Furthermore we decompose inefficiency into several factors.

4 - DEA: Economic supplier efficiency for ALMP municipality employment outcomes

James Weatherall, Social Policy, SFI, Herluff Trolles 12, 1052, Copenhagen, Denmark, jweathera@yahoo.com

The dissertation addresses the unemployment problem by evaluating whether or not the current program in the 275 municipalities in Denmark between 1995-1998 are efficiently returning welfare recipients back to the labour market after activation by measuring a new economic parameter of interest, economic supplier efficiency.

■ WA-39

Wednesday, 8:30-10:00
DEC VR II V-158

Preference Modelling for DSS

Stream: Decision Support Systems

Invited session

Chair: *Yuji Yoshida*, Faculty of Economics and Business Administration, the University of Kitakyushu, 4-2-1 Kitagata, Kokuraminami, 802-8577, Kitakyushu, Fukuoka, Japan, yoshida@kitakyu-u.ac.jp

1 - Normalization and consistency issues in alternative hierarchical logit models

J. Nicolás Ibáñez, Industrial Engineering, University of Seville, Avda. de los Descubrimientos, s/n, 41092, Sevilla,

Spain, juannicolas@us.es, *Jesús Muñuzuri*, *Pablo Cortés*, *José Guadix*, *Luis Onieva*

This paper deals with the methodology used for the application of discrete choice models to individual preference data, particularly, it focuses on modelling issues that remain controversial in the literature and related to how normalization is achieved in hierarchical logit models so as to completely identify the parameter estimation process. In doing so we distinguish this issue from the models' consistency with random utility maximising theory and show how published material on models regaining this consistency is somewhat inconsequential.

2 - Representation of Preference Orderings on $\$Lp\$$ -spaces by Integral Functionals: Myopia, Continuity and TAS Utility

Nobusumi Sagara, Faculty of Economics, Hosei University, 4342, Aihara, Machida, 194-0298, Tokyo, Japan, nsagara@mt.tama.hosei.ac.jp

We show that if preference orderings on $\$Lp\$$ -spaces satisfy norm-continuity, separability, substitutability and sensitivity, then there exists a normal integrand satisfying the growth condition such that the corresponding integral functional is order preserving with respect to the preference orderings. Moreover, if the preference orderings are weakly continuous, then the normal integrand is a convex function, and hence preference orderings are convex. We apply this result to the representation of preference orderings over time with an infinite horizon.

3 - Mean Values and Variances of Fuzzy Random Variables Induced from Evaluation Measures

Yuji Yoshida, Faculty of Economics and Business Administration, the University of Kitakyushu, 4-2-1 Kitagata, Kokuraminami, 802-8577, Kitakyushu, Fukuoka, Japan, yoshida@kitakyu-u.ac.jp

This paper discusses an evaluation method of fuzzy numbers as mean values and measurement of fuzziness defined by fuzzy measures, and the method is applicable to fuzzy numbers and fuzzy stochastic process defined by fuzzy numbers/fuzzy random variables in decision making. Next, extending the results [Yoshida, Springer LNAI 3214, 2004], we compare the measurement of fuzziness and the variance as a factor to measure uncertainty. Formulae are given to apply the results to triangle-type fuzzy numbers and trapezoidal-type fuzzy numbers.

■ WA-40

Wednesday, 8:30-10:00
SOC VR II V-257

Workshop Global Safety

Stream: Complex Societal Problems

Invited session

Chair: *Cathal Brugha*, Management Information Systems, University College Dublin, Quinn School of Business, Belfield, 4, Dublin 4, Ireland, Cathal.Brugha@ucd.ie

1 - Global Safety - discussing the issues of Bowen, brugha and Kelman

Dorien DeTombe, Methodology of Societal Complexity, Chair Euro Working Group, P.O.Box 3286, 1001 AB, Amsterdam, Netherlands, detombe@lri.jur.uva.nl, *Cathal Brugha*, *Ken Bowen*

The threat of terrorism is popping up everywhere. There is a demand for global safety. Policy often reacts on effects only by controlling individuals and abusing civil rights. Safety can be handled otherwise. Bowen pleads for total defense by increasing national identity and taken care of education, national identity, healthcare and religious intolerance. Brugha uses his Nomology to analyse the Northern Ireland conflict. This methodology, a managerial tool, gives insights to civil war, terrorist acts and their motivation. DeTombe pleads for finding the real causes by way of the COMPRAM method.

2 - The added value of problem structuring methods

Telli van der Lei, Policy Analysis, TPM, Delft University of Technology, Jaffalaan 5, 2628BX, Delft, Netherlands, t.e.vanderlei@tudelft.nl

Most papers report positive results obtained with OR/MS Problem Structuring Methods (PSM). Critiques, however, can also be found (Green 2002, Joldersma and Roelofs 2004). These critiques suggest that some PSM might be more suitable for certain problems than others. To understand why and how certain PSM are applied we reviewed papers that describe applications of these methods. The results suggest that: two types of research design can be discerned, little attention is paid to the validity of the outcomes, and the least attention is paid to method verification.

3 - Using data to stimulate conversation about complex societal problems

Stephen Taylor, Biology, Champlain Regional College, 900 Riverside Drive, J4P 3P2, Saint-Lambert, Quebec, Canada, staylor@champlaincollege.qc.ca

Teaching about sexually transmitted diseases, including AIDS, poses a challenge for health educators at the college level. Presenting students with statistics about these diseases creates an environment for serious conversations about the topic. Then, by asking them to adopt the roles of various societal players, they learn about the several facets of the complex societal problem of maintaining public health. Participants in this presentation will hear about this method and will be involved in a simulation of it.

4 - Applications of Game Theory and Drama Theory to Conflict Situations

Cathal Brugha, Management Information Systems, University College Dublin, Quinn School of Business, Belfield, 4, Dublin 4, Ireland, Cathal.Brugha@ucd.ie, *Ken Bowen*

At previous EURO conferences the authors demonstrated the parallels between Brugha's Eight Adjustment Types in Nomology and Bowen's Eight Faces of Research, showed that they reflect an inherent common structure, and proposed how this structure could be used to help managers make decisions in practice by providing frameworks and maps to elucidate issues and resolve situations. We use this model to extend ideas about Drama Theory, and Confrontation and Collaboration Analysis, which both evolved out of Game Theory.

■ WA-41

Wednesday, 8:30-10:00
SOC VR11 V-258

Human Centered Processes

Stream: Human Centered Processes (c)
Invited session

Chair: *Sara McComb*, Finance and Operations Management, University of Massachusetts Amherst, 121 Presidents Way, 01003, Amherst, MA, United States, mccomb@som.umass.edu

1 - Decision models for personnel selection

Lourdes Canos, Organizacion de Empresas, Eco. Fin. y Cont., Universidad Politecnica de Valencia, Crtra. Nazaret-Oliva s/n, 46730, Grao de Gandia (Valencia), Spain, loucada@omp.upv.es, *Vicente Liern*

Decisions about personnel selection are important in every company because human resources are the cornerstone of the strategy. Applying mathematical techniques to human resources management is sometimes a difficult task because it implies a system of interactions so quick that deterministic techniques cannot keep pace. In this paper we propose some fuzzy optimization models to order the candidates to a vacancy. We use aggregation of uncertain data and efficient analysis techniques to select that individual best matching the job characteristics considering the company circumstances.

2 - Context-based modeling of driver's behaviour in evolving situations

Juliette Brezillon, intelligence Artificielle, Lip6 - Laboratoire d'Informatique de Paris 6, 8 rue du Capitaine

Scott, 75015, Paris, France, juliette.brezillon@lip6.fr, *Patrick Brezillon*, *Charles Tijus*

The initial training leads to a driving licence but is not sufficient because the beginner does not know how to contextualize the learned procedures in effective practices. We represent the driver in two complementary systems, one for situations (an objective representation by a lattice) and the other for driver's behaviors (a subjective representation by a contextual graph) both being related through scenarios. A situation is normal, pre-critical and critical. Our goal is to help the driver to learn how to identify, analyze and make the correct decision in a pre-critical situation.

3 - Using an Information Processing Approach to Capture Mental Model Convergence in Teams

Sara McComb, Finance and Operations Management, University of Massachusetts Amherst, 121 Presidents Way, 01003, Amherst, MA, United States, mccomb@som.umass.edu

This paper examines capturing mental model convergence over time among team members by using an approach to ascertain information processing in individuals. I used the sentence stem completion test to capture mental model content and analyzed responses to determine the commonality across team members. Results confirm that individually-held mental models converge over time and show differences in the convergence processes of high and low performing teams. The results validate the sentence completion test for ascertaining mental model convergence over time.

■ WA-42

Wednesday, 8:30-10:00
SOC VR11 V-261

Agent-based Modelling Methods

Stream: Agent-Based Modeling Methods
Invited session

Chair: *Augusto Rupérez Micola*, IMD International, Chemin de Bellerive 23, CH 1006, Lausanne, Switzerland, Augusto.RuperezMicola@imd.ch

1 - Agent-based Simulation of Sequenced Electricity

Anke Weidlich, Economics and Business Engineering, University of Karlsruhe (TH), Chair of Information Management and Systems, Englerstr. 14, 76131, Karlsruhe, Germany, anke.weidlich@iw.uni-karlsruhe.de

Electricity is traded on different time scales, e.g. day-ahead, forward, and also in form of different products, e.g. physical delivery, reserved (balance) capacity. Realistic electricity market modeling therefore has to account for interrelations between different markets. Agent-based simulation has the potential to meet this requirement. It models market participants facing the problem of trading on several markets as adaptive agents. Here, an agent-based simulation model comprising an electricity spot, forward, and balancing power market will be presented and simulation results discussed.

2 - Simulation of the German Electricity Markets with an agent-based model

Massimo Genoese, Institute for Industrial Production, University of Karlsruhe, Hertzstraße 16, 76187, Karlsruhe, Germany, massimo.genoese@wiwi.uni-karlsruhe.de, *Frank Sensfuß*

This agent-based model simulates the development of the German electricity market coupling short term markets with long term capacity expansion decisions. The short-term model part consists of a daily spot market, a balancing power market and a CO₂-emissions trading market. The results of these daily markets induce the long-term investment decision. In a case study the model results are analysed and compared to German electricity prices. It is analysed if the profits of power generators are sufficient for investments. The model will be presented and the results of the simulation discussed.

3 - Analysis and Design of Industrial Networks for Sustainability Objectives

Jim Petrie, Dept. of Chemical Engineering, University of Sydney, Darlington, 2006, Sydney, NSW, Australia,

petrie@chem.eng.usyd.edu.au, *Ruud Kempener, Brett Cohen, Lauren Basson*

This paper proposes an integrated analytical framework and set of simulation tools to characterise key features of industrial networks, focusing largely on where and how decision making power is exercised, and the implications of this for network learning and evolution. Strategic behaviour is modelled explicitly by different functional and implicit characteristics of both individual agents and the network as a whole, and models allow for emergence of new agents, technologies, products and network configurations. The approach is demonstrated for a regional energy study.

■ WA-43

Wednesday, 8:30-10:00

FIN Endur Room 1

Stochastic Mathematical Programs with Equilibrium Constraints

Stream: Stochastic Programming

Invited session

Chair: *Huifu Xu*, School of Mathematics, Southampton University, Highfield, SO17 1BJ, Southampton, United Kingdom, h.xu@soton.ac.uk

1 - An MPEC approach for solving executive compensation contract.

Che-Lin Su, Center for Mathematical Studies in Economics and Management Science, Kellogg School of Management, Northwestern University, 580 Leverone Hall, 2001 Sheridan Road, 60208, Evanston, IL, United States, c-su@kellogg.northwestern.edu

We propose a principal-agent model to design the optimal mix of options and stock in the compensation contract. We formulate the agency model as an mathematical program with equilibrium constraints.

2 - Regularization Methods for Stochastic Mathematical Programs with Complementarity Constraints

Daniel Ralph, Judge Business School, Cambridge University, Trumpington St, CB2 1AG, Cambridge, United Kingdom, d.ralph@jbs.cam.ac.uk

We combine the regularization and a stochastic average approximation (SAA) methods to solve two stage stochastic mathematical programs with complementarity constraints (SMPCC). As in Shapiro & Xu's 2004 analysis of SAA applied to SMPCC, we need smoothness of the "second stage" value function, e.g., strict complementarity of the lower level solution for a.e. second stage scenario. As the sample size increases and smoothing parameter vanishes, Clarke stationary points of the regularised MPCC converge w.p.1 to (classical) stationary points of SMPCC. We also gives numerical examples.

3 - A Stochastic Multiple Leader Stackelberg Model and Equilibrium

Huifu Xu, School of Mathematics, Southampton University, Highfield, SO17 1BJ, Southampton, United Kingdom, h.xu@soton.ac.uk

This talk presents a stochastic multiple leader Stackelberg-Nash-Cournot Equilibrium (SNCE) model for an oligopoly market with non-collaborative competition. We show under certain conditions the existence and uniqueness of stochastic multiple leader SNCE. We propose a sample average approximation method to solve the stochastic multiple leader SNCE problem and show that with probability approaching 1 at exponential rate with the increase of sample size, the multiple leader SNCE of sample average approximation problem converges to the equilibrium of the true problem.

■ WA-44

Wednesday, 8:30-10:00

FIN Endur Room 2

Stochastic Programming I

Stream: Stochastic Programming (c)

Invited session

Chair: *Werner Römisch*, Institut für Mathematik, Humboldt-Universität zu Berlin, Rudower Chaussee 25, Haus 2, Raum 2.414, 12489, Berlin, Germany, romisch@mathematik.hu-berlin.de

1 - Quality of Tree Approximations for Multistage Stochastic Programming

Radoslava Mirkov, Dept. of Statistics and Decision Support Systems, University of Vienna, Universitaetsstrasse 5, A-1010, Vienna, Austria, radoslava.mirkov@univie.ac.at, *Georg Pflug*

Numerical solutions of multi-stage stochastic programs are based on the approximation of the underlying infinite-dimensional stochastic optimization model. We consider a tree-based discretization technique and investigate corresponding convergence properties utilizing minimization of various probability metrics, which are well suited for the approximation of multi-stage stochastic programming problems. In particular, we study the quality of the approximation so obtained, and set the results in the context of the most prominent financial models.

2 - Stochastic integer programming: Limit theorems and confidence intervals

Andreas Eichhorn, Department of Mathematics, Humboldt-University Berlin, Unter den Linden 6, 10099, Berlin, Germany, eichhorn@math.hu-berlin.de, *Werner Römisch*

We consider empirical approximations (sample average approximations) of two-stage stochastic mixed-integer linear programs. We derive central limit theorems for the objectives by means of empirical process theory. Central limit theorems for the optimal values of the stochastic programs are derived herefrom by applying an infinite dimensional version of the Delta Method. Finally, we show how these limit theorems can be used to derive confidence intervals for optimal values via resampling methods (bootstrap, subsampling). Numerical examples are presented to illustrate and verify the results.

3 - Finite element method for stochastic optimal control problems with information constraints

Anes Dallagi, CERMICS, ENPC, 6 et 8 avenue Blaise Pascal Cedex 2, Cité Descartes - Champs sur Marne, 77455, Marne la Vallée, France, dallagi@cermics.enpc.fr, *Guy Cohen*

Dynamic programming is the natural framework for numerical resolution of stochastic optimal control problems but the curse of dimensionality leads us to formulate new variational approaches. We present an alternative: a finite element approximation method to solve multistage stochastic programs. Two levels of approximation are needed, specifically, approximation of the expected value and approximation of the information constraints. We will present some epi-convergent approximation methods and some applications to a mid-term production management problem of an hydroelectric dam.

■ WA-45

Wednesday, 8:30-10:00

FIN Endur Room 3

Tools for Financial Planning

Stream: Models and Tools for Financial Planning

Invited session

Chair: *Stavros Zenios*, Professor of Finance and Management Science, University of Cyprus, 75 Kallipoleos street, 1678, Nicosia, Greece, zenios.stavros@ucy.ac.cy

1 - A complete term structure characterisation of an extended Hull-White model

Rogemar Mamon, Mathematical Sciences, Brunel University, Kingston Lane, UB83PH, Uxbridge, Middlesex, United Kingdom, Rogemar.Mamon@brunel.ac.uk

An extension of the Hull-White model is proposed by making the level of mean-reversion and volatility parameters follow a Markov chain process; so, both parameters have stochastic dynamics. A closed-form solution to the price of a zero-coupon bond is obtained. In turn, the forward rate and yield rate processes are also determined. Hidden Markov model filtering techniques in discrete time are employed to provide estimates of the parameters using a dataset of Treasury yields. It is shown that the proposed model incorporates stylised features associated with interest rate time series.

2 - Portfolio Management in the Mexican Bursaries Market

Maria A. Osorio-Lama, School of Computer Sciences, Universidad Autónoma de Puebla, Camino al Batán 129, Fraccionamiento Lomas del Mármol, 72574, Puebla, Mexico, aosorio@cs.buap.mx, Meliza Contreras González, Miguel Gomez-Sanchez, Gladys Linares Fleites, Abraham Sánchez-López

This research presents elements to design a decision support system for portfolio management in the Mexican market. Risk analysis was performed using a scenario tree generated by simulation. First, randomized lognormal vectors are generated and later, a main components procedure for a fixed tree architecture is applied. The suitability of the tree generated was tested statistically. The tree considers the more representative stocks chosen from 50 assets, 250 bonds and 56 cash options named CETES in the Mexican Market. The tree is used to build a modified stochastic multistage Markowitz model.

3 - The tail that wags the dog: Integrating credit risk in asset portfolios

Stavros Zenios, Professor of Finance and Management Science, University of Cyprus, 75 Kallipoleos street, 1678, Nicosia, Greece, zenios.stavros@ucy.ac.cy

Tails are of paramount importance in shaping the risk profile of portfolios with credit risk sensitive securities. In this context risk management tools require simulations that accurately capture the tails, and optimization models that limit tail effects. Ignoring the tails in the simulation or using inappropriate optimization metrics can have significant effects. The resulting portfolio risk profile can be grossly misrepresented when long run performance is optimized without consideration of the short term tail effects. We will illustrate the pitfalls and suggests models for avoiding them.

■ WA-46

Wednesday, 8:30-10:00

FIN Endur Room 4

MDPs: Theory and Applications

Stream: Applied Probability/Forecasting (c)

Invited session

Chair: Anna Jaskiewicz, Wrocław University of Technology, Institute of Math. and Comp. Sci., Wybrzeże Wyspińskiego 27, 50-370, Wrocław, Poland, ajaskiew@im.pwr.wroc.pl

1 - Spinning plates and squad systems – policies for bi-directional restless bandits

Christopher Kirkbride, The Management School, Lancaster University, Dept. Of Management Science, LA1 4YX, Lancaster, Lancashire, United Kingdom, c.kirkbride@lancaster.ac.uk, Kevin Glazebrook, Diego Ruiz

We consider two families of Markov decision problems which fall within the family of restless bandits, an intractable class of decision processes introduced by Whittle. The spinning plates problem concerns the optimal management of a portfolio of reward generating assets whose yields grow with investment but otherwise tend to decline. The squad system problem concerns asset exploitation for which the yield from an asset tends to decline when it is utilised but will recover when the asset is at rest. Numerical analyses highlight the strong performance of the index heuristics developed.

2 - Mean and Variance in Stochastic Dynamic Programming

Karel Sladky, Department of Econometrics, Institute of Information Theory and Automation, Academy of Sciences of the Czech Republic, Pod Vodarenskou vezi 4, 18208, Prague 8, Czech Republic, sladky@utia.cas.cz

Formulas for total reward and its variance of discrete- and continuous-time Markov reward chains and semi-Markov reward processes, as well as for their growth rate, are obtained. Alternative definitions of the reward variance along with their mutual connections will be discussed. For the controlled models policy iteration type methods for finding optimal policies with respect to various mean-variance selection rules are suggested. Computational experience with medium size problems (up to 100 states and actions in each state) will be presented.

3 - Semi-Markov decision processes with Feller transition probabilities

Anna Jaskiewicz, Wrocław University of Technology, Institute of Math. and Comp. Sci., Wybrzeże Wyspińskiego 27, 50-370, Wrocław, Poland, ajaskiew@im.pwr.wroc.pl

Semi-Markov control processes with Feller transition probabilities and unbounded cost functions are considered. Two widely used average cost criteria are studied: the ratio-average and time-average cost criterion. The objective of this paper is to give sufficient conditions for the existence of a lower semicontinuous and continuous solutions to the average cost optimality equation (ACOE). The proof of establishing the ACOE is based on a fixed point argument. Finally, an example of a Markov control model is provided, for which the ACOE and a stationary policy is derived.

■ WA-47

Wednesday, 8:30-10:00

FIN Endur Room 5

Credit

Stream: Financial Modelling (c)

Invited session

Chair: Gautam Mitra, CARISMA, Brunel University, Department of Mathematical Sciences, Kingston Lane, UB8 3PH, Uxbridge, Middlesex, United Kingdom, gautam.mitra@brunel.ac.uk

1 - Term structure and credit spread estimation with R

Robert Ferstl, Quantitative Management and Operations Research, Vienna University of Economics and Business Administration, Nordbergstr. 15, 1090, Vienna, Austria, robert.ferstl@wu-wien.ac.at

Zero-coupon yield curves and credit spread curves are important inputs for various financial models. Since zero-coupon rates are rarely directly observable, they have to be estimated from market data. We create an R package including three widely-used term structure estimation procedures, i.e. the parametric Nelson and Siegel approach, the Svensson approach and the cubic splines method. The traditional way of credit spread calculation often leads to unrealistic shapes of the credit spread curves. Therefore, we implement the existing joint estimation procedures.

2 - Application for Stock Price using Cumulative Damage Model

Syouji Nakamura, Human Life and Information, Kinjo Gakuin University, 1723 Omori 2-chome, Moriyama-ku, 463-8521, Nagoya, Aichi, Japan, snakam@kinjo-u.ac.jp, Toshio Nakagawa, Miwako Arafuka

This paper considers the problem of maximizing an expected liquidation profit of holdings, when the market impact of stock price is caused by the holdings sell-off. We propose the two stochastic models to evaluate the division policy of holdings division. In one model, we apply the cumulative damage model to the fluctuations of stock price, and we discuss analytically and numerically optimal division policies of holdings division which maximize the expected total amount of liquidation.

Wednesday, 10:30-12:00**■ WB-01***Wednesday, 10:30-12:00**KEY Askja N-132***KEYNOTE: Use and abuse of market simulation models in restructured electricity industry**

Stream: Electricity Markets

Invited session

Chair: *Eddie Anderson*, Australian Graduate School of Management, University of New South Wales, Unsw, 2052, Sydney, NSW, Australia, eddiea@agsm.edu.au

Chair: *Daniel Ralph*, Judge Business School, Cambridge University, Trumpington St, CB2 1AG, Cambridge, United Kingdom, d.ralph@jbs.cam.ac.uk

1 - KEYNOTE: Use and abuse of market simulation models in restructured electricity industry

Yves Smeers, CORE, Universite catholique de Louvain, 34 voie du Roman Pays, 1348, Louvain-la-Neuve, Belgium, smeers@core.ucl.ac.be

The restructuring of electricity markets gave rise to an explosion of market simulation models of different types. These models rely on basic concepts of economic theory to represent restructured electricity systems which are then cast in computable form. Very much like analytical economic models these tools are then used for market analysis, possibly leading to policy recommendations. Models can clarify or cloud issues. We discuss three issues two of them where models have helped clarify matters and one where we believe that their use may have been counter productive. 1. Consider the question of measuring marginal costs. These play a crucial role in the assessment of market power. Models have clarified that the marginal cost of electricity does not simply boil down to plant fuel costs, something that is often assumed in studies of market power. 2. The inception of ancillary markets besides energy also revealed to be critical for the well functioning of restructured electricity markets. This is in particular the case of market for transmission services. The modelling debates between proponents of the nodal and zonal systems at the time also helped clarify the issue and led to proposals for good market architecture. 3. Models have also been extensively used for exploring issues of market power, even though they appear to be much less reliable in this domain. Imperfect competition models suffer from basic shortcomings that may invalidate their results. These are not always recognized in practice with the result that very strong recommendations are often made on the basis of false certainty. We discuss this question first in terms of principles and then on the basis of a real study.

■ WB-02*Wednesday, 10:30-12:00**APP Askja N-131***Operating Room Scheduling**

Stream: OR in Health Care

Invited session

Chair: *Erik Demeulemeester*, Applied Economic Sciences, Katholieke Universiteit Leuven, Naamsestraat 69, B-3000, Leuven, Belgium, erik.demeulemeester@econ.kuleuven.ac.be

1 - Anticipating Emergency Surgery

Gerhard Wullink, Cluster 17, Erasmus Medical Centre, P.O. box 2040, Dr. Molenwaterplein 40, 3000 CA, Rotterdam, Netherlands, g.wullink@erasmusmc.nl, *Erwin W. Hans*, *Mark Van Houdenhoven*

Waiting times for emergency surgeries depend on the allocation of reserve capacity and the sequence of elective surgeries. We compare three approaches to allocate reserve capacity at the operating room (OR) with respect to waiting times, utilization, and working over time. We also investigate the NP-hard problem of optimizing the sequence of elective surgeries. Experiments show that allocating reserve capacity on all ORs instead of one emergency room reduces the waiting time for emergency surgeries. Optimizing the sequence of elective surgeries reduces the waiting time even further.

2 - A Branch-and-Bound approach for scheduling surgical cases in a day-care environment

Brecht Cardoen, Decision sciences and information management, Katholieke Universiteit Leuven, Naamsestraat 69, 3000, Leuven, Belgium,
brecht.cardoen@econ.kuleuven.be, *Erik Demeulemeester*

The sequence in which surgeries are performed greatly influences the quality of the surgery schedule. We will express non-quality by means of deviations from target values. A Branch-and-Bound procedure will be presented in order to find a schedule that minimizes this cost of deviation without violating day-care-specific constraints. Computational results will be evaluated and compared with a multiobjective programming model.

3 - Parallelization of Anesthetic Processes in Operating Rooms: Modeling and Evaluation

Rainer Kolisch, Chair of Technology-based Services Operations Management, Technical University of Munich, Arcisstr. 21, 80333, Muenchen, Germany,
rainer.kolisch@wi.tum.de, *Robert Heil*

We consider m operating rooms (ORs) where in each OR patients undergo a three stage process of induction of anesthesia, surgery and emergence from anesthesia. The makespan of one room can be reduced by assigning two anesthetists. If so, the induction of a patient is done in parallel with the preceding patient's process. We assess the benefit of employing $n \leq m$ anesthetists for m ORs by modeling the problem as stochastic resource-constrained project scheduling problem with minimal and maximal time-lags and regular objective function. The latter is solved with a branch-and-bound procedure.

■ WB-05

Wednesday, 10:30-12:00

APP Askja N-128

Mining Applications

Stream: Mining Applications

Invited session

Chair: *Alexandra Newman*, Division of Economics and Business, Colorado School of Mines, 1500 Illinois Street, 80401, Golden, CO, United States, newman@mines.edu

1 - Modelling and Software Design for Optimal Declines in Underground Mine Development

Doreen Thomas, Dept. of Electrical and Electronic Engineering, University of Melbourne, Grattan Street, Parkville, 3010, Melbourne, Victoria, Australia,
d.thomas@ee.unimelb.edu.au

In underground mining, the declines used for trucking ore to the surface typically have to satisfy a gradient and turning circle constraint to make them navigable for the large haulage trucks. In this talk we describe a method of modelling this problem as a constrained path optimisation problem in 3-space and demonstrate a software tool DOT2 that we have developed to design such navigable paths. This "obstacle problem" is a well known hard problem in the area of shortest networks and is an important one to analyse and solve. We discuss our plans for new versions of DOT2.

2 - Constrained Path Optimisation with Applications to Underground Mine Development

Marcus Brazil, Dept. Electrical and Electronic Engineering, University of Melbourne, Parkville, 3010, Melbourne, Victoria, Australia, brazil@unimelb.edu.au

In this talk we study the problem of designing a minimum cost path connecting a given set of points in 3-space, where the path must satisfy a given gradient and curvature bound. Here we show that, using a dynamic programming approach, we can reduce the problem to one of computing an optimal planar path with bounded curvature between two points with given directions of travel. We are further able to show that nice geometric characterisations of such paths exist. This has important applications to the design of haulage and access declines for underground mines.

3 - Long- and Short-term Production Scheduling at LKAB's Kiruna Mine

Alexandra Newman, Division of Economics and Business, Colorado School of Mines, 1500 Illinois Street, 80401, Golden, CO, United States, newman@mines.edu

We describe an optimization model that plans production both at the strategic and at the operational level for a large underground sublevel caving mine. We present optimization-based heuristics to expedite solution time for this large mixed-integer programming model, and supporting numerical results.

■ WB-06

Wednesday, 10:30-12:00

APP Askja N-121

Optimization of the Last Mile

Stream: Optimization in Postal Logistics

Invited session

Chair: *Stefan Irnich*, Deutsche Post Endowed Chair of Optimization of Distribution Networks, RWTH Aachen University, Templergraben 64, 52062, Aachen, Germany,
sirnich@or.rwth-aachen.de

1 - Applying arc routing optimization methods to mail delivery operations

Charles Fleurent, GIRO inc., 75, Port-Royal Est, Bureau 500, H3L3T1, Montreal, Quebec, Canada,
charles.fleurent@giro.ca, *Jean-Marc Rousseau*

GeoRoute is a routing software specifically designed to meet the diversified and often complex routing requirements of postal organizations. It can be used to plan routes that visit most streets, as required for mail delivery, as well as point-to-point routes. The presentation will focus on specific issues that have to be considered for arc routing optimization in the context of mail delivery. These include a very high number and density of locations to service on each route, use of multiple transport modes within a same route, and intricate travel paths.

2 - Route Optimization in Household Pickup or Delivery

Geir Hasle, Applied Mathematics, SINTEF ICT, P.O. Box 124 Blindern, 314, Oslo, Norway, Geir.Hasle@sintef.no,
Oddvar Kloster, *Truls Flatberg*, *Eivind Nilssen*

VRP applications such as newspaper delivery and garbage collection are particularly demanding for routing tools due to their requirements on detailed, accurate geographical information. Another reason is the efficacy of VRP methods when faced with real-life instances that may contain tens of thousands of households. Basically, such VRPs are node routing problems. We discuss how to utilize aggregation, abstraction, and local search speedup techniques to meet the requirements from routing applications where a substantial share of households in an area must be visited.

3 - Modelling and Solving Real-World Postman Problems

Stefan Irnich, Deutsche Post Endowed Chair of Optimization of Distribution Networks, RWTH Aachen University, Templergraben 64, 52062, Aachen, Germany,
sirnich@or.rwth-aachen.de

One of the most general postman problems studied in the literature is the windy rural postman problem (WRPP). The talk presents modelling and solutions methods for real-world postman problems extending the WRPP regarding several aspects. Extensions discussed are turn restrictions and/or penalties, cluster constraints, the option to have alternative service modes (including zigzag deliveries), the use of public transport to reach the postal district, etc. The solution method is based on a transformation to the ATSP and uses non-standard neighborhood search techniques.

■ WB-07

Wednesday, 10:30-12:00

APP Askja N-120

Marketing

Stream: Marketing (c)

Invited session

Chair: *Sandra Rudolph*, Operations Research, FernUniversität in Hagen, Profilstr. 8, 58084, Hagen, Germany, sandra.rudolph@fernuni-hagen.de

1 - Infinite horizon advertising in a segmented market

Bruno Viscolani, Pure and Applied Mathematics, University of Padova, via Belzoni 7, I 35131, Padova, Italy, viscolani@math.unipd.it, *Luca Grosset*

We analyse the infinite horizon optimal control problem of profit maximisation while advertising in a segmented market. First, we assume that the firm may activate an advertising channel, which affects the goodwill of the market segments differently. Then, we assume that the firm may advertise directly toward the different market segments, using a special communication channel for each segment. We determine the optimal solutions of the relevant optimal control problems. Hence we obtain a natural choice criterion among advertising channels with different characteristics.

2 - Connecting Store Refurbishment , Store Image and Patronage Intention

James Freeman, Manchester Business School, University of Manchester, Booth Street West, M15 6PB, Manchester, United Kingdom, jim.freeman@mbs.ac.uk

Store refurbishment is a strategic marketing option with costs and benefits not fully appreciated even by experienced retail professionals. The presentation concerns an ambitious revamp programme carried out by a large regional chain, specialising in the distribution of domestic electrical appliances. A structural equation modelling (SEM) analysis of data collected on customer attitudes, before and after the renovation project, uncovers significant connections between refurbishment, image improvement and patronage intention.

3 - Balancing the fit and the logistics costs of market segments

Marcel Turkensteen, Econometrics and OR, University of Groningen, Landleven 5, 9700 AV, Groningen, Netherlands, m.turkensteen@rug.nl, *Gerard Sierksma*

In market segmentation, heterogeneous consumers are divided into more or less homogeneous groups, the segments. In geographic segmentation applications, existing segmentation methods generate segments in which the constituting elements are not necessarily geographically closely located. Sometimes, high logistics costs force decision makers to use other segmentation criteria, such as taking countries as segments, which are expected to lead to segments that fit consumer preferences poorly. We present a simulated annealing approach for balancing logistics costs with fit of segments.

4 - Conjoint Analysis with a Probabilistic Expert System

Sandra Rudolph, Operations Research, FernUniversität in Hagen, Profilstr. 8, 58084, Hagen, Germany, sandra.rudolph@fernuni-hagen.de

Choice-based conjoint analysis is a method used in the new-product-development-process for the estimation of consumers' preferences concerning multiattributed products. It allows drawing conclusions from the utility estimation upon the choice decision, but involves several (unrealistic) assumptions. Therefore we suggest an alternative method using a probabilistic expert system to predict choice behaviour. This system obeys the principle of information fidelity, processing given information and nothing else (functional structure, independence etc.). In a simulation both approaches are applied.

■ WB-08

Wednesday, 10:30-12:00

EDU Oddi 101

PANEL: Role of Math in OR/MS Education

Stream: OR Education

Invited session

Chair: *Moshe Sniedovich*, Dept. of Mathematics and Statistics, University of Melbourne, Parkville, 3010, Melbourne, Victoria, Australia, m.sniedovich@ms.unimelb.edu.au

Chair: *Donna Llewellyn*, Center for the Enhancement of Teaching and Learning, Georgia Institute of Technology, 225 North Avenue, 30332-0383, Atlanta, Georgia, United States, donna.llewellyn@cetl.gatech.edu

Chair: *Stefan Voss*, Wirtschaftsinformatik/Information Systems, University of Hamburg, Von-Melle-Park 5, 20146, Hamburg, Germany, stefan.voss@uni-hamburg.de

Chair: *Janos D. Pinter*, PCS Inc. Dalhousie University, 129 Glenforest Drive, B3M 1J2, Halifax, NS, Canada, jdpinter@hfx.eastlink.ca

1 - Role of Math in OR/MS Education

Moshe Sniedovich, Dept. of Mathematics and Statistics, University of Melbourne, Parkville, 3010, Melbourne, Victoria, Australia, m.sniedovich@ms.unimelb.edu.au, *Stefan Voss*, *Janos D. Pinter*, *Donna Llewellyn*

In this open public discussion we plan to examine the role that mathematics can/should play in OR/MS education. We expect a lively exchange of contrasting ideas and hopefully some consensus.

■ WB-09

Wednesday, 10:30-12:00

IT Oddi 106

Feature Selection in Data Mining

Stream: Data Mining

Invited session

Chair: *Dolores Romero Morales*, Saïd Business School, University of Oxford, Park End Street, OX1 1HP, Oxford, United Kingdom, dolores.romero-morales@sbs.ox.ac.uk

1 - Feature selection and validation for mass spectral data in proteomics

Jia Ni, School of Mathematics, University of Southampton, Highfield Campus, SO17 1BJ, Southampton, United Kingdom, jiani@soton.ac.uk, *Julia Bennell*, *Lyn Thomas*, *Chris Potts*

In the area of proteomics, one of the applications is to detect a given type of disease on the basis of patient blood samples. A well-recognized challenge in classification for this type of problem is that there are thousands of features, but only a limited number of samples available. Thus, feature selection becomes an essential procedure to prevent over-fitting before any classification model can be built. We discuss various ways in selecting the key features from the feature space, with respect to the performance of the classification model, as well as the biological implication.

2 - Binarized Support Vector Machines

Belen Martin-Barragan, Dpto. Estadística e Investigación Operativa, University of Seville, Fac. Matemáticas, Avda. Reina Mercedes s/n, 41012, Sevilla, Spain, belmart@us.es, *Emilio Carrizosa*, *Dolores Romero Morales*

Support Vector Machine (SVM) method has shown good results in Supervised Classification problems. Classification Trees have become popular thanks to their interpretability. We propose an SVM-based method that automatically detects the most important predictor variables, and those values critical for the classification. It behaves comparable to SVM and clearly better than Classification Trees. The method involves the optimization of a Linear Programming problem with a large number of decision variables, for which we use the well-known Column Generation technique.

3 - Multi-objective feature selection in naive Bayes models. Application in the prognosis of survival of cirrhotic patients treated with TIPS.

Rosa Blanco, Statistics and Operations Research, Public University of Navarra, Edificio Los Magnolios 1º planta, Campus de Arrosadfa, 31006, Pamplona, Navarra, Spain, rosa.blanco@unavarra.es, Concha Bielza, Pedro Larrañaga

In clinical prognosis models not all predictor variables are useful. Due to their heterogeneity some of them could be irrelevant or redundant for prognosis purposes. The medical tests to obtain variables could be invasive and painful for patients. Moreover, not all these tests have an affordable economical cost. We adapt thus the naive Bayes model to perform a feature selection process in a multiobjective optimization task where the classification accuracy and the economical cost are the objectives. This framework is carried out over a collected dataset of cirrhotic patients treated with TIPS.

4 - On consistent biclustering with applications in biomedicine

Panos Pardalos, ISE Department, University of Florida, 303 Weil Hall, FL 32611, Gainesville, Florida, United States, pardalos@ufl.edu

Biclustering is a simultaneous partition of given samples and their features into classes. Samples and features classified together are supposed to have a high relevance to each other. We define the notion of consistency for biclustering and prove that it implies separability of the classes by convex cones. A fractional 0-1 optimization model for supervised biclustering whose consistency is achieved by feature selection is proposed. Encouraging computational results on DNA microarray data sets are reported.

■ WB-10

Wednesday, 10:30-12:00

OR Oddi 201

OR in Conflicts and the Society of OR

Stream: OR - The Profession: Ethics in OR

Invited session

Chair: *Giorgio Gallo*, Informatica, University of Pisa, Largo B. Pontecovo, 2, 56127, Pisa, Italy, gallo@di.unipi.it

1 - Analysis of conflict data via logic functions

Giovanni Felici, Istituto di Analisi dei Sistemi ed Informatica, Consiglio Nazionale delle Ricerche, Viale Manzoni 30, 00185, Roma, Italy, felici@iasi.cnr.it, *Claudia Sodini*

The application of learning tools based on logic functions for analysing the interstate militarized disputes (MIDs) is described. The aim is to discover hidden patterns which allow to separate in the observations space those points which correspond to conflict situations from those which do not. Such task is performed identifying a good subset of the features and properly logic formulas that explain the available observations and perform reliable predictions. An implementation of this methodology is described along with numerical results. A comparison with other approaches is presented.

2 - Analysing the phases of a conflict via Multicriteria Clustering

Giorgio Gallo, Informatica, University of Pisa, Largo B. Pontecovo, 2, 56127, Pisa, Italy, gallo@di.unipi.it, *Claudia Sodini*, *Alexis Tsoukiàs*

Crucial to conflict prevention and resolution is the capability of determining in which phase a conflict is, and of anticipating the path it will follow in the future. Conflict phases have been studied making use of different quantitative methodologies, among them clustering analysis. Often in these studies data are aggregated into single indicators, so allowing the use of standard clustering algorithms, but at the expense of loss of information. Here we explore the application of multi-criteria clustering techniques and investigate their effectiveness in analysing conflict phases.

■ WB-11

Wednesday, 10:30-12:00

TRANS Oddi 202

Freight Terminal Management

Stream: Transportation

Invited session

Chair: *Giulio Erberto Cantarella*, Dept of Civil Engineering, University of Salerno, via Ponte Don Melillo, 1, 84084, Fisciano (SA), Italy, g.cantarella@unisa.it

1 - Petri-net modelling of automated container handling in intermodal terminals

Angela Di Febbraro, Dept. Machines, Energy Systems, and Transportation, University of Genova, Via Montallegro, 1, I-16145, Genova, Italy, angela.difebbraro@unige.it, *Nicola Sacco*, *Federico Negri*

Petri nets are applied in this work to define a modular, performance-evaluation oriented model of an innovative automated system to handle containers in intermodal terminals, recently proposed in Italy. A major objective is to speed up the operations of loading/unloading containers on/from trains, based on the idea of assimilating goods to passengers in transportation, thus increasing the flexibility of the whole system and optimizing the space allocation inside each terminal. In this framework, no models to evaluate the performances of such a promising system have been proposed yet.

2 - Simulation technology for planning and optimisation of operational processes in maritime container terminals

Carsten Boll, Planning and Simulation Systems, Institute of Shipping Economics and Logistics, Stresemannstrasse 46, 27570, Bremerhaven, Bremen, Germany, Boll@isl.org

The system "container terminal" is characterized by numerous parameters and interactions between technical, operational and economical components. Furthermore, some of the influencing factors have a random character as e.g. arrival times, daily volume of containers, loading and discharging times of vessels, handling times etc. With the aid of special simulation models it is possible to reproduce the real system "container terminal" as a virtual system in order to analyze an existing or planned terminal in detail.

3 - Diachronic network models for container terminal analysis

Giulio Erberto Cantarella, Dept of Civil Engineering, University of Salerno, via Ponte Don Melillo, 1, 84084, Fisciano (SA), Italy, g.cantarella@unisa.it, *Armando Carteni*, *Stefano de Luca*

Many existing contributions to container terminal simulation follow a microscopic approach, which supports very detailed analysis, but is rather computer demanding. Models following a macroscopic approach are based on container flows rather than single container movement, and can be more effective to simulate the whole container terminal ; so far they can more effectively support strategic / tactical planning and management. This paper proposes a diachronic network model following the latter approach, and reports the results of an application to the Salerno Container Terminal (IT).

■ WB-12

Wednesday, 10:30-12:00

TRANS Oddi 205

Air Transportation

Stream: Transportation

Invited session

Chair: *Milica Kalic*, Faculty of Transport and Traffic Eng., University of Belgrade, Vojvode Stepe 305, 11000, Belgrade, Serbia and Montenegro, m.kalic@sf.bg.ac.yu

1 - Crew Pairing Problem in a Small Sized Flight Network

Hatice Tekiner, Industrial Engineering, Sabanci University, B1-301 Orhanli, Tuzla, 34956, Istanbul, Turkey, htekiner@su.sabanciuniv.edu, *S. Ilker Birbil*

The main difficulty in crew pairing problem is the large number of possible pairings. Main approach to solve this problem is using column generation methods. Here, we solve the crew pairing problem for a medium scale airline company with a small sized flight network, where all pairings can be enumerated. However, the resulting integer programming problem is still difficult to solve. Thus, we analyze the optimal pairings to exploit the structure of a solution and to determine rules to decrease the number of pairings. Finally, we discuss how to add an extra flight to the flight schedule.

2 - Simulation of airline online auctions

Marijana Radovic, Aviation Security, JAT Airways, Bulevar umetnosti 16, 11000, Belgrade, Serbia and Montenegro, radovicm@jat.com, *Milica Kalic*

This paper presents a specific scenario for airline online auctions, focused on the central question of how an airline can make dynamic decisions to maximize revenue. The online auction simulator of airline marketplace behavior in an environment with buyers, sellers, and auction rules is presented. Using the daily reserve price and the number of seats released each day this paper proposes two airline decision strategies as methods for increasing revenue: reserve pricing strategy and seat releasing strategy.

3 - A Decision Support System for Airline Daily Flight Scheduling

Milica Kalic, Faculty of Transport and Traffic Eng., University of Belgrade, Vojvode Stepe 305, 11000, Belgrade, Serbia and Montenegro, m.kalic@sf.bg.ac.yu, *Obrad Babic*, *Goran Pavkovic*, *Slavica Dozic*, *Mirjana Cangalovic*

A Decision Support System for Airline Daily Flight Schedule (DSSADFS) is developed in order to support decision making during the irregular events. The effects of these disturbances are certain delayed flights and/or cancellations. The output of DSSADFS is a redesigned operational daily schedule. The problem is mathematically modeled and a heuristic is developed for solving schedule perturbations with an appropriate, user-friendly software interface. The DSSADFS operates in real time. The software application is illustrated using the JAT Airways schedule example where DSSADFS is implemented.

■ WB-13

Wednesday, 10:30-12:00

TRANS Oddi 206

Vehicle Routing

Stream: Vehicle Routing (c)

Invited session

Chair: *Andreas Lackner*, Abteilung 1, Insitut für Wirtschaftsinformatik, Platz der Goettinger Sieben 5, 37077, Göttingen, Germany, alackne@gwdg.de

1 - A dynamic day-ahead paratransit planning problem

Marloes Cremers, Department of Econometrics, University of Groningen, P.O. Box 800, 9700 AV, Groningen, Netherlands, M.L.A.G.Cremers@rug.nl, *Wim Klein Haneveld*, *Maarten Van der Vlerk*

We consider a dynamic planning problem for paratransit transport. We focus on a decision to take one day ahead: which requests to serve with own vehicles, and which requests to subcontract to taxis? We call this problem the Dynamic Day-ahead Paratransit Planning Problem. The developed model is a non-standard two-stage integer recourse model. Both stages consist of two parts: requests are clustered into routes, and these routes are assigned to vehicles. To solve this model, a genetic algorithm approach is used. Computational results are presented for randomly generated data sets.

2 - Heuristic algorithms for vehicle routing problems of less-than-truckload carriers

Julia Rieck, Department for Operations Research, Clausthal University of Technology, Julius-Albert-Str. 2, 38678, Clausthal-Zellerfeld, Germany, julia.rieck@tu-clausthal.de

As a consequence of globalisation and increasing customer expectations, medium-sized less-than-truckload carriers operate together in cooperations. Each cooperative member faces a multitude of requirements when constructing a low-cost, feasible set of routes. Taking up this problem, we consider among other aspects simultaneous pick-up and delivery at customer locations, multiple use of vehicles and timely allocation of vehicles to loading bays at the depot. To solve the resulting vehicle routing problem, we present a sampling procedure and a genetic algorithm.

3 - Evolutionary strategies for the dynamic vehicle routing problem

Andreas Lackner, Abteilung 1, Insitut für Wirtschaftsinformatik, Platz der Goettinger Sieben 5, 37077, Göttingen, Germany, alackne@gwdg.de, *Ole Brodersen*

The competition in transportation and the expected service level of a delivery service is rising every year. This requires a flexible routing in real time, where the optimization has to be able to deal with problems changing over time and to consider updated information into the optimization process. In spite of these requirements most papers still concentrate on the static and deterministic problem. This paper shows how evolutionary strategies behave in the context of such a dynamic vehicle routing (DVR) compared to local optimization procedures and discuss their suitability for DVR.

■ WB-14

Wednesday, 10:30-12:00

PROD Arnag 101

Realistic Production Scheduling, part I

Stream: Realistic Production Scheduling

Invited session

Chair: *Ruben Ruiz*, Departamento de Estadística e Investigación Operativa Aplicadas y Calidad, Universidad Politécnica de Valencia, Camino de Vera S/N, 46021, Valencia, Spain, rruiz@eio.upv.es

1 - Scheduling in an Automobile Supplier. Models and heuristics.

Carlos Andres, Management Department, Technological University of Valencia, Camino de Vera S/N, 46022, Valencia, Spain, candres@omp.upv.es, *Cristobal Miralles*, *José P. Garcia-Sabater*

This paper deals with the problem of scheduling in a single facility with sequence-dependent setups. The real problem is described and formulated, considering all the restrictions and variables of the problem. In the second part of the paper some solution procedures are formulated with a discussion about the real application of these heuristics to the real environment that has inspired it. The final part of the paper is devoted to explain the reasons of the company for selecting the heuristics and the first improvements established in practice.

2 - Fast Genetic Algorithms for lateness Minimization in no-wait flowshop with setup times

Ruben Ruiz, Departamento de Estadística e Investigación Operativa Aplicadas y Calidad, Universidad Politécnica de Valencia, Camino de Vera S/N, 46021, Valencia, Spain, rruiz@eio.upv.es, *Ali Allahverdi*, *Gerardo Minella*

We propose several efficient genetic algorithms as well as fast heuristics for a m-machine flowshop problem that results from the consideration of two interesting constraints: jobs are not allowed to wait in between machines (no-wait) and separable sequence-independent setup times. The optimization criterion considered is the minimization of the maximum lateness. The genetic algorithms use simple structures and operators and yet show excellent performance when compared to the heuristics or to other adapted methods from the literature, especially when hybridized with local search techniques.

3 - A Comparison of Heuristics and Metaheuristics for the M-machine Flowshop Problem minimizing total tardiness

Eva Vallada, Estadística e Investigación Operativa Aplicadas y Calidad, Universidad Politécnica de Valencia, Cno. Vera s/n Edificio I-3, 46022, Valencia, Spain, evallada@eio.upv.es, *Ruben Ruiz*, *Gerardo Minella*

In this work, a review and evaluation of heuristics and metaheuristics for the m-machine flowshop scheduling problem with the objective to minimize total tardiness is presented. Published reviews about this objective usually deal with single machine or parallel machines and no recent methods are compared. We have implemented several techniques and we have analyzed their performance under the same benchmark. In this comparison we study from the classical priority rules to the most recent tabu search, simulated annealing and genetic algorithms.

WB-15

Wednesday, 10:30-12:00

PROD Arnag 201

Supply Chain Management V

Stream: Supply Chain Management (c)

Invited session

Chair: *Roberto Abreu*, Information Technology Department, Centro de Logística da Aeronáutica- Brazilian Air Force Logistics Center, Avenida Monteiro Lobato, 5339 - Cumbica, 07184000, Guarulhos, SP, Brazil, abreurbca@terra.com.br

1 - Election Logistics in India: A Process Based Approach

Ravichandran Narasimhan, Production Quantitative Methods Area, Indian Institute of Management, Ahmedabad, Vastrapur, 380 015, Ahmedabad, Gujarat, India, nravi@iimahd.ernet.in

India as a vibrant democracy conduct elections on schedule as per the constitution requirements. There are several stakeholders involved in the smooth conduct of the election. Such an exercise requires extensive planning, coordination, control and de-risking. This document describes the complexity of the event and how the Indian administrative machinery handles this. Over a period of time, robust world class systems have been developed by the administrative missionary so that elections can be conducted smoothly irrespective of the context and the local leadership.

2 - Application of the theory of constraints to supply chain management

Fernando Marins, Production, UNESP - São Paulo State University, Av. Ariberto Pereira da Cunha, 333, 12516-410, Guaratinguetá, SP, Brazil, fmarins@feg.unesp.br, *Artur Moellmann*

With the evolution of SCM tools, gained benefits are noticeable. But, it is reported that users didn't achieve better profitability and efficiency. TOC proposes a solution to those problems, and exposes the dilemma that restricts profits maximization in the SC, and how the chain members can realize the global initiatives of improvement. We present a study that shows how lack of an approach over the restrictive aspects affects the global performance of the chain avoiding the maximization of the user benefits in profitability, operational processes optimization, management and decision making.

3 - A Spreadsheet Approach for Solving METRIC Problems

Roberto Abreu, Information Technology Department, Centro de Logística da Aeronáutica- Brazilian Air Force Logistics Center, Avenida Monteiro Lobato, 5339 - Cumbica, 07184000, Guarulhos, SP, Brazil, abreurbca@terra.com.br, *Marilson Alves*

This research seeks to describe an alternative approach for implementing METRIC theory for repairable inventory systems. It uses genetic algorithms for searching the best mix of spare items. The use of spreadsheet format allows managers to adjust the template to their needs without re-programming efforts. The high costs associated with repairable item management and its impact on system's availability make the decisions of "what-to-buy" and "where-to-locate" critical for supply managers. The approach has been tested with problems of different scale. The results have been very satisfactory.

WB-16

Wednesday, 10:30-12:00

PROD Arnag 301

Production Planning and Scheduling I

Stream: Scheduling

Invited session

Chair: *Hlynur Stefansson*, Centre for Process Systems Engineering, Imperial College London, SW7 2AZ, London, United Kingdom, hlynur.stefansson@ic.ac.uk

1 - A priority-rule based method for continuous process scheduling

Sascha Herrmann, Operations Management Group, Institute of Management and Economics, Julius-Albert Str. 2, 38678, Clausthal-Zellerfeld, Germany, sascha.herrmann@tu-clausthal.de

In this talk we consider the production scheduling problem of multipurpose continuous plants in the process industries. This problem consists in allocating processing units, input materials, and storage space over time to the execution of a given set of operations. Due to constraints on material availability and storage capacity for intermediate products, classical schedule-generation schemes cannot be applied. We propose a new two-phase priority-rule-based algorithm, dealing with the two types of inventory constraints separately. Computational experience is reported.

2 - Back to the basics: Continuous or discrete time, campaign or order scheduling?

Sigrun Lilja Sigmarsson, Dept. of Engineering, University of Iceland, Skjalagerdi 7, 108, Reykjavik, Iceland, sigrsig@gmail.com, *Pall Jensson*, *Hlynur Stefansson*

For the last stage in a pharmaceutical company, how many orders can be scheduled in a feasible time? Is it really useful to group orders into campaigns and schedule them instead of simply schedule the orders directly? We will try to answer these questions and compare MILP models with different time representation. The scheduling problem is the packaging stage in a secondary pharmaceutical plant, with five parallel machines, sequence dependent changeover and variable demand pattern. As well as looking at CPU times the models are compared regarding how well they represent the real situation.

3 - Hierarchically Structured Integrated Multi-scale Algorithm for Production Planning and Scheduling

Hlynur Stefansson, Centre for Process Systems Engineering, Imperial College London, SW7 2AZ, London, United Kingdom, hlynur.stefansson@ic.ac.uk, *Pall Jensson*, *Nilay Shah*

In this work we propose an efficient modelling approach based on an integrated multi-scale algorithm together with optimisation models and solution methods for planning and scheduling of a MTO production process under uncertain and varying demand conditions. The approach is based on a moving horizon framework with hierarchically structured levels. The levels are integrated with versatile integration strategies that transfer and implement decisions at the adjacent levels. The approach has been tested with full-scale datasets from a complex problem originated in the pharmaceutical industry.

■ WB-17

Wednesday, 10:30-12:00

PROD Arnag 303

Resource Constrained Project Scheduling

Stream: Scheduling

Invited session

Chair: *Martin Romauch*, Dept. of Business Studies, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, martin.romauch@univie.ac.at

1 - Heuristics for a practically relevant extension of the resource constrained project-scheduling problem

Jörg Homberger, University of Applied Science Kaiserslautern, Adolf-Ludwig-Ring 2a, 66955, Pirmasens, Germany, j.homberger@web.de, *Hermann Gehring*

Subject of the paper is an extension of the well-known resource constrained project scheduling problem. According to practical requirements, the activities are specified by their estimated work load instead of their duration. Further, activities may be interrupted and dead lines for the end of their execution may be specified. Two solution methods are presented, a priority-based construction-heuristic and a genetic algorithm. Numerical tests show that both methods are suited to solve benchmark instances generated in accordance with practical requirements as well as instances from the PSPLib.

2 - A priority-rule based method for batch production scheduling

Rafael Fink, Institut für Wirtschaftswissenschaft, Technische Universität Clausthal, Julius-Albert-Str. 2, 38678, Clausthal-Zellerfeld, Germany, rafael.fink@tu-clausthal.de

The problem of batch production scheduling in the process industries consists in scheduling a given set of operations on alternative multipurpose processing units subject to material-availability and storage-capacity constraints, sequence-dependent cleaning times of processing units, and prescribed time lags between operations. We present a priority-rule based method that is able to cope with all of these constraints. The method exploits the cyclic structure of the MPM network belonging to the prescribed time lags. Computational results for a test set from literature are reported.

3 - A Resource Constrained Scheduling Problem

Martin Romauch, Dept. of Business Studies, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, martin.romauch@univie.ac.at, *Walter Gutjahr*, *Richard Hartl*

The considered problem which is motivated from semiconductor industries generalizes the job shop problem. Here we extend the job shop problem by distributing additional but constrained resources to accelerate processes. We propose several models with different levels of complexity based on mathematical formulations and we show that in some variants, the single machine problem is already NP complete. For one of the modeling variants we discuss an exact solution approach as well as a heuristic solution technique based on a hybridization of a GA.

4 - Efficient Solution for a Nondelay Resource Constrained Project Scheduling Problem

Arik Sadeh, Management of Technology, Holon Institute of Technology, 52 Golomb Street, P.O. Box 305, 58102, Holon, Israel, sadeh@hit.ac.il, *Yuval Cohen*, *Ofer Zwikael*

A non-delay RCPSP arises when there are resources available to start execution of an activity and no delay is allowed. An efficient procedure based on Branch and Bound BB, to find the shortest make span for non-delay RCPSP is developed. The n stages of BB are built up sequentially according to the n activities of the project. A stage is ended with a set of efficient partial schedules and only the information from that stage is saved. The procedure is a single mode RCPSP, easily manageable, and efficient in number of calculations. Many comparisons of the suggested procedure have been conducted.

■ WB-18

Wednesday, 10:30-12:00

PROD Arnag 304

Uncertainty and Location

Stream: Locational Analysis

Invited session

Chair: *Matthias Massmann*, Chair of Operations Management, Johann Wolfgang Goethe University, Mertonstr. 17, D-60054, Frankfurt, Germany, massmann@wiwi.uni-frankfurt.de

1 - Locating new facilities in an uncertain environment

Maria J. Canos, Matemáticas para la Economía y la Empresa, Universitat de Valencia, Avda. Tarongers s/n, 46071, Valencia, Spain, Maria.J.Canos@uv.es, *Carlos Ivorra*, *Vicente Liern*

Nowadays, companies face long-term decisions in uncertain environments. Among them, structural decisions as locating new facilities have serious consequences for their finances. In previous works, we have approached this location problem by means of a fuzzy version of the well-known p -median problem. Since real world problems lead to large-sized instances we have developed various suitable heuristic procedures. Here we present some improved results based on a specific exact algorithm used in the second phase of a heuristic concentration.

2 - Fuzzy Facility Location Problem with Preference of Candidate Sites and Barriers

Hiroaki Ishii, Osaka University, Japan, ishii@ist.osaka-u.ac.jp

We consider the following facility location model. 1) The region considered is rectangular with barriers that cannot be passed and distance is rectilinear. 2) There exist finite demand points and for each demand point, satisfaction degree with respect to the distance to the facility is defined. 3) Candidate sites for a facility construction are given with their preferences for the facility construction. 4) The objective is to find the site of the facility maximizing both minimal satisfaction degree among all demand points and its preference.

3 - Capacitated Stochastic Dynamic Facility Location Planning - An Approach

Matthias Massmann, Chair of Operations Management, Johann Wolfgang Goethe University, Mertonstr. 17, D-60054, Frankfurt, Germany, massmann@wiwi.uni-frankfurt.de

Determining facility locations is a long-term decision. Thus changes of location factors over time and estimation uncertainties of future data have to be considered, making a dynamic and stochastic model necessary. We describe the temporal development of each customer's random demand by a Markov chain. Our goal is the constrained maximisation of the entire expected profit. Decomposition by Lagrangean relaxation and application of stochastic dynamic programming methods results in a set of inequalities by which a decision about opening or closing a facility can be reached in each period.

■ WB-19

Wednesday, 10:30-12:00

PROD Arnag 311

Resource Allocation in Project Management

Stream: Project Management & Scheduling (c)

Invited session

Chair: *Selcuk Karabati*, Koc University, College of Admin. Sciences and Economics, 34450, Sariyer, Istanbul, Turkey, skarabati@ku.edu.tr

1 - Resource Allocation in Cost Engineering Project Management

Dimitri Golenko-Ginzburg, Industrial Engineering Management, Academic College of Judea and Samaria,

44837, Ariel, Israel, dimitri@bgumail.bgu.ac.il, *Doron Greenberg, Avner Ben-Yair*

We consider a company which simultaneously monitors several contractors. The system under consideration is based on a single storehouse where all the resources are stored and, if necessary, send to a certain contractor. After finishing an operation all the resources undertaking that operation are returned to the storehouse. The problem is to minimize the average of the company's expenses and is solved by means of a heuristic algorithm by a combination of the cyclic coordinate descent method (at the upper level) and a simulation scheduling model (at the lower level).

2 - A metaheuristic algorithm for the resource leveling problem

Francisco Ballestin, Department of Statistics and OR, Public University of Navarra, Campus Arrosadia, S/N, 31006, Pamplona, Spain, *Francisco.Ballestin@uv.es*, *Christoph Schwindt, Jürgen Zimmermann*

We consider the resource leveling problem which consists in scheduling the activities of a project in such a way that the variance in the resource utilization over time is minimized subject to prescribed minimum and maximum time lags between activities. We have developed an iterated greedy algorithm for this problem. In each iteration, a schedule is chosen from the current population. This schedule is transformed into a new schedule by deleting some activities, which are rescheduled consecutively at locally optimal start times.

3 - An Approach for Multi Project Scheduling in the Construction Industry

Frank Schultmann, Business Administration, Construction Management and Economics, University of Siegen, Paul-Bonatz-Strasse 9-11, 57076, Siegen, Germany, *frank.schultmann@uni-siegen.de*, *Nicole Sunke*

The construction industry is characterised by a high mobility, cyclical and seasonable instability as well as by a site-specific production characteristic, all triggering the need for sophisticated scheduling approaches. We will present a multi project planning approach for the construction industry. Based on a model developed by Lova and Tormos a resource constrained multi project scheduling approach is developed considering construction project specific peculiarities like awarding authority dependent release and due dates for projects as well as variable resource availabilities.

4 - Quantifying Project Management Delay Costs through Simulation Modeling

Deborah Cernauskas, Northern Illinois University, 4541 Saratoga Ave., 60515, Downers Grove, IL, United States, *dcernauskas@wans.net*, *Andrew Kumiega*

Unplanned project delays resulting in cost overruns occur for many reasons including shortages and weather. Managers must schedule the activities needed to complete the project on time and on budget. At each step, the possibility of a delay and cost overrun exists. The probability of a delay is generally accounted for by padding the duration of activities and cost estimates. This article allows random delays in the development of the project critical path through simulation. We also quantify the cost of crashing the stochastic CPM as well as determine the distribution of the resulting costs.

■ WB-20

Wednesday, 10:30-12:00

HEUR Arnag 422

Metaheuristics I

Stream: Metaheuristics (c)

Invited session

Chair: *Jose Brandao*, Management, University of Minho, Largo do Paço, 4704 -553 , Braga, Portugal, *sbrandao@eeg.uminho.pt*

1 - A Genetic Algorithm With An Ageing Operator For Solving The Resource-sharing And Scheduling Problem (rssp)

Gaby Pinto, Department of Industrial Engineering and Management, Ben Gurion University of the Negev, P.o.b.

653, 84105, Beer Sheva, Israel, *pintog@bgu.ac.il*, *Inessa Aimbinder, Gad Rabinowitz*

The RSSP deals with the scheduling of multiple operations with precedence constraints. Each operation uses multiple resources in various optional modes. The objective is to minimize the makespan. In this study a DNA-inspired GA with an ageing operator is presented. This operator has a two-fold purpose: it retains few of the best individuals for the next generation and, it deteriorates their fitness through the generations in order to avoid local optimum. Numerical experiments demonstrated that our algorithm performs better than other GA's both in runtime and deviation from optimality.

2 - Parameters' values in max-min ant system: empirical analysis

Paola Pellegrini, Applied Mathematics, Ca' Foscari University, Dorsoduro 3825/E, 30123, Venice, Italy, *paolap@pellegrini.it*, *Daniela Favaretto, Elena Moretti*

One of the most successful ACO algorithms is studied: max-min ant system. The impact of the values of the parameters on the behavior of the algorithm is analyzed. Typically, a relation between the values of the parameters and the time available is not considered. Instead, it is clearly detectable in practise. Experiments on the TSP and two versions of the VRP are used for supporting this statement. We read the results in terms of speed of convergence. One can expect that, when increasing the time available, the speed of convergence should decrease. This arguing is confirmed by the results.

3 - A tabu search algorithm for fleet size and mix vehicle routing problem

Jose Brandao, Management, University of Minho, Largo do Paço, 4704 -553 , Braga, Portugal, *sbrandao@eeg.uminho.pt*

In this paper we study the fleet size and mix vehicle routing problem (FSMVRP), which is a variation of the classical vehicle routing problem (VRP). In the FMSVRP a heterogeneous fleet of vehicles is considered with different capacities, fixed costs and variable costs. The objective is to define the size of the fleet, the types of vehicles and the routes in order to minimize the total cost. We solved the FMSVRP using a tabu search algorithm. In order to evaluate the performance of our algorithm we used twenty test problems from the literature.

■ WB-22

Wednesday, 10:30-12:00

OPT Adal 050

Optimality Conditions and Duality for Multicriteria Problems

Stream: Multiple Objective Optimization

Invited session

Chair: *Christiane Tammer*, Mathematics and Computer Science, Martin-Luther-University Halle-Wittenberg, Theodor-Lieser-Str. 5, D-06120, Halle, Germany, *christiane.tammer@mathematik.uni-halle.de*

1 - Fuzzy necessary optimality conditions for vector optimization problems

Christiane Tammer, Mathematics and Computer Science, Martin-Luther-University Halle-Wittenberg , Theodor-Lieser-Str. 5, D-06120, Halle, Germany, *christiane.tammer@mathematik.uni-halle.de*

In order to derive some fuzzy optimality conditions for vectorial (not necessary convex) optimization problems, where the objective function is locally Lipschitz, we study some properties and the structure of the sub-differential of a scalarizing functional. So it is possible to get sharper optimality conditions or duality assertions. Finally, we present some applications for vectorial control-approximation problems.

2 - A New Approach to Duality in Vector Optimization

Andreas Loehne, Dep. of Optimization and Stochastics, MLU Halle-Wittenberg, 06099 Halle, 00000, Halle,

Germany, loehne@mathematik.uni-halle.de, *Christiane Tammer*

We investigate convex vector optimization problems. We modify a given vector optimization problem such that the image space is a complete lattice, namely a sublattice of the power set. So we can carry over the structures of scalar Fenchel duality. We apply the results to linear problems. The dual problem is set-valued, but has a simple structure. The dual objective values are hyperplanes and the dual origin space is just the R_m . Moreover the dual feasible set is polyhedral if the ordering cone is so and the dual optimal value is attained in vertices of the dual feasible set.

3 - Portfolio selection with coherent risk measures

Frank Heyde, Department of Mathematics and Computer Sciences, Martin-Luther-University of Halle-Wittenberg, Theodor-Lieser-Str. 5, D-06099, Halle (Saale), Germany, heyde@mathematik.uni-halle.de

We consider a Markowitz type portfolio selection problem where the standard deviation is replaced by a deviation measure derived from a coherent risk measure. If the financial market is complete we can solve the parametric optimization problem using the density of the unique equivalent risk neutral probability.

■ WB-23

Wednesday, 10:30-12:00
OPT Adal 051

Approximating Graph Problems

Stream: Approximation Algorithms

Invited session

Chair: *Hadas Shachnai*, Department of Computer Science, Technion - Israel Institute of Technology, 32000, Haifa, Israel, hadas@cs.technion.ac.il

Chair: *R Ravi*, Tepper School of Business, Carnegie Mellon University, 5000 Forbes Avenue, 15217, Pittsburgh, PA, United States, ravi@andrew.cmu.edu

1 - Approximating Batched Coloring Problems

Magnus M. Halldorsson, Dept. of Computer Science, University of Iceland, Vr-ii, IS-107, Reykjavik, Iceland, magnusmh@gmail.com

We consider coloring problems where vertices have lengths, and the coloring corresponds to a partition into batches. The length of a batch is the length of the longest vertex; the length of a coloring is the sum of the length of the batches. The completion time of a vertex is the sum of the preceding batches, plus the length of the job. We consider approximation algorithm for both the makespan and sum of completion times versions. In particular for the latter version, we give new or improved approximations for general, interval, line, and perfect graphs. Joint work Epstein, Levin & Shachnai.

2 - Approximating Bounded Metric TSP and Related Problems

Marek Karpinski, Department of Computer Science, University of Bonn, Roemerstr. 164, 53117, Bonn, Germany, marek@cs.uni-bonn.de

We present some of the recent results on the approximability of the bounded metric Traveling Salesman Problem and related Path Packing Problems.

3 - Greedy Approach to Independent Set Problem in Bounded-Degree Hypergraphs

Elena Losievskaja, Department of Computer Science, University of Iceland, VR III, Haskoli Islands, 101, Reykjavik, Iceland, elenal@hi.is, *Magnus M. Halldorsson*

An independent set in a hypergraph H is two-fold: a strong (weak) independent set intersects any edge of H in at most one (at most all but one) element. In this paper we study hypergraphs with degree bounded by D . We show that the performance ratio of the greedy algorithm is $(D+1)/2$ for weak independent set and D for strong independent set; both bounds are tight. However, the performance ratio of the greedy algorithm is better in p -uniform hypergraphs: for weak independent the tight bound is $(1 + (D+1)/p)$, for strong independent set the tight bound is $(D + (D+1)/p)$.

4 - Strip Graphs: Recognition and Scheduling

Ragnar Karlsson, Dept. of Mathematics, University of Iceland, 107, Reykjavik, Iceland, ragnark@gmail.com, *Magnus M. Halldorsson*

We consider the class of strip graphs, a generalization of the interval graphs. We show that recognition of the class of strip graphs is NP-complete even if all intervals are of length 2.

Consider job interval scheduling on m machines. For 1 machine, this is equivalent to the problem of finding the maximum independent set in a strip graph, which we show to be tractable for a fixed number of overlapping rows. We introduce a concatenation operation on strip graphs which reduces the m -machine case to the 1-machine case. We also reduce the optimization version of JISP to the 1-machine case.

■ WB-24

Wednesday, 10:30-12:00
OPT Adal 052

Hierarchical models applications

Stream: Dynamical and Anticipatory Systems

Invited session

Chair: *Ryszard Klempous*, Faculty of Electronics, Wrocław University of Technology, 27 Wybrzeże Wyspińskiego Street, 50370, Wrocław, Poland, klempous@yahoo.com

Chair: *Michael Affenzeller*, Department of Software Engineering, Upper Austrian University of Applied Sciences, Hauptstr. 117, A-4232, Hagenberg, Austria, michael@heuristicslab.com

1 - NIE Models of Emergency Services Interoperability

Essam Rahali, Faculty of Engineering, University of Technology, Sydney, Broadway, Broadway, 2007, Sydney, NSW, Australia, a.rahali@yahoo.com, *Zenon Chaczko*, *Perez Moses*

The goal of the paper is to provide an insight into modelling techniques for studying emergency services interoperability functions in system design to avoid hidden points of failures. Concepts of artificial Neuro-Immune-Endocrine (NIE) models for autonomous self-configuring and self-healing systems are discussed. The paper features examples of collaborative software agents' behaviour in hostile environments, cooperating protocols, smart embedded devices and pro-active infrastructures in various areas related to emergency services operations.

2 - Socio-inspired Design Models for Software System Infrastructures.

Marcel Caroly, Faculty of Engineering, University of Technology, Sydney, 21 Tipperary Ave, Killarney Heights, 2087, Sydney, NSW, Australia, neloc@optushome.com.au, *Zenon Chaczko*

This paper outlines our charitable model, the technical challenges that drove the concept behind this model and the rationale behind its design. Social models such as the benefactor/beneficiary model of Multiagent Distributed Storage Middleware can be applied to many areas as a means of automating a wide variety of resource distribution challenges in both traditional and future distributed systems. An environment populated with many redundant components can benefit from a charitable entity, allowing wasted resources to be efficiently distributed to the network on a voluntary manner.

3 - Introducing extra knowledge into image filtering process

Bartosz Jablonski, Institute of Computer Engineering, Control and Robotics, Wrocław University of Technology, Janiszewskiego Str. 11/17, 50-370, Wrocław, Poland, bartosz.jablonski@pwr.wroc.pl

A method of introduction extra information into diffusion process is presented. Assuming that we have a general knowledge about shapes which should be found in the image, a filtering can be processed taking into account the prediction of shapes. Shape evaluation is based on Hough transform. We show that the information obtained from the Hough transform can be used as an extra knowledge during non-linear image filtering. A modification of PDE-based process is presented. The comparison between the standard Peron-Malik filtering and the presented method is carried out.

4 - Reference Governor Optimization and Control of a Distributed Solar Collector Field

Cristina Rogelia Martinez Cirre, Concentrating Solar Systems, Plataforma Solar de Almería-Universidad de Almería, Crta. Senés, s/n, Tabernas, 04200, Almería, Spain, cristina.martinez@psa.es, *Loreto Valenzuela, Ryszard Klempous, Manuel Berenguel*

A lumped parameter physical model of the solar field has been used to provide figures about electricity production and the cost associated to it, then, a constrained nonlinear optimization method is applied to calculate the optimal reference temperatures. These trajectories are used as inputs to a control structure formed by an IPD and a feedforward controller both in parallel. The complete hierarchical control has been checked in a well validated simulator of the solar field with real operating data inputs. Experimental results demonstrate benefits of this kind of control in a solar field.

■ WB-25

Wednesday, 10:30-12:00

OPT Adal I-111

Multiobjective Optimization II

Stream: Mathematical Programming

Invited session

Chair: *Jorge Pinho de Sousa*, INESC Porto / FEUP, Campus da FEUP, Rua Dr Roberto Frias, 4200-465, Porto, Portugal, jsousa@inescporto.pt

1 - Supporting a strategic planning for acquisition of military capabilities using multiple criteria decision analysis

Nilton de Oliveira Lessa, Programa de Pós-Graduação em Aplicações Operacionais, Instituto Tecnológico de Aeronautica, Praça Marechal Eduardo Gomes, 50, 12228-611, São José dos Campos, SP, Brazil, lessa@ita.br, *Mischel Carmen N. Belderrain, Monica De Marchi*

This paper suggests the use of Multiple Criteria Decision Analysis to support a strategic planning for acquisition of military capabilities for the Brazilian Air Force, considering a given set of prospective scenarios. We propose that current military capabilities be assessed based on a Multiple Criteria Decision Aid approach. We also propose use of Multiobjective Programming, considering the difference between actual and needed BAF's competences, which outcome should be a strategic planning for achieving robust and flexible forces across all scenarios, under a resource-constrained condition.

2 - Sustainable production technologies which take into account environmental constraints

Constanta Zoie Radulescu, Research, National Research RD in Informatics, Averescu Avenue 8-10, 011455, Bucharest, Romania, radulescu@ici.ro, *Marius Radulescu, Sorin Radulescu*

A general production process is studied and a multiobjective programming problem is formulated in order to obtain optimal production plans in the presence of constraints on pollution emissions. Starting from the above problem are formulated a minimum pollution risk problem and a maximum expected return problem. For each polluting emission three levels are defined. The desirable or the target pollution level, the alarm level and the maximum acceptable level. Penalties proportional to the amount of pollution emission that exceeds these levels are considered. Some special cases are investigated.

3 - Multiobjective local search for mean-risk capacity planning in a supply network

Jorge Pinho de Sousa, INESC Porto / FEUP, Campus da FEUP, Rua Dr Roberto Frias, 4200-465, Porto, Portugal, jsousa@inescporto.pt, *João Claro*

We consider a mean-risk multi-stage multi-resource capacity expansion problem, with a scenario tree describing the evolution of demand and investment costs, fixed-charge cost functions and discrete capacity. An approach based on multiobjective local search was designed to find good quality approximations to the mean-risk efficient set, in reasonable computational times. A multi-product extension of this problem can be used in a supply network context. The multiobjective local search approach was also extended to deal with this version of the problem.

■ WB-26

Wednesday, 10:30-12:00

OPT Adal III=231

Routing and Location Problems (SADERYL1)

Stream: Combinatorial Optimization

Invited session

Chair: *Juan José Salazar González*, Estadística e Investigación Operativa, Universidad de La Laguna (Tenerife), Av. Astrofísico Francisco Sánchez, s/n, 38271, La Laguna, Tenerife, Spain, jjsalaza@ull.es

Chair: *Elena Fernandez*, Estadística i Investigació Operativa, Universitat Politècnica de Catalunya, Campus Nord, C5-208, Jordi Girona, 1-3, 08034, Barcelona, Spain, e.fernandez@upc.edu

1 - Combinatorial Auction Optimization

Mercedes Landete, Departamento de Estadística y Matemática Aplicada, University Miguel Hernández of Elche, Avda. del Ferrocarril s/n, 03202, Elche, Alicante, Spain, landete@umh.es, *Alfredo Marín*

In the past, auctions were a tool for selling single items, such as paintings or old furniture, while nowadays auctions allow a wide variety of exchanges on the market. Auctions where bidders express their interest for bundles of different articles are called combinatorial auctions. In this work, we present several properties of the usual Combinatorial Auction Problem integer programming formulation and then we use some of these properties to deduce new constraints. We develop a polyhedral study of the problem and present the results of our computational experiment.

2 - Tight bounds and optimal solution to the capacitated p-center problem.

Elena Fernandez, Estadística i Investigació Operativa, Universitat Politècnica de Catalunya, Campus Nord, C5-208, Jordi Girona, 1-3, 08034, Barcelona, Spain, e.fernandez@upc.edu, *Juan Díaz*

In this work we consider the capacitated p-center problem, CpCP. We propose a new model with a linear objective function, as well as an exact algorithm. Upper and lower bounds on the optimal value of CpCP allow reducing the number of variables in the model. To obtain the bounds we propose a lagrangean decomposition of the auxiliary problem of finding the maximum demand that can be satisfied with at most p plants within a given coverage radius. The radius d that gives the best lower bound for CpCP is obtained with binary search. Experimental testing shows the quality of the bounds.

3 - Valid inequalities for the p-median single plant location problem with order

Alfredo Marín, Departamento de Estadística e Investigación Operativa, University of Murcia, Facultad de Matemáticas, Campus de Espinardo, 30100, Murcia, Spain, amarin@um.es, *Lazaro Canovas, Sergio Garcia Quiles*

The single plant location problem is well known in the literature. Sometimes, the customers don't want to be allocated to the closest open facility, they have different assignment criteria. This is known as the simple plant location problem with order (SPLPO). In this talk, the p-median extension of the SPLPO is studied, that's to say, when the number of facilities to be open is fixed to be p. Some valid inequalities will be obtained and computational results for showing the improvement will be displayed.

4 - Solution of the Identical Parallel Machine Scheduling Problem

Manuel Iori, DEIS, University of Bologna, Viale Risorgimento 2, 40136, Bologna, Italy, miori@deis.unibo.it, Mauro dell'Amico, Silvano Martello, Michele Monaci

We consider the classical scheduling problem of minimizing the makespan on identical parallel machines. The problem, denoted as $P||C_{max}$, is NP-hard and has been extensively addressed in the literature. We provide an approach which includes upper and lower bounds from the literature, a scatter search heuristic and a column generation. The column generation is based on a set covering formulation and iteratively solves bin packing instances with tentative threshold values, possibly improving both upper and lower bound. Computational results show a good performance of the algorithm.

■ WB-27

Wednesday, 10:30-12:00

OPT Adal V=229

COIN-OR User Meeting

Stream: COIN-OR: Open Source Software

Invited session

Chair: Robin Lougee-Heimer, Mathematical Sciences, IBM Research, T.J. Watson Research Center, 1101 Kitchawan Road, 10598, Yorktown Heights, NY, United States, robinlh@us.ibm.com

1 - COIN-OR User Meeting

Robin Lougee-Heimer, Mathematical Sciences, IBM Research, T.J. Watson Research Center, 1101 Kitchawan Road, 10598, Yorktown Heights, NY, United States, robinlh@us.ibm.com

Any one interested in open-source software tools, open standards, open data, or open model repositories for OR is encouraged to attend the european users meeting of the Computational Infrastructure for OR (COIN-OR). COIN-OR is a initiative to promote open-source for operations research. Operating since 2000, COIN-OR now hosts twenty projects in its on-line repository –all available free of charge with complete source code. Current offerings include tools for linear, non-linear, and discrete optimization. New project contributions are welcome.

■ WB-28

Wednesday, 10:30-12:00

OPT Adal VI=207

Dynamic Programming I

Stream: Dynamic Programming (c)

Invited session

Chair: Lars Relund Nielsen, Research Unit of Statistics and Decision Analysis, Danish Institute of Agricultural Sciences (DIAS), P.O. Box 50, 8830, Tjele, Denmark, lars@relund.dk

1 - A Sequential Decision Problem for Optimal Expenditure of Public Sector Based on the Outcome

Toru Nakai, Faculty of Economics, Kyushu University, Hakozaki 6-19-1, 812-8581, Fukuoka, Japan, nakai@en.kyushu-u.ac.jp

It is usual to grasp the activity of the public sector as a cycle of inputs, outputs and outcomes. The inputs are the resources or expenditures, the outputs are the products or services achieved, and the outcome is the criterion to measure the results. We will consider an optimal expenditure policy by formulating it as a sequential decision problem with Markovian transition with the outcome as a state. Especially, the outcome relates to the total amount of resources, but the strict relationship is unknown. The problem is how much to expend to the public services to improve the outcomes.

2 - Information Acquisition and Technology Adoption

James Smith, Fuqua School of Business, Duke University, Box 90120, 27708-0120, Durham, NC, United States, jes9@duke.edu, Canan Ulu

We consider a dynamic programming model of a decision maker considering adopting a technology whose value is uncertain and may be non-stationary. We formulate this problem in a general setting, taking the state variable to be a probability distribution describing the decision maker's beliefs about the value of the technology. In each period, the decision maker can choose to adopt or reject the technology or gather more information. We study monotonicity properties of the value function and optimal policies using stochastic orderings on the beliefs.

3 - Finding the K best policies in a finite-horizon Markov decision process

Lars Relund Nielsen, Research Unit of Statistics and Decision Analysis, Danish Institute of Agricultural Sciences (DIAS), P.O. Box 50, 8830, Tjele, Denmark, lars@relund.dk, Anders Kristensen

In this communication we consider finite-horizon Markov decision processes (MDPs) with finite state and action space and present an algorithm for finding the K best policies. That is, we are interested in ranking the first K policies in non-decreasing order using an additive criterion of optimality. The algorithm uses a directed hypergraph to model the finite-horizon MDP. It is shown that the problem of finding the optimal policy can be formulated as a minimum weight hyperpath problem and be solved in linear time, with respect to the input data representing the MDP.

■ WB-29

Wednesday, 10:30-12:00

OPT Adal VII=225

Global optimization and applications

Stream: Global Optimization: Deterministic and Stochastic Methods

Invited session

Chair: Marco Locatelli, Informatica, Università Torino, Corso Svizzera, 185, 10149, Turin, Italy, locatell@di.unito.it

1 - Packing unequal disks in a smallest container - exploiting the continuous and combinatorial structure of an hard problem

Fabio Schoen, Dipartimento di Sistemi e Informatica, Università di Firenze, via di Santa Marta, 3, 50139, Firenze, Italy, fabio.schoen@unifi.it, Marco Locatelli

Placing N non-overlapping circles in a smallest container is a widely studied, hard problem. Recently a public contest has been held for finding putative optimal solutions to the special case consisting of placing different disks inside the smallest circle. The contest saw the participation of 155 teams who submitted 27490 solutions. The aim of the paper is to show how we won the competition with relatively little computational power, mixing local and global optimization strategies with random search and local moves.

2 - Set oriented methods for the numerical treatment of global multi-objective optimization problems

Oliver Schütze, Institute for Industrial Mathematics, University of Paderborn, Warburger Str. 100, 33095, Paderborn, Germany, schuetze@upb.de

We will present new set oriented methods for the numerical treatment of multi-objective optimization problems (MOPs). Due to the global approach of these subdivision techniques it is possible to obtain an approximation of the entire solution set (Pareto set) of the underlying model. We will introduce several algorithms for the numerical solution of MOPs for different smoothness assumptions and will finally demonstrate the efficiency of our algorithms both on academic MOPs and on problems which naturally arise in the design of mechatronical systems and in space mission design.

3 - The Multiobjective Fractional Transportation Problem of "bottleneck" type.

Tkacenko Alexandra, Applied Mathematics, Moldova State University, Alexei Mateevici str. 60, 2009, MD, Chisinau, Moldova, Republic Of, tkacenko@moldovacc.md

In the paper we studied the transportation problem of "bottleneck" type with multiple fractional criteria. In order to solve, we suggested to reduce it to another multicriterial linear model, adding the nonlinear time-constraining criterion of "bottleneck" type. We develop an iterative procedure of finding the basic efficient solutions set, which was tested on some examples. The theorems that prove the equivalence of the both models, meaning the common set of their basic efficient solutions are given.

■ WB-30

Wednesday, 10:30-12:00

NONL Adal X=220

Practical applications of semi-infinite optimization I

Stream: Nonlinear Semi-Infinite Optimization

Invited session

Chair: *Kok Lay Teo*, Dept. of Maths Stats, Curtin University of Technology, GPO Box U1987, 6845, Perth, WA, Australia, K.L.Teo@curtin.edu.au

1 - Algorithms for semi-infinite semi-definite programming

Soon-Yi Wu, National Cheng Kung University, No. 1, Ta-Hsueh Road, 701, Tainan, Taiwan, soonyi@mail.ncku.edu.tw

We develop two discretization algorithms with a cutting plane scheme for solving combined semi-infinite and semi-definite programming problems, i.e., a general algorithm when the parameter set is a compact set and a typical algorithm when the parameter set is a box set in the m -dimensional space. We prove that the accumulation point of the sequence points generated by the two algorithms is an optimal solution of the combined semi-infinite and semi-definite programming problem under suitable assumption conditions. Two examples are given to illustrate the effectiveness of the typical algorithm.

2 - Semismooth Newton method for semi-infinite programming problems

Oliver Stein, Dept. of Mathematics - C, RWTH Aachen University, Templergraben 55, 52056, Aachen, Germany, stein@mathC.rwth-aachen.de, *Aysun Tezel*

This talk is based on semismooth Newton method for semi-infinite programming problems. By use of an NCP-function first order optimality conditions are resulted in a system of semismooth equations. Nonsmoothness is related to violation of strict complementarity slackness (SCS). Convergence of semismooth Newton method is analyzed in lack of SCS and in the case of SCS holds at stationary points. The well-known Fischer-Burmeister and min NCP functions are used with Schur complements in the proof. Numerical results from design centering and robust optimization are also included.

3 - Impulsive Optimal Control Problems Subject to State Inequality Constraints

Kok Lay Teo, Dept. of Maths Stats, Curtin University of Technology, GPO Box U1987, 6845, Perth, WA, Australia, K.L.Teo@curtin.edu.au

Consider an impulsive optimal control problem with continuous state inequality constraints, where the time points at which the impulses take place and their strengths are decision variables. Using a time scaling transform followed by a further time rescaling and then the constraint transcription method, we obtain a sequence of approximate optimal control problems involving ordinary differential equations with constraints on the two end points, but without constraints on the state variables.

■ WB-31

Wednesday, 10:30-12:00

NONL Adal XI=222

Generalized Newton Methods III

Stream: Generalized Newton Methods

Invited session

Chair: *Andrew Eberhard*, Mathematical and Geospatial Sciences, RMIT University, RMIT University, GPO Box 2476V, 3001, Melbourne, Victoria, Australia, andy.eb@rmit.edu.au

1 - Unconstrained optimization using improved directions of negative curvature

Alberto Olivares, Statistics and Operational Research, Rey Juan Carlos University, C/ Tulipan s/n, 28933, Móstoles, Madrid, Spain, alberto.olivares@urjc.es, *Javier Moguerza*, *Francisco Prieto*

Nonlinear unconstrained optimization problems can be solved using algorithms based on Newton's method. Many algorithms have been proposed in the literature but only a few attempt to use the second-order information available from the Hessian matrix. We are interested in developing procedures to compute second order KKT points for this kind of problems. In particular, we describe linesearch strategies that use directions of negative curvature in an efficient manner. This second order information is computed by applying efficient iterative processes.

2 - A derivative-free algorithm for inequality constrained optimization problems

Stefano Lucidi, Dipartimento di Informatica e Sistemistica, University of Rome, via Buonarroti 12., 00185, Rome, Italy, lucidi@dis.uniroma1.it, *Giampaolo Liuzzi*

This paper is concerned with the solution of nonlinear constrained optimization problems in case where first order derivatives of the objective function and the constraints can not be used. Our approach is based on the use of a nonsmooth exact penalty function; we propose a derivative-free algorithm which is globally convergent towards Kuhn-Tucker points of constrained problems. This method is able to overcome the difficulties due to the nonsmoothness of the exact penalty function and to the right choice of the penalty parameter which guarantees the exactness of the penalty function.

3 - Second Order Qualification Conditions, the Calculus of Limiting Sub-Hessians and Newton Algorithms

Andrew Eberhard, Mathematical and Geospatial Sciences, RMIT University, RMIT University, GPO Box 2476V, 3001, Melbourne, Victoria, Australia, andy.eb@rmit.edu.au

We discuss various qualification assumptions that allow calculus rules for limiting subhessians to be derived. Such qualification assumptions are based on a singular limiting subset derived from a sequence of efficient subsets of symmetric matrices. We introduce a new efficiency notion that results in a weaker qualification assumption than that introduced in Ioffe and Penot and prove some calculus rules that are valid under this weaker qualification assumption. We will also discuss the potential use of such concepts in the development of model Newton's algorithms for nonsmooth functions.

■ WB-32

Wednesday, 10:30-12:00

NONL Adal XIII=218

Topics in Semidefinite Programming II

Stream: Semidefinite Programming

Invited session

Chair: *Samuel Burer*, Department of Management Sciences, University of Iowa, S346 Pappajohn Business Building, 52242-1000, Iowa City, IA, United States, samuel-burer@uiowa.edu

1 - Recent progress in PENSDP

Michael Stingl, Institut fuer Angewandte Mathematik 2, Friedrich-Alexander-Universitaet-Erlangen-Nuernberg,

Martensstrasse 3, 91058, Erlangen, Germany,
stingl@am.uni-erlangen.de, *Michal Kocvara*

In the scope of this talk we will discuss recent improvements of PENSDP on certain classes of medium to large scale semidefinite programs. In particular we will demonstrate the impact of a hybrid technique for the solution of linear systems, exploitation of low rank properties and enhancements of certain linear algebra routines.

2 - Optimal and Near-Optimal Solutions for Single-Row Layout Problem via Semidefinite Optimization

Miguel Anjos, Management Sciences, University of Waterloo, 200 University Avenue West, N2L 3G1, Waterloo, Ontario, Canada, anjos@stanfordalumni.org,
Anthony Vannelli

The single-row layout problem is concerned with finding a row placement of facilities with varying dimensions so as to minimize the total cost associated with their given connectivities. This problem occurs in several practical contexts, such as flexible manufacturing and standard-cell circuit design. We propose a semidefinite programming approach that provides global optimal solutions for small- and medium-sized problems, and placements within a few percentage points of the global optimal solution for large problems.

3 - Semidefinite-Based Branch-and-Bound for Non-convex Quadratic Programming

Samuel Burer, Department of Management Sciences, University of Iowa, S346 Pappajohn Business Building, 52242-1000, Iowa City, IA, United States, samuel-burer@uiowa.edu

We present a branch-and-bound algorithm for nonconvex quadratic programming, which is based on solving semidefinite relaxations at each node of the enumeration tree. Computational results demonstrate the effectiveness of the method, with a particular highlight being that only a small number of branch-and-bound nodes are required.

■ WB-34

Wednesday, 10:30-12:00

DEC VR11 V-138

General Systems I

Stream: Systems and Game Theory

Invited session

Chair: *Irinel Dragan*, Mathematics, University of Texas, 411 S.Nedderman Dr., Pickard Hall, Arlington, Texas, United States, dragan@uta.edu

1 - Multiobjective Control of Time-Discrete Systems and Dynamic Games on Networks

Dmitrii Lozovanu, Institute of Mathematics and Computer Science, Academy of Sciences, Kishinev, Moldova, Republic Of, lozovanu@math.md

We consider time-discrete systems with a finite set of states. The starting and the final states of the dynamical system are fixed. We assume that the dynamics of the system is controlled by players and each of them intends to optimize his own integral-time cost of system's passages by a certain trajectory. Applying optimality principles, we obtain multiobjective control problems, solutions of which correspond to solutions of dynamic games, respectively. Necessary and sufficient conditions for the existence of Nash equilibrium and Pareto optimum in considered game control models are derived.

2 - A decision model with feedback dependences using fuzzy ANP

Jaroslav Ramik, Dept. of Math. Methods in Economics, Silesian University, School of Business, University Sq. 1934/3, 73340, Karvina, Czech Republic, ramik@opf.slu.cz

We propose a decision model with feedback dependences between criteria and alternatives working with expert data given as special fuzzy numbers. The model is based on Analytical Network Process (ANP). New operations with fuzzy numbers are proposed as well as possibility and necessity fuzzy relations to compare fuzzy outcomes. An illustrating numerical example is presented to clarify the methodology.

3 - A Spatial Equilibrium Analysis of Transmission Charge Reform in Japan's Electric Power Industry

Nobuhiro Hosoe, National Graduate Institute for Policy Studies, 7-22-1 Roppongi, Minato, 106-8677, Tokyo, Japan, nhosoe@grips.ac.jp, *Shu-ichi Akiyama*

A key intention of the regulatory reform of transmission charge schemes in Japan was to promote inter-regional competition by lowering long-distance transmission charges with a postage-stamp charge scheme. This can lead to extensive use of inter-regional links and cause congestion to segment the market into several regional markets. With a nine-region spatial equilibrium model we simulated the reform at the peak-load hour. We found the reform would lead to significant increases of inter-regional transmission and congestion at the link between the 50-Hz area and the 60-Hz area

4 - High to Low and Low to High: Product line introduction Strategies

Oded Koenigsberg, Business School, Columbia University, 505 Uris Hall, 3022 Broadway, 10027, New York, NY, United States, ok2018@columbia.edu, *Eyal Byalogorsky*

Many times firms introduce different models sequentially over a period of time. These decisions are usually made in the face of significant uncertainty regarding the demand conditions in the market. It is important for managers to understand whether to launch a product line from the high end or the low end, and under what conditions each strategy is warranted. We derive the optimal introduction strategies under different conditions, and provide guidelines to managers how they should launch their product line, and whether they should first introduce the high end model or the lower end model.

■ WB-35

Wednesday, 10:30-12:00

DEC VR11 V-147

Supporting Strategic Development

Stream: OR and Strategy

Invited session

Chair: *Frances O'Brien*, Warwick Business School, University of Warwick, Gibbet Hill Road, CV4 7AL, Coventry, United Kingdom, F.A.O'Brien@warwick.ac.uk

1 - Strategic Problems in the OR Literature

Peter Bell, Richard Ivey School of Business, University of Western Ontario, N6A 3K7, London, Ontario, Canada, pbell@ivey.ca

Business strategy aims to create and sustain competitive advantage. This presentation will review the OR practice literature with the objective of identifying common problem types where OR work has a record of supporting this strategic objectives. Successful work on these kinds of problems has raised the internal profile of many OR practitioners and groups.

2 - An Empirical Investigation of Toeholds as Real Options

Augusto Rupérez Micola, IMD International, Chemin de Bellerive 23, CH 1006, Lausanne, Switzerland, Augusto.RuperezMicola@imd.ch, *Didier Cossin*

We conjecture that a partial acquisition is analogous to the first stage of a growth real option. Our main theoretical resting point is adverse selection and we focus on two general research questions: Do firms carry out partial acquisitions following a real options logic? Do financial markets value partial acquisitions following the same logic?

3 - The role of OR in strategy support: A survey of UK practitioners

Frances O'Brien, Warwick Business School, University of Warwick, Gibbet Hill Road, CV4 7AL, Coventry, United Kingdom, F.A.O'Brien@warwick.ac.uk

This paper will report on the progress of research into how OR can be used to support strategy within organisations. The phase of the research reported here focuses on the perspective of OR practitioners. The paper will describe the design of a survey targeted at OR practitioners within the UK to explore both the nature of the strategic issues that OR people engage with and the approaches that they use to provide support. If available, findings of the survey will be presented.

■ WB-37

Wednesday, 10:30-12:00
DEC VR II V-156

Dealing with imperfect knowledge in MCDA

Stream: Multiple Criteria Decision Aiding
Invited session

Chair: *Risto Lahdelma*, Department of Information Technology, University of Turku, Lemminkäisenkatu 14 A, FIN-20520, Turku, Finland, risto.lahdelma@cs.utu.fi

1 - Multicriteria decision aiding in the deregulated energy market

Simo Makkonen, Process Vision Ltd., Melkonkatu 18, 00210, Helsinki, Finland,
simo.makkonen@processvision.fi, *Otso Ojanen*, *Risto Lahdelma*

The European energy market changed radically during the last 10 years. Liberation of the power market, unbundling of vertically integrated businesses, scarcity of natural resources, and increasing emphasis on the environmental effects have created a new business environment, where complex, interacting decision problems must be solved in co-ordination. These stochastic decision problems involve multiple criteria and a large number of decision variables. We present how a combination of efficient simulation, optimization and multicriteria decision aiding methods can be used in these problems.

2 - Different techniques to handle dependent uncertainties in MCDA

Risto Lahdelma, Department of Information Technology, University of Turku, Lemminkäisenkatu 14 A, FIN-20520, Turku, Finland, risto.lahdelma@cs.utu.fi, *Pekka Salminen*

We consider multi-criteria group decision-making problems, where the decision makers (DMs) want to identify their most preferred alternative(s) based on uncertain or inaccurate criteria measurements. In many real-life problems the uncertainties may be dependent. We focus on MCDM problems where the criteria and their uncertainties are computed using a stochastic simulation model. We present and compare different ways of treating the uncertainty and dependency information in MCDA and illustrate this using the SMAA-2 multi-criteria decision aid method.

3 - Selecting Elevators to an Office Building with Multicriteria Decision Making

Henri Hakonen, Kone Elevators Ltd, Keilasatama 3, 02150, Espoo, Finland, henri.hakonen@kone.com, *Risto Lahdelma*, *Marja-Liisa Siikonen*

In elevator planning a suitable elevator system for a building is selected. The requirements for a good transportation system are to move people efficiently and comfortably with as little investment as possible and without taking too much floor space in the building. Different performance criteria are evaluated through stochastic simulation. We present how multicriteria decision aiding methods can be applied to find the right balance between conflicting and imprecisely measured criteria. As an application we consider an office building utilizing a destination control system.

■ WB-38

Wednesday, 10:30-12:00
DEC VR II V-157

DEA Applications II

Stream: DEA and Performance Measurement (c)
Invited session

Chair: *Douglas Nanka-Bruce*, Departament d'Economia de l'Empresa, Universitat Autònoma de Barcelona, Edifici B, 08193, Bellaterra - Barcelona, Catalunya, Spain, dcnbruce@yahoo.com

1 - Evaluating efficiency in the framework of the Resource-based View of the Firm. Evidence from Polish and Spanish textile and clothing industry.

Magdalena Kapelko, Departament d'Economia de l'Empresa, Universitat Autònoma de Barcelona, Edifici B, Room B1-129, 08193, Bellaterra, Catalonia, Spain, mkapelko@poczta.wp.pl, *Diego Prior*, *Josep Rialp*

In the paper we propose to evaluate efficiency in the framework of the Resource-based View of the Firm, an increasingly important school of thought in the strategic management research. Using the samples of firms in the textile and clothing industry we perform a longitudinal comparison of efficiency and its explanatory factors between Polish and Spanish firms. We apply panel tobit regressions in order to test the relationship among the Resource-based View variables and the Data Envelopment Analysis efficiency scores.

2 - DEA Benchmarks for Electricity Networks - Cost Structures and Cost Allocations

Mette Bjørndal, Department of Finance and Management Science, Norwegian School of Economics and Business Administration, NHH, Helleveien 30, N-5045, Bergen, Norway, mette.bjorndal@nhh.no, *Endre Bjørndal*

We investigate the DEA model used in the regulation of the Norwegian electricity network industry. We illustrate the importance of using information on the structure of the cost functions, even if this information is very "mild", i.e. we only know that some costs are separable. It seems to be possible to distinguish between customer- and network-related costs, and this distinction may be used in the performance measurements. Moreover, we evaluate the effects of analyzing distribution and regional transmission in separate models under different model-assumptions, including super-efficiency.

3 - Dea As Benchmarking Tool In Business Planning: The Case Study Of Chemical Companies

Hirofumi Amatatsu, Graduate School Of Engineering, Information Science, Seikei University, 3-3-1 Kichijoji-Kitamachi, 180-8633, Musasino-shi, Tokyo, Japan, amatatsu@mint.ocn.ne.jp, *Tohru Ueda*

Benchmarking is one of the most important tools in business planning which enables organizations to study the best practices. Successful benchmarking simultaneously takes into account several factors including variations in product, sales, income, asset, labor cost and other structural characteristics as well as difference in efficiency and inaccuracy of panel data. Using data of 40 chemical companies, this paper examines the possibilities of DEA and other methodologies such as interval regression analysis to serve as a comprehensive tool in the business planning process.

4 - Corporate ownership and technical efficiency analysis in the Spanish Real Estate sector

Douglas Nanka-Bruce, Departament d'Economia de l'Empresa, Universitat Autònoma de Barcelona, Edifici B, 08193, Bellaterra - Barcelona, Catalunya, Spain, dcnbruce@yahoo.com, *Diego Prior*

The Real Estate sector keeps contributing significantly to the Spanish economy. A recent news article reports the existence of inefficiencies in the nature and delivery of new properties. We investigate the technical efficiency of this sector using a non-parametric 'reasonable' benchmarking frontier, acknowledging the marked influence of the sector's shadow economy. We then relate the results applying a panel data analysis to the shareholding concentration and identity of firm ownership.

■ WB-39

Wednesday, 10:30-12:00

DEC VR11 V-158

DSS and Web applications

Stream: Decision Support Systems

Invited session

Chair: *Pascale Zaraté*, Institut de Recherche en Informatique de Toulouse, 118 route de NarBonne, 31062, Toulouse, France, zarate@irit.fr

1 - Critical questions for Web usage mining

Ilija Subasic, Department of Business Information Systems and Quantitative Methods, Faculty of Economics Subotica, Segedinski put 11, 24000, Subotica, Serbia and Montenegro, ilija@eccf.su.ac.yu, *Zita Boshnjak*

Today's dynamical and competitive Web environment demands the adaptation of web pages for specific needs of each visitor. One way to accomplish this is by tracking and tallying user's Web site browsing activities, and using these information for discovering the usual patterns of navigation through web pages. Web access logs are usually used for finding these patterns. This paper is an attempt to point out the critical aspects of web usage mining from the results through data collection, choosing the similarity/distance measures and constraints put on by both Web page design and wum software.

2 - Delegated Operator Management Support Systems

Aidan Hughes, BTS , Bombardier Aerospace, PO Box 241, Airport Road, BT39DZ, Belfast, Antrim, United Kingdom, hughesai@yahoo.co.uk, *William Blackburn*

In the aircraft manufacturing industry, employee non-conformance in work performance may significantly affect profitability. Employees categorised as delegated operators inspect their own work, overseen by quality controllers. This paper presents a web-enabled system designed to support related management decision-making, using non-conformances to profile each operator. A corrective action component seeks to recognise patterns and prioritise operators to train, be coached, or be otherwise advised of their performance. The system effectiveness is appraised and future developments discussed.

3 - Performance management systems in higher education: an empirical application

Fernando Freire, Military Academy, Av. C. Castro Guimarães, 2720-113, Amadora, Portugal, fernandovicentefreire@yahoo.com.br, *Ana Bravo*

We think that Balanced Scorecard (BSC) may offer a useful contribution to the improvement of the actual systems of evaluation of Higher Education Institutions in a comprehensive way and embedded into the strategy of the institutions. By adapting the BSC methodology to the study-case of Military Higher Education in Portugal, we show that higher education institutions may derive large benefits from adopting not only an outcome evaluation scheme but a performance management system that focus also on the monitoring of internal processes.

4 - Group DSS : A proposal of Architecture

Pascale Zaraté, Institut de Recherche en Informatique de Toulouse, 118 route de NarBonne, 31062, Toulouse, France, zarate@irit.fr, *Abdel-Kader Adla*

The idea of this work is to present a global of architecture of GDSS. These systems are able to support Decision Makers in Distributed and Asynchronous situations. They also will support users during the whole process of decision making through cooperative facilitations.

■ WB-40

Wednesday, 10:30-12:00

SOC VR11 V-257

New Frontiers in Sustainable Living

Stream: Complex Societal Problems

Invited session

Chair: *Ali Gökmen*, Department of Chemistry, Middle East Technical University, 06531, Ankara, Turkey, agokmen@metu.edu.tr

1 - Improving Sustainable Living in Rural Areas in Turkey

Ali Gökmen, Department of Chemistry, Middle East Technical University, 06531, Ankara, Turkey, agokmen@metu.edu.tr, *Gerhard-Wilhelm Weber*, *Dorien DeTombe*, *Inci Gokmen*

Improvement of living conditions in rural areas is an important issue in Turkey. The interplay between energy and agriculture is influenced by availability of land, water, quality of soil, nutrients, livestock, commercial energy and labour. In order to understand this complex relationship, some energy and agricultural cycles are considered. Dynamics of various cycles are analyzed through mathematical models. Ecological land planning, renewable energies, sustainable agricultural practices should be based on the information obtained from environment and the behaviour of the local people.

2 - Participation of Women and Adolescent in Decision Making in Rural Areas of Turkey

Inci Gokmen, Chemistry, Middle East Technical University, METU Department of Chemistry, 06531, Ankara, Turkey, igokmen@metu.edu.tr, *Ali Gökmen*

In rural areas important decisions are made by middle aged or older males, women and adolescent are excluded. Older males are conservative on applications of new production techniques and do not care much about production with environmental concerns. In general villagers may accept the new applications when they witness the results of applications of others. Analysis of attitudes of people, participation of experts in decision making process and implementation of some changes to improve the quality of living in rural areas are considered.

3 - A Problem Structuring Method for Complex Societal Decisions: its Philosophical and Psychological Dimensions

Donald Hector, Dept. of Chemical Engineering, University of Sydney, Darlington, 2006, Sydney, NSW, Australia, dhector@grassick.com.au, *Carleton Christensen*, *Jim Petrie*

A novel approach to problem structuring for decisions relating to the sustainability of public infrastructure is presented. The philosophical (a critical realist ontology and epistemology), psychological (the effect of biases and heuristics on decision outcomes), and systems dimensions (dynamics and emergent properties) of the problem are discussed, and form the basis of the approach. This is structured as a system of "trilemmas", representing different dimensions of the problem. A case study in the Australian water supply industry is developed to demonstrate the value of the approach.

4 - Systems Model for Intentional Transmission of HIV/AIDS

Linnet Ozdamar, Logistical Management, Izmir University of Economics, Sakarya Cad 156 Balcova, 35330, Izmir, Turkey, linetozdamar@lycos.com, *Chandra Sekhar Pedamallu*

The system approach is a holistic way of solving problem in a real - time scenario. This approach will solve problems with a very limited undesirable and counter intuitive result. This paper proposes a systems approach for AIDS diffusion in developing countries. It also presents the basic model to be simulated to identify the most impact variable (i.e. policy variables).

■ WB-41

Wednesday, 10:30-12:00

SOC VR11 V-258

Management in Human Centered Processes I

Stream: Human Centered Processes (c)

Invited session

Chair: *Costas Zafiroopoulos*, Business Administration, Technological Education Institute of Serres, Greece, Terma Magnisias, 62124, Serres, Greece, costas.zafiroopoulos@yahoo.gr

1 - Ad-hoc Workflow Management for Knowledge Sharing

Hiroshi Tsuji, Graduate School of Engineering, Osaka Prefecture University, 1-1 Gakuencho, 5998531, Sakai, Osaka, Japan, tsuji@cs.osakafu-u.ac.jp

This paper describes a workflow management system which allows a group to reuse a series of ad-hoc tasks. Given an event, it recommends to reuse the relative best practice which has been judged useful by others. The proposed system works under the premise of human-computer collaboration for knowledge management.

2 - Implementation of a two-stage survey model for selecting and investigating the ICT professions and specializations

Vassilis Kostoglou, Department of Informatics, TEI of Thessaloniki, P.O. Box 141, 57400, Thessaloniki, Greece, vkostogl@it.teithe.gr

This paper introduces a two-stage survey model for analyzing the ICT professions and their classifications. They are initially selected through personal interviewing of a 20-member group of businessmen and academics. The main research stage consists of a national survey addressed to all ICT enterprises using a structured questionnaire. Several relevant issues are examined, including the statistical effects of enterprise profile characteristics on them.

3 - A model for the study of school violence and gender identities within the school frame

Costas Zafropoulos, Business Administration, Technological Education Institute of Serres, Greece, Terma Magnisias, 62124, Serres, Greece, costas.zafropoulos@yahoo.gr, *Anastasia Psalti*

The phenomenon of school violence and intimidation (bullying) is frequently observed within modern societies. It has been connected with the research for the gender identities, the male identity and its study under the feminist perspective. This paper presents a multivariate model for the study of gender issues regarding bullying. Data from 1838 students of secondary education in Greece are used. The results indicate that high schools students perceive bullying in various forms and dimensions.

■ WB-43

Wednesday, 10:30-12:00

FIN Endur Room 1

Adaptive and innovative sampling techniques

Stream: Stochastic Programming

Invited session

Chair: *Fabian Bastin*, The Parallel Algorithms Project, Cerfacs, 42, Avenue Gaspard Coriolis, 31057, Toulouse, France, bastin@cerfacs.fr

1 - A non-parametric sampling approach for nonlinear stochastic programming

Philippe L. Toint, Mathematics, FUNDP, Namur, Belgium, pht@math.fundp.ac.be, *Fabian Bastin*, *Cinzia Cirillo*

A major difficulty in stochastic programming is the choice of probability distributions present in the objective functions. This is especially true for parameters estimation problems, as maximum likelihood or least-squares. We propose here to focus on the cumulating functions: sampling over $[0, 1]$, we estimate inverse cumulating functions by means of B-cubic splines. The resulting optimization problem is a nonlinear program subject to additional monotonicity constraints. This problem is solved with an adapted constrained trust-region procedure, using projections to keep the iterates feasible.

2 - Quasi-Monte Carlo Methods in Stochastic Programming

Tito Homem-de-Mello, Industrial Engineering and Management Sciences, Northwestern University, 2145

Sheridan Rd, 60208, Evanston, IL, United States, tito@northwestern.edu

We discuss the use of Quasi-Monte Carlo (QMC) methods when solving stochastic programming models via sample average approximations. It is known that pointwise convergence of approximating solutions and values is ensured under mild assumptions; here, we focus on rates of convergence. We show that, for some classes of functions, QMC methods can be much more efficient than standard Monte Carlo. We also discuss some techniques to pick the important components of the underlying random vector so that QMC can be used only on those components. We present numerical results illustrating the ideas.

3 - Randomized Quasi-Monte Carlo for Markov Chains

Pierre L'Écuyer, DIRO, Université de Montréal, C.P. 6123, Succ. Centre-Ville, H3C 3J7, Montreal, QC, Canada, lecuyer@IRO.UMontreal.CA

We discuss and compare two types of randomized quasi-Monte Carlo (RQMC) methods for reducing the variance when simulating a Markov chain with state-dependent costs, over a finite horizon. The first method uses one point of a high-dimensional RQMC point set to simulate each copy of the chain. The second method, designed recently by L'Écuyer, Lécot, and Tuffin, simulates n copies of the chain in parallel, using a low-dimensional RQMC point set at each step. Both methods provide unbiased estimators. We provide convergence results and several numerical illustrations.

■ WB-44

Wednesday, 10:30-12:00

FIN Endur Room 2

Stochastic Programming II

Stream: Stochastic Programming (c)

Invited session

Chair: *Gus Gassmann*, School of Business Administration, Dalhousie University, 6100 University Avenue, B3H 3J5, Halifax, Nova Scotia, Canada, hgassman@mgmt.dal.ca

1 - On solving mixed 0-1 problems

Celeste Pizarro Romero, Dpto. de Estadística e Investigación Operativa, Universidad Rey Juan Carlos, Escuela de CC. Experimentales y Tecnología, 28933, Móstoles, Spain, celeste.pizarro@urjc.es, *Antonio Alonso-Ayuso*, *Laureano Fernando Escudero*

We present a framework for solving multistage mixed 0-1 problems under uncertainty in some parameters. A scenario analysis scheme is used to represent the stochastic program with complete recourse, by using a splitting variable representation. Non-anticipativity constraints are partially relaxed, so, scenarios are grouped in different cluster. Branch-and-Fix Coordination is applied to coordinate the selection of the branching Twin Node Families (TNFs) in the subproblems to be jointly optimized. We consider Lagrangian Techniques for bounding purposes at the candidate TNFs and TNF integer sets.

2 - A Scenario Optimisation Procedure to Plan Annualised Working Hours under Demand Uncertainty

Amaia Lusa, IOC Research Institute / Management Department, Technical University of Catalonia, Avda. Diagonal 647, p11, 08028, Barcelona, Spain, amaia.lusa@upc.edu, *Albert Corominas*, *Norberto Muñoz*

Annualising working hours enables to adapt production capacity to fluctuations in demand. The demand depends on several factors and often it is not possible to obtain a reliable prediction of the demand or it is not realistic to consider that can be adjusted to a probability distribution. In some cases, it is possible to determine a set of demand scenarios, each one with a related probability. In this work we present a multistage stochastic optimisation model which provides a robust solution (i.e., feasible for any possible scenario) and minimises the expected total capacity shortage.

3 - Using package Matchcad for the solving applied statistical problems of unbiased and point estimation

Victor Lyumkis, Department of Computer Technologies, Transport and Telecommunication Institute, Lomonosov 1, LV-1019, LV-1019, Riga, Latvia, vlyumkis@yahoo.com

There is discussed some problems of unbiased and point estimation. From the problems of unbiased estimation sing out the problem finding unbiased estimators of powers parameters from the distributions with scale and location parameters. The demonstration of possibilities the package Matchcad is realised for some important problems actuarial mathematics also.

4 - An XML-based schema for stochastic programs

Gus Gassmann, School of Business Administration,
Dalhousie University, 6100 University Avenue, B3H 3J5,
Halifax, Nova Scotia, Canada, hgassman@mgmt.dal.ca,
Robert Fourer, Kipp Martin, Jun Ma

This talk concerns the latest developments in an XML-based schema to describe stochastic programming problems. It is part of an on-going effort towards a unified problem description for all mathematical programming problems. System capabilities allow the formulation of recourse problems with and without deterministic problem dimensions, chance-constrained problems, alternate measures of risk, robust optimization problems, all subject to a number of built-in or user-specified probability distributions.

The talk will describe the schema using illustrative examples.

■ WB-45

Wednesday, 10:30-12:00

FIN Endur Room 3

Models for Financial Planning

Stream: Models and Tools for Financial Planning

Invited session

Chair: *Günter Schmidt*, Saarland University, Box 151150,
66041, Saarbrücken, Germany, gs@itm.uni-sb.de

1 - Mean-Risk Models Using Two Risk Measures: A Multi-Objective Approach

Gautam Mitra, CARISMA, Brunel University, Department
of Mathematical Sciences, Kingston Lane, UB8 3PH,
Uxbridge, Middlesex, United Kingdom,
gautam.mitra@brunel.ac.uk, *Kenneth Darby-Dowman*,
Diana Roman

We propose a portfolio model in which distributions are characterised by three statistics: the expected value, the variance and the CVaR. This is formulated as a multi-objective model which is transformed into a single objective problem which is a quadratic program. The mean-variance and mean-CVaR efficient solutions are particular efficient solutions of the proposed model. The model has efficient solutions that are discarded by both mean-variance and mean-CVaR models, although they may improve the return distribution. The model is tested on data drawn from the FTSE 100 index.

2 - Portfolio Construction Based on Stochastic Dominance and Target Return Distributions

Kenneth Darby-Dowman, Mathematical Sciences, Brunel
University, Kingston Lane, UB8 3PH, Uxbridge,
Middlesex, United Kingdom, mastkhd@brunel.ac.uk, *Diana
Roman, Gautam Mitra*

The Construction of a portfolio, which is non-dominated with respect to second order stochastic dominance and whose return distribution has specified desirable properties, is considered. The model is multi-objective and is transformed into a single objective model by using the reference point method. The performance of the models on real data drawn from the FTSE 100 index is investigated.

3 - Personal Financial Planning with Life Charts

Günter Schmidt, Saarland University, Box 151150, 66041,
Saarbrücken, Germany, gs@itm.uni-sb.de

Life Charts is a new tool for IT-based decision making in personal financial planning. We introduce the basic components and show how the tool can be used to help to answer questions related to determining the financial status, setting up financial goals and supervising financial actions. Moreover we present an architecture for decision support systems in personal financial planning based on Life Charts.

4 - Portfolio Optimization with Higher Order Risk Measures

Jieqiu Chen, Mechanical and Industrial Engineering,
University of Iowa, Iowa City, IA, United States,
jieqiu-chen@uiowa.edu, *Pavlo Krokhmal*

We consider implementation of risk-averse preferences in stochastic programming problems using risk measures. The axiomatic foundation of coherent risk measures and deviation measures is utilized in order to develop simple representations for these measures that facilitate their incorporation into stochastic programs. It is demonstrated that the developed representations allow for construction of coherent risk measures that are consistent with the second order stochastic dominance. The presented approach is demonstrated on a portfolio optimization problem with higher order risk measures.

■ WB-46

Wednesday, 10:30-12:00

FIN Endur Room 4

Forecasting and Economic Applications

Stream: Applied Probability/Forecasting (c)

Invited session

Chair: *Teofilo Valdes*, Statistics and Operations Research,
Complutense University of Madrid, Plaza de las Ciencias 3,
Facultad de Matematicas, 28040, Madrid, Spain,
teofilo_valdes@mat.ucm.es

1 - Survival combination scores for revolving credit

Galina Andreeva, Management School Economics,
University of Edinburgh, 50 George Sq, EH8 9JY,
Edinburgh, United Kingdom, Galina.Andreeva@ed.ac.uk,
Jake Ansell, Jonathan Crook

The paper extends the application of survival analysis to revolving credit. Previously advantages of survival approach were shown for modelling default and profit for fixed-term credit products. Profit estimation for a revolving credit is complicated by necessity to assess the product usage. The paper provides an empirical investigation whether time to the next purchase (as a measure of usage) can be incorporated into the estimation of credit account value alongside with time to default. This is benchmarked against the current industry standard of predicting default using logistic regression.

2 - Density forecasting in sequential decision problems

Antonio Rodrigues, CIO-FCUL, University of Lisbon,
Edificio C6, Campo Grande, 1749-016, Lisboa, Portugal,
ajrodrigues@fc.ul.pt, *José Luís Carmo*

A relatively simple methodology, based on density forecasting through exponentially-weighted kernels, is proposed to efficiently approach sequential decision problems within stochastic nonstationary environments. In many cases, optimal solutions can then be simply defined as, or derived from quantiles of the estimated density. The approach is illustrated in the context of inventory management dealing with irregularly observed demand processes. Reference is also made to its application to other problems, such as financial trading and asset allocation, or quality and process control.

3 - An algorithm based on discrete response regression models suitable to analyse incomplete panel data

Teofilo Valdes, Statistics and Operations Research,
Complutense University of Madrid, Plaza de las Ciencias 3,
Facultad de Matematicas, 28040, Madrid, Spain,
teofilo_valdes@mat.ucm.es, *Carlos Rivero, Carmen Anido*

We present an algorithm suitable to analyse incomplete panel data. The aim of the algorithm is the estimation of the individual probabilities of capturing information from the perspective of discrete response regression models. First, the parameters of the models are estimated by means of the conditional likelihoods, after solving some crucial points; then, the individual probabilities mentioned above are used to correct the biases in the incomplete cross section samples of the panel data. The performance of the algorithm is commented on through several simulations and real life case studies.

■ WB-47

Wednesday, 10:30-12:00

FIN Endur Room 5

Performance I

Stream: Financial Modelling (c)

Invited session

Chair: *John Slof*, Universitat Autònoma de Barcelona, Edifici B, 08193, Bellaterra, Spain, ericjohn.slof@uab.es

1 - OR techniques and tools for validating Basel II models

Christophe Mues, School of Management, University of Southampton, SO17 1BJ, Southampton, United Kingdom, C.Mues@soton.ac.uk, *David Martens*, *Bart Baesens*, *Hsin-Vonn Seow*, *Reza Shahi*

Implementing Basel II is a complex process requiring banks to commit to a major overhaul of both business and ICT systems. Having adopted a wide range of OR techniques, validation will be the next step in ensuring the quality of the systems implemented. Backtesting and benchmarking are key validation tools. Backtesting aims at monitoring the discriminatory power and calibration of a rating system. Benchmarking allows banks to compare ratings and default probabilities assigned to similar obligors. Different OR techniques and tools will be discussed for both backtesting and benchmarking.

2 - Testing On Equality Of Two Performance Indicators

Elza Jurun, Faculty of Economics, University of Split, Department of Quantitative Methods in Economics, Matice hrvatske 31, 21000, Split, Croatia, elza@efst.hr, *Josip Arneric*

The paper originates from the practical need to compare 1744 manufacturing companies in Dalmatian County according to business performances. Rate of the return of equity, degree of indebtedness and current liquidity coefficient have been chosen as the most relevant ones. To compare and test the basic set had to be divided into 3 homogeneous subsets. The entire process of hypothesis testing on equality of two performance indicators is carried out. For that purpose the average performance, average dispersion coefficient, test value and the region of acceptance the null-hypothesis were defined.

3 - Compromise programming paradigm consideration of balance sheet ratios of a specific group of firms.

Jose M Anton, Matematica Aplicada a la Ingenieria Agronomica, Universidad Politecnica de Madrid, Escuela Tecnica Superior de Ingenieros Agronomos, Av. Complutense s/n, 28040, Madrid, Spain, josemanuel.anton@upm.es, *Juan B Grau*, *Elena Sanchez*, *Ana M. Tarquis*

To perform a comparative Financial Analysis of a specific group of firms, a matrix containing columns of balance sheet ratios of these firms was established. The Compromise Programming (CP) Ideal Point of benchmark subgroup and expressive Standardised Ratio Gaps columns are obtained. From them some CP Distances to the Ideal Point and some derived Utility-like Functions are suggested intending to represent the quality of firms. That aids to put in evidence economic features from a sample of Spanish banks in 1995 as case study.

4 - Assessing The Impact Of Adoption Of Fair Value Accounting On Financial Statement Analysis; A Dea Approach

Magda Solà, Economia de la empresa, Universitat Autònoma de Barcelona, Edifici B, 08193, Bellaterra, Barcelona, Spain, magda.sola@uab.es, *Gonzalo Rodriguez Pérez*, *John Slof*, *Margarita Torrent*, *Immaculada Vilardell*

Financial statement analysts simultaneously evaluate a battery of ratios linking different financial statement items within the context of industry benchmarks. We simulate analyst reasoning with DEA, assuming that they will rank companies depending on their relative efficiency in transforming inputs (measured as the book value of assets and expenses) into valuable output (measured as accounting revenues), and explore to which extent the use of fair values might lead to different analyst conclusions than traditional historical cost based accounting for assets.

■ WB-48

Wednesday, 10:30-12:00

EWG Logberg 102

EWG: Human Centered Processes

Stream: EWG Meetings

Invited session

Chair: *Gilles Coppin*, LUSI, ENST Bretagne, Cs 83818, 29238, Brest Cedex 3, France, Gilles.Coppin@enst-bretagne.fr

1 - Meeting of EURO WG "Human Centered Processes"

Gilles Coppin, LUSI, ENST Bretagne, Cs 83818, 29238, Brest Cedex 3, France, Gilles.Coppin@enst-bretagne.fr

This meeting of about one our will take place during EURO XXI 2006. The members and interested friends of EURO Working Group "Human Centered Processes" are cordially welcome.

■ WB-49

Wednesday, 10:30-12:00

EWG Logberg 103

EWG: OR in Agriculture and Forest Management

Stream: EWG Meetings

Invited session

Chair: *LluisM Pla*, Mathematics, University of Lleida, JaumeII,73, 25001, Lleida, Spain, lmpa@matematica.udl.es

1 - Meeting of EURO WG "OR in Agriculture and Forest Management"

LluisM Pla, Mathematics, University of Lleida, JaumeII,73, 25001, Lleida, Spain, lmpa@matematica.udl.es

The meeting of EURO WG "OR in Agriculture and Forest Management" will take place after all the presentations within its stream at EURO XXI 2006. Members and interested friends are cordially welcome!

Wednesday, 12:30-13:30

■ WC-01

Wednesday, 12:30-13:30

PLEN HBio Big Stage

"The George B. Dantzig Memorial Session": How Good is the Simplex Method, continued...

Stream: Semi-Plenary Sessions

Invited session

Chair: *Ilan Adler*, IEOR, University of California at Berkeley, 4143 Etcheverry Hall, 94720, Berkeley, CA, United States, adler@ieor.berkeley.edu

Chair: *Jakob Krarup*, Dept. of Computer Science, University of Copenhagen, Universitetsparken 1, DK-2100, Copenhagen, Denmark, krarup@di.ku.dk

1 - How Good is the Simplex Method, continued

Ilan Adler, IEOR, University of California at Berkeley, 4143 Etcheverry Hall, 94720, Berkeley, CA, United States, adler@ieor.berkeley.edu

In the sixty or so years since G.B. Dantzig first developed the Simplex method, it has become a phenomenally successful tool for solving real world problems. However, for almost as long, researchers have struggled to develop a theory to explain this success. We will trace the practical success of the method as well as the underlying theoretical developments.

■ WC-02

Wednesday, 12:30-13:30

PLEN HBio Hall 1

Problem Structuring and Formulation in Decision Aiding

Stream: Semi-Plenary Sessions

Invited session

Chair: *Valerie Belton*, Dept. Management Science, University of Strathclyde, 40 George Street, G1 1QE, Glasgow, United Kingdom, val.belton@strath.ac.uk

Chair: *Ian Mitchell*, OR Society, 3 Beyer Road, Amesbury, SP4 7XG, Salisbury, Wiltshire, United Kingdom, IanMitch1@aol.com

1 - Problem Structuring for MCDA

Valerie Belton, Dept. Management Science, University of Strathclyde, 40 George Street, G1 1QE, Glasgow, United Kingdom, val.belton@strath.ac.uk

Problem structuring is the process of making sense of an issue. The paper will begin by discussing its role in a broad methodology for MCDA, incorporating the wide range of MCDA methods. This is a socio-technical process in which the "A" reflects both "analysis" and "aid". The paper will describe different approaches - including formal problem structuring methodologies, such as Eden and Ackermann's approach to causal mapping and Checkland's Soft Systems Methodology, as well as informal checklists - and illustrate their use in practice, drawing on the experience of the author and others.

■ WC-03

Wednesday, 12:30-13:30

PLEN HBio Hall 2

Global Optimization in Practice: Software and Applications

Stream: Semi-Plenary Sessions

Invited session

Chair: *Janos D. Pinter*, PCS Inc. & Dalhousie University, 129 Glenforest Drive, B3M 1J2, Halifax, NS, Canada, jdpinter@hfx.eastlink.ca

Chair: *Bjarni Kristjansson*, Maximal Software, Inc., 2111 Wilson Boulevard, 22201, Arlington, Virginia, United States, bjarni@maximalsoftware.com

1 - Global Optimization in Practice: Software and Applications

Janos D. Pinter, PCS Inc. Dalhousie University, 129 Glenforest Drive, B3M 1J2, Halifax, NS, Canada, jdpinter@hfx.eastlink.ca

Nonlinearity is a key characteristic of a vast range of objects, formations and processes in nature and in society. Consequently, nonlinear descriptive models are relevant in many areas of the sciences and engineering. The objective of Global Optimization (GO) is to find the absolutely best solution of nonlinear decision models, in the presence of multiple local optima. GO has received increasing attention in recent decades. The key theoretical developments regarding models and solution algorithms have been followed by software implementations. As of today, GO software is available for compiler platforms, spreadsheets, optimization modeling languages, and integrated computing systems. We shall review these developments, and then discuss the use of global optimization techniques and software in various engineering and scientific applications. The presentation is partially based on recent and ongoing joint projects with several research groups: we highlight case studies from computational chemistry, data classification, engineering design, model fitting, object configuration analysis, process optimization, radiotherapy design, and other areas.

■ WC-04

Wednesday, 12:30-13:30

PLEN HBio Hall 3

Dynamics and Control of Epidemic Processes

Stream: Semi-Plenary Sessions

Invited session

Chair: *Gustav Feichtinger*, Operations Research and Nonlinear Dynamical Systems, Vienna University of Technology, Argentinierstr. 8 / Inst. 105-4, A-1040, Vienna, Austria, or@server.eos.tuwien.ac.at

Chair: *Ulrike Leopold-Wildburger*, Statistics and Operations Research, Karl-Franzens-University, Universitätsstraße 15/E3, 8010, Graz, Austria, ulrike.leopold@uni-graz.at

1 - Dynamics and Control of Epidemic Processes

Gustav Feichtinger, Operations Research and Nonlinear Dynamical Systems, Vienna University of Technology, Argentinierstr. 8 / Inst. 105-4, A-1040, Vienna, Austria, or@server.eos.tuwien.ac.at

I present intertemporal cost-benefit analysis of three kinds of epidemic processes. Firstly, I present a word-of-mouth two-state compartment model where the number of satisfied and not-satisfied customers are the state variables. Secondly, I present a larger case study, namely on the US cocaine epidemic, where the optimal mix of drug control interventions vary over time. My third application is localized at the intersection of population dynamics, epidemiology and health management. It deals with the dynamics and the control of an HIV/AIDS pandemic.

■ WC-05

Wednesday, 12:30-13:30

PLEN Askja N-132

Design and Optimization of Emission Trading Markets and Sustainable Bargaining Systems

Stream: Semi-Plenary Sessions

Invited session

Chair: *Stefan Pickl*, Department for Computer Science, Universität der Bundeswehr München, Heisenbergstr. 39, 85577, Neubiberg-München, Bavaria, Germany, stefan.pickl@unibw.de

Chair: *Martin Zachariassen*, Dept. of Computer Science, University of Copenhagen, Universitetsparken 1, DK-2100, Copenhagen, Denmark, martinz@diku.dk

1 - Emission Trading Markets

Stefan Pickl, Department for Computer Science, Universität der Bundeswehr München, Heisenbergstr. 39, 85577, Neubiberg-München, Bavaria, Germany, stefan.pickl@unibw.de

This semi-plenary talk deals with a description of so-called emission trading markets. Special properties are introduced and characterized. The role of simulation and mathematical analysis within the framework of Kyoto Protocol is discussed. Two software projects are presented (TEMPI: Technology Emissions Means Process Identification; JET: Joint International Emissions Trading). They are based on a special bargaining model which was introduced by the author.

Wednesday, 14:00-15:30

■ WD-01

Wednesday, 14:00-15:30

PLEN HBio Big Stage

Closing Session - Plenary

Stream: Plenary Sessions

Invited session

Chair: *Snjolfur Olafsson*, Faculty of Economics and Business Administration, University of Iceland, Oddi, IS-101, Reykjavik, Iceland, snjolfur@hi.is

1 - Closing Session - Plenary

Tuula Kinnunen, Kirkkotie 285, FI-21370, Aura kk, Finland, euro@tuulakinnunen.fi, *Jean-Pierre Brans*, *Valerie Belton*, *Alexis Tsoukiàs*, *Snjolfur Olafsson*

The closing session will be chaired by Snjolfur Olafsson, the Chair of the Organising Committee. Two prizes will be awarded in the closing session. The EURO Doctoral Dissertation Award (EDDA) will be announced by the Chair of jury, Professor Jean-Pierre Brans and the Best Discussion Presentation Paper will be awarded by the Chair of the jury, Professor Valerie Belton. Following them, the highlight of the conference, the IFORS Distinguished Lecture will be given by Professor Saul Gass. The Chair of the Programme Committee Tuula Kinnunen will next give a summary of this conference, followed by brief introduction of the future OR conferences EURO 2007 and IFORS 2008 by their respective organizers. The President of EURO Alexis Tsoukiàs will finalise the business matters and the Chair of the Organising Committee Snjolfur Olafsson will say 'farewell' to the conference participants.

2 - IFORS Distinguished Lecture: An Annotated Timeline of Operations Research

Saul Gass, University of Maryland, 8809 Maxwell Drive, 20854, Potomac, Maryland, United States, SGass@rhsmith.umd.edu

We review our recent efforts to develop a history of OR viewed as a timeline description of events, people, and other influences. To date, we have identified over 400 such items extending over 400 years. We discuss a biased sample of such items that relate to the question: How did OR get from there to here? We include answers to the following OR trivia: Who first solved the general n-point facility location problem when he was 16 years old? Who wrote the first book on operations research OR methods and when was it published? When was the first OR journal published and who sponsored it? Why did the economist T.C. Koopmans give \$40,000 (a third of his Nobel 1975 prize in economics) away?

Wednesday, 16:00-17:30

■ WE-02

Wednesday, 16:00-17:30

APP Askja N-131

Master Surgical Scheduling

Stream: OR in Health Care

Invited session

Chair: *Gerhard Wullink*, Cluster 17, Erasmus Medical Centre, P.O. box 2040, Dr. Molenwaterplein 40, 3000 CA, Rotterdam, Netherlands, g.wullink@erasmusmc.nl

1 - Evaluation model for a nurse rostering problem with varying constraints

Greet Vanden Berghe, Information Technology, KaHo Sint-Lieven, Gebr. Desmetstraat 1, 9000, Gent, Belgium, greet.vandenbergh@kahosl.be

This nurse rostering problem allows nurses' contracts/qualifications to vary during the planning period. In case a nurse's schedule constraints change at a certain date, the solution should be evaluated partially with the original set of constraints and partially with the new set. This model splits each personal roster up into intervals with fixed constraints. We impose an additional set of boundary' conditions on the transition between consecutive intervals. The model has been solved with metaheuristics and the approach has been applied in different practical hospital settings.

2 - A Master Surgical Scheduling approach for cyclic scheduling in operating room departments

Jeroen van Oostrum, Department of Operating rooms, Anesthesiology, and Intensive Care, Erasmus Medical Center, Nh-4a, P.O.Box 2040, 3000 CA, Rotterdam, Netherlands, j.vanoostrum@erasmusmc.nl, *Johann Hurink*, *Erwin W. Hans*, *Gerhard Wullink*, *Mark Van Houdenhoven*

Operating room (OR) schedules are often not optimal regarding use of scarce OR time, are repetitive in nature, and cause demand fluctuations in other departments such as surgical wards and intensive care units. To deal with this problem we propose cyclic operating room schedules, so-called Master Surgical Schedules (MSSs). We propose a two-phase column generation approach that first maximizes the OR utilization and subsequently levels the demand for succeeding hospital departments such as wards and intensive care units. We test the solution approach with data from the Erasmus Medical Center.

3 - The impact of cyclic master surgery scheduling on bed occupancy: two case studies

Jeroen Belien, Decision Sciences and Information Management, Katholieke Universiteit Leuven, Naamsestraat 69, 3000, Leuven, Belgium, jeroen.belien@econ.kuleuven.be, *Erik Demeulemeester*

This work starts with the presentation of a software tool for visualizing the usage of various resources as a function of the cyclic master surgery schedule. Next, we focus on one resource: beds. We present a number of mixed integer programming based heuristics and a simulated annealing heuristic to level the resulting bed occupancy. The models take into account stochastic numbers of patients for each operating room block and a stochastic length of stay for each operated patient. The methodology is illustrated by means of two case studies in Belgian hospitals.

■ WE-04

Wednesday, 16:00-17:30

APP Askja N-129

Optimization methods in energy

Stream: Electricity Markets

Invited session

Chair: *Daniel Ralph*, Judge Business School, Cambridge University, Trumpington St, CB2 1AG, Cambridge, United Kingdom, d.ralph@jbs.cam.ac.uk

1 - Decomposition techniques in energy risk management

Oktay Surucu, Institute of Applied Mathematics, Middle East Technical University, Financial Mathematics, 06531, Ankara, Turkey, oktays@metu.edu.tr, *Esma Gaygisiz*

Risk management plays a very important role for energy companies in liberalized markets due to complex and incomplete characteristics of these markets. Since risk management necessitates optimization under uncertainty, stochastic programming is the main method used by energy companies. The complexity and large scale characteristic of these models require the use of decomposition techniques in their solutions. This study aims to reduce the cost of stochastic programming approach used in energy risk management by providing comparisons of different solution techniques and algebraic methods.

2 - Multiobjective wind power planning in Portugal.

Paula Ferreira, Department of Production and Systems, University of Minho, Campus de Azurem, 4800-058 Guimarães Portugal, 4800-058, Guimarães, Portugal, paulaf@dps.uminho.pt, *Maria Madalena Araújo*, *M.e.j. O'Kelly*, *Lino Costa*

This paper presents a multiple objective energy planning optimization model integrating environmental and economical issues. The model is applied to the Portuguese case, taking into consideration its high levels of hydro power and, in particular, the increasing importance of wind turbine electricity generation. For solving the model a Multiobjective Elitist Evolution Strategy is used. The results include a set of compromise solutions, detailing plans for new thermal and wind plants installation over a ten years planning horizon.

3 - Using Mixed-Integer Programming to Solve Power Grid Blackout Problems

Sara Mattia, DIS, Università di Roma, via Buonarroti 12, 00185, Roma, Italy, mattia@dis.uniroma1.it

During the last decade, several large-scale failures of national power transmission networks took place. We consider optimization problems related to the prevention of large-scale cascading blackouts in power transmission networks subject to multiple scenarios of externally caused damage. We present computation with networks with up to 600 nodes and 827 edges, and many thousands of damage scenarios.

4 - Optimal bid by electricity generator in the Australian market

Vladimir Kazakov, School of Finance Economics, University of Technology, Sydney, PO Box R1636, 1225, Royal exchange, NSW, Australia, vladimir.kazakov@uts.edu.au, *Anatol Tsirlin*

Australian electricity spot market trading is modelled as linked sequence of noisy one period nonlinear programming problems (optimal dispatch problems for network of regional markets) with mixed constraints. The problem of optimal bidding by electricity producer in Australian spot market is formulated as stochastic optimal control problem. Its conditions of optimality derived and numerical method for solving these conditions constructed. Numerical example is given.

■ WE-06

Wednesday, 16:00-17:30

APP Askja N-121

IT Systems

Stream: Optimization in Postal Logistics

Invited session

Chair: *Sander van den Berg*, Supply Chain Consulting, DHL Exel Supply Chain, Godesberger allee 83-91, 53175, Bonn, Germany, sander.vandenberg@dhl.com

1 - Geographical Information Systems (GIS) for the Delivery of Letters, Parcels and Other Products

Norbert Will, Zentrale/Headquarters, 181, Deutsche Post AG, Charles-de-Gaulle Str. 20, 53250, Bonn, Germany, N.Will@DeutschePost.de

About 50 percent of all industries use geographical information systems directly or indirectly for their work, and so does Deutsche Post World Net. The vast majority of business processes at Deutsche Post have some geographical reference. So on its way to becoming the leading logistics company in the world, Deutsche Post World Net has been using GIS-based optimization tools with different algorithm for quite some time now. The potential to reduce the travel distances covered in postal delivery was identified as far back as the mid-1990s.

2 - Strategic planning for newspaper express distribution networks

Halil Ibrahim Guenduez, Deutsche Post Lehrstuhl für Optimierung, RWTH Aachen University, Templergraben 64, 52062, Aachen, Germany, halil@or.rwth-aachen.de

Express distribution networks for newspapers considered here guarantee same or next day delivery. When comparing different scenarios for locations, the main task in strategic planning is to assign printing shops and distributions centers to given depots. The resulting transportation networks consist of three stages, i.e., transportation from printing shop to depot, from depot to depot, and from depot to distribution center. The talk focuses on models for a specific network. Costs of time-constrained transports have to be estimated in such a way that location models become more realistic.

3 - Optimisation potential in logistics networks

Sander van den Berg, Supply Chain Consulting, DHL Exel Supply Chain, Godesberger Allee 83-91, 53175, Bonn, Germany, sander.vandenberg@dhl.com

DHL Exel Supply Chain design, manages and operates logistics solutions for a wide range of customers. The logistics world becomes more and more complex, since more and more activities are outsourced and need to be integrated. To bring the value and savings that the customer increasingly requires, advanced logistics solutions need to be developed and optimized while being operated. This requires an advanced methodology and optimization tools. DHL will present their optimization methodology from an operational perspective.

WE-08

Wednesday, 16:00-17:30

EDU Oddi 101

OR Education

Stream: OR Education (c)

Invited session

Chair: *Dwight Collins*, Presidio School of Management, 20 Ellis Drive, 07920, Basking Ridge, NJ, United States, dwight.collins@verizon.net

1 - Mobile exam announcement

Petar Cisar, Transmission systems Telecommunications, Telekom Srbija, Prvomajska 2, 24000, Subotica, Serbia and Montenegro, petarc@telekom.yu

Exam announcement is a periodically procedure on every high school or faculty. It means acquisition and inserting a great amount of data related with announced exam and student in limited period of time. Exams are mostly announced by filling examination forms or by Internet - applications. Actual mobile technology brings a new way of announcement - by mobile phones. It seems to be the most comfortable and fastest way for educational establishments as well as for students. It also makes possible giving a wide variety of useful information. This paper describes one of this solutions.

2 - The Virtual Classroom Within A Blended Learning Context: Using Synchronous Conferencing As A Support Tool

Adriana Gnudi, Mathematics, Statistics, Computer science and Applications, University of Bergamo, Via dei Caniana, 2, 24127, Bergamo, Italy, adriana.gnudi@unibg.it, *Lucia Malvisi*

The University of Bergamo delivers a computer module with a blended learning element. Last year through a partnership with ABB Italia, a "Virtual Classroom" was established whereby synchronous events were scheduled using video conferencing technology. We were interested to see what impact this had on the students, especially as in a blended learning module the students have face to face sessions with the lecturer. We wondered whether the synchronous event would have any value and if so what? The experience of the students and lecturer is described both in qualitative and quantitative terms.

3 - Comparing 'of the social skill actual perform' with cognition of potential' and restrain at the discretion' -proposal for the skill not using one's skill-

Yukako Ishii, Education, Kyoto University, Kyoto, Japan, yukako-i@p03.mbox.media.kyoto-u.ac.jp, *Hiroaki Ishii*

I investigated questionnaire for 111 youth to examine it which question form was proper in the social skill measurement. As a result of factor analysis, correlation analysis, pass analysis, it was shown that when I adopt the question form to ask the degree cognition about their potential ability to use skills, the relationship with mental health is stronger than to ask frequency of performance that has been used as usual. And result also showed that the form to ask frequency of restraint their skill-using action on a voluntary basis is important according to the circumstances.

4 - Operational Research at University of Akureyri

Thorir Sigurdsson, Natural Resource Sciences, University of Akureyri, Nordurslod, 602, Akureyri, Iceland, thorir@unak.is, *Bjarni Hjardar*

University of Akureyri in North-Iceland was established 1987 with 50 students and 2 permanent teachers in 2 faculties. Now it has 6 faculties, 100 teachers and 1500 students, mostly undergraduates. OR was taught from the start in two courses for students specialising in QC; now there is one compulsory and one elective in the Faculty of Management, both 6 ECTS. We will describe topics, texts, methods and projects in these courses. They are both traditional with moderate prerequisites in calculus and statistics, emphasising applications rather than theory, induction rather than deduction.

5 - Teaching Sustainable Operations Management in a New US MBA Program in Sustainable Management: A Progress Report

Dwight Collins, Presidio School of Management, 20 Ellis Drive, 07920, Basking Ridge, NJ, United States, dwight.collins@verizon.net

The author teaches sustainable operations management (OM) at the Presidio School of Management in San Francisco. He will discuss the challenges in crafting a syllabus that encompasses both traditional OM basics and elements of sustainable OM such as industrial ecology, remanufacturing, and life cycle assessment. He will review how including the sustainability dimension influences the content material taught in the traditional OM sectors such as supply chain design and forecasting.

WE-09

Wednesday, 16:00-17:30

IT Oddi 106

Geometry of multidimensional data

Stream: Data Mining

Invited session

Chair: *Mikhail Belkin*, Computer Science and Engineering, The Ohio State University, 395 Dreese Laboratories, 2015 Neil Avenue, 43210-1277, Columbus, Ohio, United States, mbelkin@cse.ohio-state.edu

1 - CUR Matrix Decompositions for Improved Data Analysis

Michael Mahoney, Yahoo Research, New Haven, United States, mahoney@yahoo-inc.com

Given a matrix A , decompose it as a product of three matrices, C , U , and R , where C/R consists of a few columns/rows of A and U is a small matrix such that CUR is "close" to A . Applications of such decompositions include matrix reconstruction, kernel-based statistical learning, sparsity-preservation in low-rank approximations, and improved interpretability of data analysis methods. Our main result will be an algorithm that computes matrices C , U , and R such that the (Frobenius) norm of the error matrix $A - CUR$ is almost minimal. Several data applications will also be discussed.

2 - A Geometric Perspective on Data Analysis

Partha Niyogi, University of Chicago, 1100 E. 58th Street, Ryerson 167, 60637, Chicago, IL, United States, niyogi@cs.uchicago.edu

Increasingly we face machine learning problems in very high dimensional spaces. Although data lives in high dimensions they often have relatively few degrees of freedom. A way to formalize this intuition is to model data as lying on or near a low dimensional manifold embedded in high dimensional space. This approach leads to a new class of manifold motivated algorithms and new theoretical questions surrounding their analysis. A central construction in these algorithms is a data-derived graph and we will relate its geometry to that of the underlying manifold. Applications will be considered.

3 - Estimation of gradients and coordinate covariation in classification

Sayan Mukherjee, Duke University, 101 Science Drive, Box 3382, 27708, Durham, NC, United States, sayan@stat.duke.edu

We introduce an algorithm that simultaneously estimates a classification function as well as its gradient in the supervised learning framework. The motivation for the algorithm is to find salient variables and estimate how they covary. An efficient implementation with respect to both memory and time is given. The utility of the algorithm is illustrated on simulated data as well as a gene expression data set. An error analysis is given for the convergence of the estimate of the classification function and its gradient to the true classification function and true gradient.

■ WE-11

Wednesday, 16:00-17:30

TRANS Oddi 202

Transport Planning

Stream: Transportation

Invited session

Chair: *Jorge Freire de Sousa*, Industrial Management Unit, Faculty of Engineering University of Porto, Rua Roberto Frias, 4200-465, Porto, Portugal, jfsousa@fe.up.pt

1 - Applying Knowledge Discovery Process to Traffic Data Warehouse of Hanshin Expressway

Hiroiyuki Kawano, Department of Information and Telecommunication Engineering, Nanzan University, Seirei-cho 27, Seto, 4890863, Seto, Aichi, Japan, kawano@it.nanzan-u.ac.jp, *Hiroiyuki Takada*, *Yasuhiro Ishii*, *Yoshio Hisari*, *Toshiharu Hasegawa*

The Hanshin Expressway Company Limited has been gathering and providing traffic information since 1970. At present, congestion, incidents and other data are integrated in the traffic data warehouse. We analyze 58,738 records stored from 2004 April to next March. We select major attributes, "routes, number of lanes, causes, trouble level, day/night" by CfsSubsetEval of mining tool WEKA, and remove construction records using EM algorithm. By using "SMOreg, IBK, Bagging, DecisionTable" and "LinearRegression, M5P, M5Rules", we try to derive mathematical models of duration of incidents.

2 - A Generalization of Wilson's Entropy Model with Respect to Multiple Halfway Stops

Yudai Honma, Faculty of Science and Technology, Keio University, 3-14-1 Hiyoshi Kohoku-ku, 223-8522, Yokohama, Kanagawa, Japan, yudai@ae.keio.ac.jp, *Osamu Kurita*

In this study, Wilson's doubly-constrained entropy maximizing spatial interaction model is generalized in order to deal with trips with multiple halfway stops between origin and destination. Adding halfway stopping constraint to the classical model, we first formulate spatial interaction models for trips with a halfway stop. The advanced models will be then proposed to consider multiple halfway stops and touring behavior in a same zone set. We also apply the model to Tokyo metropolitan trip data and National traveler's flow data to examine the validity of the model.

3 - Travel time prediction and decision support in public transportation

Jorge Freire de Sousa, Industrial Management Unit, Faculty of Engineering University of Porto, Rua Roberto Frias, 4200-465, Porto, Portugal, jfsousa@fe.up.pt, *João Moreira*, *Alípio Jorge*

The main mass transit companies have done, in the last years, strong investments in Advanced Transport Information Systems. Such systems allow to monitor and to manage the fleet in real time. These systems also gather information from the crew assignment and from the driver duties; both the planned and the real operations are recorded. Taking advantage from the huge amount of usable information, the aim of our project is to find an end-to-end approach for the travel time prediction in operational planning, and also to link the transport management goals to the prediction tasks.

■ WE-13

Wednesday, 16:00-17:30

TRANS Oddi 206

Vehicle Routing with Time Windows

Stream: Vehicle Routing (c)

Invited session

Chair: *Brian Kallehauge*, Centre for Traffic and Transport, Technical University of Denmark, Building 115, 2800, Kgs. Lyngby, Denmark, bk@ctt.dtu.dk

1 - A cluster-lightening route reduction strategy for the vehicle routing problem with time windows

Francesco Carrabs, Dipartimento di Matematica ed Informatica, Università degli Studi di Salerno, via Ponte don Melillo, 84084, Gesualdo, Italy, fcarrabs@unisa.it, *Raffaale Cerulli*, *Monica Gentili*

We propose a new technique to improve the route elimination phase of any heuristic for the Vehicle Routing Problem with Time Windows and its variants. This new strategy is based on two main steps. Given a route r to be removed from the current solution: (i) identify a set S of routes having more chances to receive customers from r (clustering step), (ii) reduce the number of customers of each route in S in order to generate "spaces" where to introduce customers of r . Test results show the efficacy of our technique in improving the final solution of existing heuristics.

2 - Cooperative strategy and multiple use of vehicles in routing problem with pickup and delivery time windows

Ka Yuk Carrie Lin, Dept. of Management Sciences, City University of Hong Kong, 83 Tat Chee Ave, HK SAR, Kowloon, Hong Kong, mslincky@cityu.edu.hk

This paper studies the resources requirement and routing strategies in courier services. Past VRP literature describe a set of vehicles operating independently to service customers. This study addresses a VRP with customer pickup and delivery time windows. Independent strategy and cooperative strategy among vehicles are formulated respectively by integer programming models with heuristics developed. Multiple use of vehicles is also examined. The objective is to minimize the sum of fixed cost and variable operating cost. Results are reported on local data and simulated data.

3 - A branch-and-cut algorithm for the VRP with time windows

Brian Kallehauge, Centre for Traffic and Transport, Technical University of Denmark, Building 115, 2800, Kgs. Lyngby, Denmark, bk@ctt.dtu.dk

In this talk we present a new branch-and-cut algorithm for the VRP with time windows (VRPTW). The approach is based on path inequalities that eliminate paths that are infeasible because of some deadline or vehicle capacity is violated. We determine the dimension of the VRPTW polytope and present a facet proof for the path inequalities. We also transferred precedence constraints to the VRPTW context and implemented classes of ATSP inequalities to further strengthen the bounds. The algorithm shows promising results and finds a solution to a previously unsolved 50-node test problem of Solomon.

■ WE-14

Wednesday, 16:00-17:30

PROD Arnag 101

Realistic Production Scheduling, part II

Stream: Realistic Production Scheduling

Invited session

Chair: *Ruben Ruiz*, Departamento de Estadística e Investigación Operativa Aplicadas y Calidad, Universidad Politécnica de Valencia, Camino de Vera S/N, 46021, Valencia, Spain, rruiz@eio.upv.es

1 - Heuristics for Highly Constrained Hybrid Flexible Flowshop Scheduling Problems

Thijs Urlings, Departamento de Estadística e Investigación Operativa Aplicadas y Calidad, Universidad Politécnica de Valencia, Camino de Vera S/N, 46021, Valencia, Spain, T.Urlings@student.unimaas.nl, *Ruben Ruiz*, *Funda Sivrikaya Serifoglu*

A realistic scheduling problem is approached by heuristic and meta-heuristic techniques. More precisely, a hybrid flexible flowshop is considered where there is a number of stages with unrelated parallel machines at each stage. Jobs might skip stages and have anticipatory as well as non-anticipatory sequence dependent setup times, time lags and precedence constraints. Not all machines in stages are eligible and we also find machine release dates. We propose heuristics and some genetic algorithms with varied verbosity in the chromosome representation. The results are compared and commented.

2 - Production scheduling in pharmaceutical industry

Dario Pacciarelli, Dipartimento di Informatica e Automazione, Università Roma Tre, Via Della Vasca Navale, 79, 00146, Roma, Italy, pacciarelli@dia.uniroma3.it, *Michele Ciavotta*, *Carlo Meloni*, *Marco Pranzo*

In this talk we discuss a general methodology for rapid prototyping of scheduling algorithms. Its main characteristics are modularity, adaptability to different objectives and constraints, easiness of implementation, and ability of incorporating human experience in the scheduling algorithms. Hence, the algorithms are not based on strong mathematical properties of the particular problem to solve. Rather, the search process is guided by heuristic building blocks. Computational experience carried out on two case studies from pharmaceutical industry show the effectiveness of this approach.

■ WE-16

Wednesday, 16:00-17:30

PROD Arnag 301

Production Planning and Scheduling II

Stream: Scheduling

Invited session

Chair: *Cristobal Miralles*, Depto. Organización de Empresas, Universidad Politécnica de Valencia, Cami de Vera s/n, 46022, Valencia, Spain, cmiralles@omp.upv.es

1 - Bi-objective Scheduling Of Single-period Orders In Make-to-order Manufacturing

Tadeusz Sawik, Computer Integrated Manufacturing, AGH University of Science Technology, Faculty of Management,

Al.Mickiewiczza 30, 30-059, Krakow, Poland, ghsawik@cyf-kr.edu.pl

A lexicographic approach and integer programming formulations are presented for a dual-objective, long-term production scheduling in make-to-order manufacturing. The problem objective is to assign single-period customer orders for various product types to planning periods to complete all the orders with minimum number of tardy orders as a primary criterion and to level the aggregate production over a planning horizon as a secondary criterion. Numerical examples modeled after a real-world assembly line in the electronics industry are provided and some computational results are reported.

2 - Some Approaches To Balancing Production Lines With Blocks Of Parallel Operations At Stations

Genrikh Levin, Operations Research Laboratory, United Institute of Informatics Problems, 6, Surganova str., 220012, Minsk, Belarus, levin@newman.bas-net.by, *Nikolai Guschinsky*, *Alexandre Dolgui*

Production lines with stations in series and blocks of parallel operations at stations are considered. Blocks at stations are executed either simultaneously, or sequentially. The problem consists in choosing the number of the stations and the number of the blocks, and in assigning operations into blocks to minimize the line cost under the following constraints: the required output, precedence relation of operations, admissibility or inadmissibility of executing some operations into the same block or at the same station. The work is supported in part by Projects INTAS-03-51-5501 and ISTC-B-986.

3 - An activity-based approach for worker scheduling to minimize makespan and overtime hour under manufacturing environment with a fixed production rate

Sukardi Sukardi, Agroindustrial Technology, Bogor Agricultural University, Kampus IPB Darmaga, P.O.Box 220, 16002, Bogor, JABAR, Indonesia, sukardi_ri@yahoo.com, *Mehmet Bayram Yildirim*

In this research we address a single-product fixed production period scheduling problem typical to an aircraft manufacturer with the objective to minimize schedule makespan and total overtime hours. We solve the problem using a two-stage heuristic. First, we formulate the problem using mixed integer linear programming to determine the initial system status. Then, we develop an activity-based approach to provide a minimum total incurred overtime hours. Computational results show that the developed method is able to provide a stable schedule with optimal makespan and overtime hours.

4 - Balancing assembly lines with sequence dependent setup times between tasks: IP model and GRASP algorithm for a new problem

Cristobal Miralles, Depto. Organización de Empresas, Universidad Politécnica de Valencia, Cami de Vera s/n, 46022, Valencia, Spain, cmiralles@omp.upv.es, *Carlos Andres*, *Rafael Pastor*

In the Assembly Line Balancing literature the question of scheduling the execution of tasks assigned to every station has never been reported. This is a new problem where both the inter-station balancing issue and the intra-station scheduling of tasks must be solved simultaneously; supposing a new more realistic scenario for many real assembly lines. After formulating a mathematical model for this new problem and show the high combinatory nature of the problem, eight different heuristic rules and a GRASP algorithm are designed and tested.

■ WE-17

Wednesday, 16:00-17:30

PROD Arnag 303

Vehicle Routing

Stream: Scheduling

Invited session

Chair: *Manuel Martinez*, Economic Analysis and Business Administration, University of La Coruna, E U Diseno Industrial, Dtr Vazquez Cabrera SN, 15403, Ferrol - La Coruna, Spain, mmc@udc.es

1 - A comparison of two approaches to solve a real world PVRP using ACO algorithms

Ana Matos, Dept. of Mathematics, Escola Superior de Tecnologia - Instituto Politécnico de Viseu, Campus Politécnico de Repeses, 3500, Viseu, Portugal, amatos@mat.estv.ipv.pt, Rui Oliveira

This paper presents and compares two algorithms using ACO to solve a real-world instance of PVRP involving waste collection with large number of customers and a large number of possible visit patterns. In the first approach, routes are initially created using ACO and then assigned to days of the time horizon. In the second algorithm, the problem is approached through an integrated framework where an initial solution is generated using work-load balancing and geographical proximity criteria. An ACO procedure is then applied to design routes, followed by a series of interchange mechanisms.

2 - Modeling and optimization for vehicle routing on loop with shortcut

Hiroshi Kise, Department of Mechanical and System Engineering, Kyoto Institute of Technology, Mastugasaki, Sakyo, 606-8585, Kyoto, Japan, kise@kit.ac.jp

This paper discusses a material handling system (MHS) which consists of a loop with a shortcut, processing stages located to the loop and a fleet of (robotic) vehicles which serve the stages, traveling on the loop and the shortcut. Such systems are found in real factories and automated warehouses among others. One of the important issues on such system is the interference between vehicles. This paper discusses some vehicle routing rules for allocating each job sent by a vehicle to a stage and proposes an optimal vehicle routing rule to minimize the interference.

3 - Development Of The Aladin Algorithm For The Vrptw: New Findings On Construction Heuristics

Manuel Martinez, Economic Analysis and Business Administration, University of La Coruna, E U Diseno Industrial, Dtr Vaquez Cabrera SN, 15403, Ferrol - La Coruna, Spain, mmc@udc.es, Eduardo Guillén Solorzano, Susana Barbeito

In this research we have applied new rules to the Algorithm of Additions and Insertions for solving the VRPTW. This new rules consider new situations not previously considered in the original algorithm, such as the retention factor for the furthest nodes, additions with eliminations, and some variations in the selection of the initial parameters. These new rules prove that the results can be improved by using new construction rules that rationally apply to the decision criteria used. A comparison with both Solomon results and the original results is provided.

■ WE-19

Wednesday, 16:00-17:30

PROD Arnag 311

Quality Management

Stream: Quality Management (c)

Invited session

Chair: *J. Rodrigues Dias*, Mathematics, University of Evora, R. Diogo Pires, 83, 7000, Evora, Portugal, jrd@uevora.pt

Chair: *Margarida Saraiva*, Gestão de empresas, Universidade de Évora, Largo dos Colegiais, 2, 7000-804, Évora, Portugal, msaraiva@uevora.pt

1 - Unified Risk-cost-benefit Approach For Quality Management Of European Union Regional Programs

Evangelos Michalopoulos, University of Macedonia, Stamati Kleanthi 10, 50100, Kozani, Greece, emichalo@otenet.gr, Andreas Georgiou, Konstantinos Paparrizos

This paper presents a generic decision making approach for the European Union regional programs based on combined attributes of risk, cost and benefit analytical qualitative and quantitative techniques. The method is applied to small business competitiveness initiatives of the Regional Operational Program in West Macedonia, Greece. The generic nature of the method permits its use in the quality management and effectiveness of similar European regional programs in Greece and other countries.

2 - A Simple Approach For The Minimization Of The Total Expected Cost In Quality Control

J. Rodrigues Dias, Mathematics, University of Evora, R. Diogo Pires, 83, 7000, Evora, Portugal, jrd@uevora.pt

Many papers have been published considering not periodic sampling schemes in quality control. Also, we proposed an adaptive approach introducing the density function of the standard normal distribution in which a scale factor k appears. Here, considering different quality costs using control charts, we introduce a simple expression to calculate approximately k in order to minimize the total expected cost by cycle, in such a way that the sampling times can be quickly obtained. This approximation is compared with the optimal solution and it can be concluded that it is a very good one.

3 - The Total Quality Management philosophy: The Deming's principles in two Portuguese institutions of high education.

Margarida Saraiva, Gestão de empresas, Universidade de Évora, Largo dos Colegiais, 2, 7000-804, Évora, Portugal, msaraiva@uevora.pt

Usually, the process of TQM is implemented in the industry and in services through the adoption of a group of principles. Deming that presented a set of principles to improve the quality process in a organisation. The study applied some of the Deming's principles in two Portuguese institutions of high education. The objective was to understand if the Deming's principles could be applied. The results showed a group of possible difficulties and benefits and concluded that can be implemented. Their correct application could allow them to evolve from quality to excellence.

■ WE-23

Wednesday, 16:00-17:30

OPT Adal 051

Approximating Geometric Packings

Stream: Approximation Algorithms

Invited session

Chair: *Klaus Jansen*, Institut für Informatik und Praktische Mathematik, Universität Kiel, Olshausenstr. 40, 24098, Kiel, Germany, kj@informatik.uni-kiel.de

Chair: *Magnus M. Halldorsson*, Dept. of Computer Science, University of Iceland, Vr-ii, IS-107, Reykjavik, Iceland, magnusmh@gmail.com

1 - Approximative Algorithms for Three-Dimensional Box Packing

Ralf Thöle, Institute for Computer Science, University of Kiel, Olshausenstraße 40, 24105, Kiel, Germany, rth@informatik.uni-kiel.de, *Florian Diedrich*, *Klaus Jansen*, *Rolf Harren*

We study the problem of geometrically packing three-dimensional boxes into a dedicated bigger box in order to maximize the profit where rotation of the boxes is forbidden. This NP-hard problem is motivated from logistics as well as combinatorial optimization. We obtain fast approximation algorithms based on strip-packing with absolute approximation ratios $9 + \epsilon$ and $8 + \epsilon$ and derive a criterion under which a list of boxes can be packed into the unit cube. Thus, we algorithmically detect and certify a subset of the feasible instances of the corresponding decision problem.

2 - Approximation Algorithms for Three-Dimensional Orthogonal Knapsack Problems

Florian Diedrich, Institute for Computer Science and Applied Mathematics, University of Kiel, Olshausenstrasse 40, 24098, Kiel, Germany, fdi@informatik.uni-kiel.de, *Klaus Jansen*, *Ralf Thöle*, *Rolf Harren*

We consider the problem of packing boxes into a dedicated target box and wish to maximize the total profit, volume or number of boxes. More precisely we consider the cases where rotation by 90 degrees around each axis is forbidden or permitted. For each scenario we obtain approximation algorithms with different constant ratios. Furthermore we study the special case of packing cubes into the unit cube. The general non-rotational case is NP-hard, but the hardness of packing cubes into the unit cube is an open problem.

3 - An Asymptotic Approximation Algorithm for 3D-Strip Packing

Roberto Solis-Oba, Department of Computer Science, University of Western Ontario, Middlesex College Building, N6A5B7, London, Ontario, Canada, solis@csd.uwo.ca, Klaus Jansen

We present an asymptotic $(2+\epsilon)$ -approximation algorithm for the 3D-strip packing problem, for any positive ϵ . In this problem the input is a set of 3-dimensional boxes. Each box has width, length, and height at most 1. The goal is to pack the boxes into a bin B of width 1, length 1 and minimum height. We consider only orthogonal packings without rotations. This algorithm improves on the previously best algorithm of Miyazawa and Wakabayashi which has asymptotic performance ratio 2.64. Interestingly, our algorithm also yields a $(4+\epsilon)$ -approximation algorithm for the 3D-bin packing problem.

■ WE-24

Wednesday, 16:00-17:30

OPT Adal 052

Evolutionary Systems Identification

Stream: Dynamical and Anticipatory Systems

Invited session

Chair: Ryszard Klempous, Faculty of Electronics, Wrocław University of Technology, 27 Wybrzeże Wyspińskiego Street, 50370, Wrocław, Poland, klempous@yahoo.com

Chair: Zenon Chaczko, Faculty of Engineering, University of Technology, Sydney, Broadway, PO Box 123, 2007, Sydney, NSW, Australia, zenon@eng.uts.edu.au

1 - Evolutionary Systems Identification. New Algorithmic Concepts

Michael Affenzeller, Department of Software Engineering, Upper Austrian University of Applied Sciences, Hauptstr. 117, A-4232, Hagenberg, Austria, michael@heuristiclab.com, Stephan Winkler, Stefan Wagner

This paper describes new algorithmic concepts in the field of Genetic Programming. These self-adaptive algorithmic extensions enable the general concept of Genetic Programming to solve machine learning problems like time-series, symbolic regression or classification problems in superior quality which is stated on the basis of several established benchmark problems.

2 - Evolutionary Systems Identification. The Challenge of Finding the Appropriate Degree of Fitting

Stephan Winkler, Department of Software Engineering, Upper Austrian University of Applied Sciences, Hauptstr. 117, A-4232, Hagenberg, Austria, stephan@heuristiclab.com, Michael Affenzeller, Stefan Wagner

This paper describes the integration of local fitting methods into Genetic Programming (GP) based machine learning. Tree pruning and local parameter optimization methods enable the general GP concept to solve structure identification problems in superior quality. Furthermore, this paper addresses the appropriate use of local optimization methods within global optimization.

3 - Heuristic Systems Optimization in Practice. Advanced Evolutionary Algorithms and their Applications

Stefan Wagner, Department of Software Engineering, Upper Austrian University of Applied Sciences, Hauptstr. 117, A-4232, Hagenberg, Austria, stefan@heuristiclab.com, Michael Affenzeller, Stephan Winkler, Roland Braune

Due to the increase of computational power, today heuristic optimization techniques like Evolutionary Algorithms, Ant Algorithms, or Swarm Systems are highly compatible optimization paradigms. In this article recent advances in Evolutionary Computation and their application in economic fields like job scheduling, automated model generation, or route planning are discussed.

■ WE-25

Wednesday, 16:00-17:30

OPT Adal I-111

Network Optimization

Stream: Network Optimization

Invited session

Chair: Luis Gouveia, DEIO, University of Lisbon, Campo Grande, Bloco C6, 1749-016, Lisbon, Portugal, lgouveia@fc.ul.pt

1 - The Multilayer Capacitated Survivable IP Network Design Problem

Sylvie Borne, LIMOS - Université Blaise Pascal, Clermont-Fd II, Complexe scientifique des Cézéaux, 63 177, Aubière, France, sylvie.borne@isima.fr, Eric Gourdin, Olivier Klopfenstein, Ali Ridha Mahjoub

Telecommunication networks can be seen now as the stacking of several layers like, for instance, IP-over-Optical networks. This new infrastructure has to be sufficiently survivable to restore the traffic in case of failure. Moreover, it should have adequate capacities so that the demands can be routed between the origin-destinations. Here we consider the Multilayer Capacitated Survivable IP Network Design problem. We propose a Branch-and-Cut-and-Price algorithm for the problem and present some computational results.

2 - Modeling and Solving the Rooted Distance-Constrained Minimum Spanning Tree Problem

Ana Paías, DEIO/CIO, University of Lisbon, Portugal, ampaías@fc.ul.pt, Luis Gouveia, Dushyant Sharma

We discuss the rooted distance-constrained minimum spanning tree problem. We present three theoretically equivalent modeling approaches, a column generation scheme, a Lagrangian relaxation combined with subgradient optimization procedure and a shortest path (compact) reformulation of the problem. Our results indicate that the layered graph path reformulation model is quite good when the arc weights are reasonably small. Lagrangian relaxation combined with subgradient optimization procedure appears to work better than column generation.

3 - Extended node-arc formulation for the two edge-disjoint hop-constrained paths problem

Quentin Botton, Institut d'Administration et de Gestion, Université Catholique de Louvain, Place Des Doyens, 1, 1348, Louvain-la-Neuve, Belgium, botton@poms.ucl.ac.be, Bernard Fortz

The two edge-disjoint hop-constrained paths problem consists in finding a minimum cost subgraph such that there exist two edge-disjoint paths between given pairs of nodes, and such that the length of these paths is at most equal to a given parameter L . This problem was considered in the past using only design variables. We consider an extended formulation, introducing flow variables to model the paths. Additional classes of valid inequalities are added to strengthen the model leading to the complete description of the associated polyhedron and to some performance in terms of computing times

■ WE-26

Wednesday, 16:00-17:30

OPT Adal III=231

New trends for the QAP: New Applications and Recent Results

Stream: Combinatorial Optimization

Invited session

Chair: Monique Guignard-Spielberg, Opim, University of Pennsylvania, 5th floor, JMH, 3730 Walnut Street, 191046340, Philadelphia, PA, United States, guignard@wharton.upenn.edu

1 - Recent Advances and Challenges in Quadratic Assignment Problems

Peter Hahn, Electrical and Systems Engineering, University of Pennsylvania, 200 South 33rd Street, 19104-6314, Philadelphia, PA, United States, hahn@seas.upenn.edu,
Yi-rong Zhu

The Quadratic Assignment Problem (QAP) has long been of interest to researchers. Recently, exact solutions have been found to difficult instances as large as 90, though many smaller problems are still unsolvable. We discuss a broad class of QAPs and the techniques used for their exact solution. Among these are the Generalized Quadratic Assignment Problem, the Three-Dimensional Assignment Problem, the Cross-dock Door Assignment Problem, the Quadratic 3-dimensional Assignment Problem (Q3AP), the Cubic Assignment Problem and the Generalized Quadratic 3-Dimensional Assignment Problem.

2 - A Level-2 Reformulation-Linearization Technique Bound for the Quadratic Assignment Problem

Monique Guignard-Spielberg, OPIM, University of Pennsylvania, 5th floor, JMHH, 3730 Walnut Street, 191046340, Philadelphia, PA, United States, guignard@wharton.upenn.edu, *Warren Adams*, *Peter Hahn*, *William Hightower*

This paper studies polyhedral methods for the QAP. Bounds on the optimum are obtained using a reformulation-linearization technique (RLT). RLT provides different "levels" of representations that give increasing strength. This paper focuses on implementing level-2. The bounds are computed by RLT1 followed by RLT2 and are embedded within an enumerative algorithm. The reduced number of nodes needed is striking and the lower bounds are sharp, leading, in spite of the large RAM requirement of RLT2, to very competitive exact solution strategies for the more difficult problems of size 24 to 30.

3 - Exact solutions of large instance of QAP on clusters

Catherine Roucairol, PRISM lab. - CNRS, Univ. of Versailles Saint Quentin en Yvelines, 45, avenue des Etats-Unis, 78035, Versailles Cedex, France, Catherine.Roucairol@prism.uvsq.fr, *Van-Dat Cung*, *Bertrand Le Cun*, *Abdelaziz Djerrah*

We present an efficient parallel B&B for the QAP using a new bound, a new branching scheme, a symmetry test, and powerful cluster environments. The new bounds are based on Linearization Techniques and derived from the Dual procedure (Hahn and Grant). Several polytopic efficient branching schemes have been tested and symmetric assignments are also eliminated. Two libraries are used: BOB++, a library to develop B&B methods, Kaapi, a parallel programming and run-time environment with dynamic task scheduling, load balancing and checkpointing for parallel systems (clusters/grids).

■ WE-27

Wednesday, 16:00-17:30
OPT Adal V=229

Problems on graphs

Stream: Graphs (c)

Invited session

Chair: *Andrea Scozzari*, Matematica per le Decisioni Economiche, Finanziarie ed Assicurative, Facoltà di Economia, Via del Castro Laurenziano 9, 161, Roma, Italy, andrea.scozzari@uniroma1.it

1 - Composite semirings and path problems in graphs

Robert Manger, Department of Mathematics, University of Zagreb, Bijenicka cesta 30, 10000, Zagreb, Croatia, manger@math.hr

Path problems in graphs can generally be formulated and solved by algebraic means. For this purpose, an abstract algebraic structure is introduced whose instances are called semirings. Each particular type of path problem is characterized by a different instance of the structure. This paper presents a method for combining already known semirings into new ones. The obtained composite semirings correspond to relatively complex path problems, such as explicit identification of optimal paths or multi-criteria optimization. The usefulness of the whole construction is illustrated by examples.

2 - Coloring perfect (2,l)-split neighbourhood graphs

Hacene Ait Haddadene, Faculty of Mathematics, Dept of Operations research, USTHB University, BP32 Bab ezzouar 16111, 16111, Algiers, Algeria, aithaddadenehacene@yahoo.fr

A (k,l) partition of a graph G is a partition of its vertices into k cliques and l stables. A vertex v in a graph G is called a (k,l) -split vertex if its neighbourhood in G admit a (k,l) partition. A graph G is called perfect (k,l) -split neighbourhood graphs (noted SNAP (k,l)) if G is perfect and every induced subgraph of G contains a (k,l) -split vertex. In this paper we give a polynomial combinatorial algorithm for coloring any graph of this class for $k=2$ and $l=1$.

3 - The minimum switches path problem

Monica Gentili, University of Salerno, P.te Don Melillo, Fisciano, 84084, Salerno, Italy, mgentili@unisa.it

Let G be an oriented graph with a label (color) assigned to each arc. Given a path P in G and two subsequent arcs of P , we say there is a switch between the two arcs if they have different colors. The Minimum Switches Path Problem consists in finding a path on G such that the total number of switches in the path is minimized. In this paper we present two polynomial algorithms to solve the problem: the first algorithm is a classical label correcting algorithm defined on G and the second one is a label setting algorithm defined on the dual graph of G .

4 - On the complexity of some subgraph problems

Andrea Scozzari, Matematica per le Decisioni Economiche, Finanziarie ed Assicurative, Facoltà di Economia, Via del Castro Laurenziano 9, 161, Roma, Italy, andrea.scozzari@uniroma1.it, *Fabio Tardella*

We study the complexity of the existence, in some classes of graphs, of a spanning subgraph of a given graph, and that of finding a maximum weight such subgraph. We establish some general relations among the problem of the existence of a spanning subgraph, the maximum spanning subgraph problem, and the maximum weight spanning subgraph problem. Using some results from extremal graph theory, these relations allow one to obtain new NP-completeness results. Moreover, we provide a simple linear time algorithm for finding the maximum spanning chordal subgraph in graphs with vertex degree at most 3.

■ WE-28

Wednesday, 16:00-17:30
OPT Adal VI=207

Dynamic Programming II

Stream: Dynamic Programming (c)

Invited session

Chair: *Anabela Costa*, Métodos Quantitativos, ISCTE - Instituto Superior de Ciências do Trabalho e Empresa, AV. das Forças Armadas, 1649-026, Lisboa, Portugal, anabelacosta@netcabo.pt

1 - Reengineering the deferred path heuristic for phylogenetic trees

Benny Kjær Nielsen, DIKU, University of Copenhagen, Universitetsparken 1, DK-2100, Copenhagen, Denmark, benny@diku.dk, *Martin Zachariassen*, *Winter Pawel*

We give a new simple description of the deferred path heuristic originally developed by Schwikowski and Vingron. Given a set of sequences, e.g. DNA, this heuristic simultaneously finds a multiple alignment and a phylogenetic tree. It uses the concept of sequence graphs to represent large sets of sequences and it uses a generalization of a dynamic programming algorithm to do pairwise alignment of these sequences graphs. For a fixed tree, the heuristic solves the tree alignment problem. The result depends on the order in which the tree is built. We show how to efficiently avoid this dependence.

2 - Temporal Decomposition of Link Scheduling in Wireless Mesh Networks

Katerina Papadaki, Operational Research, London School of Economics and Political Science, Houghton Street, WC2A 2AE, London, United Kingdom, k.p.papadaki@lse.ac.uk, *Vasilis Friderikos*

The scheduling problem in Wireless Mesh Networks (WMNs) is to decide for every time slot in a timeframe which subset of the one-hop active links will transmit. This paper investigates a formulation of the problem, where interference generated from all transmitting nodes is considered. The objective is to minimize the weighted buffer size and ensure that each link transmits at least once within the timeframe. We formulate the problem as a dynamic program, and use approximate dynamic programming to estimate the optimal transmission policies; we use both deterministic and stochastic traffic.

3 - A Real Options approach for evaluating a portfolio of R&D projects with a budget constraint

Anabela Costa, Métodos Quantitativos, ISCTE - Instituto Superior de Ciências do Trabalho e Empresa, AV. das Forças Armadas, 1649-026, Lisboa, Portugal, anabelacosta@netcabo.pt, *José Pinto Paixão*

The Real Options approach has proved to be very satisfactory for the financial evaluation of R&D projects since it captures the value of flexibility in R&D projects. Since the risk of an R&D project is usually due to singular characteristics of the project and is uncorrelated with financial markets, the traditional contingent claims analysis may be not adequate to value R&D project. In this talk, we consider an evaluation model of an R&D project, which apply dynamic programming, and discuss approaches for extending it for a portfolio of R&D projects.

WE-29

Wednesday, 16:00-17:30

OPT Adal VII=225

Global optimization and space missions

Stream: Global Optimization: Deterministic and Stochastic Methods

Invited session

Chair: *Marco Locatelli*, Informatica, Università Torino, Corso Svizzera, 185, 10149, Turin, Italy, locatell@di.unito.it

Chair: *Massimiliano Vasile*, Aerospace Engineering, University of Glasgow, James Watt South Building, G12 8QQ, Glasgow, United Kingdom, m.vasile@aero.gla.ac.uk

1 - A Behavioural-Based Approach to the Global Optimisation of Space Mission Design Problems

Massimiliano Vasile, Aerospace Engineering, University of Glasgow, James Watt South Building, G12 8QQ, Glasgow, United Kingdom, m.vasile@aero.gla.ac.uk, *Marco Locatelli*

Many stochastic based approaches for global optimisation implement some heuristic derived from nature. From the very basic evolutionary paradigms to the more complex behaviours of ant colonies or bird flocks, each one of these heuristics can be interpreted as a basic behaviour (e.g. reproduction or trail following) associated to an agent. This paper presents a generalisation of this concept: a population of agents is endowed with a set of individualistic and social behaviours, in order to explore a virtual environment made of the solution space of some typical space mission design problems.

2 - Ant Colony Algorithms for Interplanetary Trajectory Optimisation

Matteo Ceriotti, Department of Aerospace Engineering, University of Glasgow, James Watt South Building, G12 8QQ, Glasgow, United Kingdom, mcieriott@aero.gla.ac.uk, *Gianmarco Radice*, *Massimiliano Vasile*

The purpose of this paper is to present the results of the application of ant colony algorithms to interplanetary trajectory optimisation. Ant colony algorithms are inspired by the behaviour of natural ant colonies, in the sense that they solve their problems by multi agent cooperation using indirect communication through modifications in the environment. The main idea is to use simulations of artificial ants behaviour to generate new solutions to the problem at hand. This optimisation method will be applied to multi-gravity, impulsive transfers.

3 - Robust Optimisation of Space Missions Design Problems Through Evidence Theory

Matteo Ceriotti, Department of Aerospace Engineering, University of Glasgow, James Watt South Building, G12 8QQ, Glasgow, United Kingdom, mcieriott@aero.gla.ac.uk, *Massimiliano Vasile*

In this paper, the preliminary design of a space mission is approached introducing uncertainties on the design parameters and formulating the resulting reliable design problem as a multiobjective optimization. Uncertainties are modelled through evidence theory and the belief in the successful achievement of mission goals and constraint satisfaction is maximised. The multiobjective optimisation problem is solved through an algorithm based on the collaborative multiple agents in search for sets of highly reliable solutions. Two typical problems are used to illustrate the proposed methodology.

WE-30

Wednesday, 16:00-17:30

NONL Adal X=220

Practical applications of semi-infinite optimization II

Stream: Nonlinear Semi-Infinite Optimization

Invited session

Chair: *Ralf Werner*, Allianz GRC, Königinstr. 28, 80802, Muenchen, Germany, werner_ralf@gmx.net

1 - Semi-Infinite Optimization in Gemstone Cutting

Anton Winterfeld, Optimization, Fraunhofer ITWM, Fraunhofer-Platz 1, 67663, Kaiserslautern, Germany, winterfeld@itwm.fraunhofer.de

We consider a volume maximization problem arising in gemstone cutting industry. The problem can be formulated as a general semi-infinite program (GSIP), and an interior-point method developed by Stein can theoretically be used to solve it. However, to become practical, the problem dimensions need to be drastically reduced. To this end, clustering techniques and parameterized enclosing hulls are used. An iterative process of optimization and adaptive refinement steps is employed to obtain an optimal solution for the original problem. Numerical results based on real-world data will be presented.

2 - Constrained velocity planning for autonomous vehicle via semi-infinite optimization

Corrado Guarino Lo Bianco, University of Parma, Parco Area delle Scienze 181/A, I-43100, Parma, Italy, guarino@ce.unipr.it, *Massimo Romano*

The paper addresses a velocity planning problem for autonomous vehicles. Appropriate bounds on velocities and accelerations have to be considered in order to avoid wheels slippage and actuators saturation. Planned profiles fulfill an assigned travelling time, while longitudinal jerk is minimized in order to increase the motion smoothness. In the paper it is shown that the velocity planning problem can be formulated as a non-linear semi-infinite optimization, to be solved in real time by means of an appositely devised algorithm, characterized by a light computational burden.

3 - Continuity properties of robust conic optimization

Ralf Werner, Allianz GRC, Königinstr. 28, 80802, Muenchen, Germany, werner_ralf@gmx.net, *Katrin Schöttle*

In recent years the robust counterpart approach gained more and more interest among both academics and practitioners. In contrast to classical parametric semi-infinite problems, these robust formulations have much more structure, especially in the infinite index set of the constraints. Using this structure, we derive results on the costs of robustification, similar to those given by Ben-Tal and Nemirovski. Further, we are able to extend our analysis to gain insight into the continuity properties of robust problems, thus allowing to characterize the benefits of robustification.

■ WE-31

Wednesday, 16:00-17:30

NONL Adal XI=222

Global Optimization in Stochastic and Financial Applications

Stream: Global Optimization: Deterministic and Stochastic Methods

Invited session

Chair: *Mirjam Duer*, Department of Mathematics, Darmstadt University of Technology, Schlossgartenstr. 7, D-64289, Darmstadt, Germany, duer@mathematik.tu-darmstadt.de

1 - Adaptive global search based on sparse grids

Izabella Ferenczi, Friedenstr. 63, 97072, Würzburg, Germany, IzabellaF@gmx.de, *Ralf Werner*

Driven by the needs of an application in finance, we have investigated the added value of global optimization compared to standard local approaches. For the application in mind we have examined potential improvements of the hcp algorithm developed by Novak and Ritter (1995). This method relies on an adaptive global search, where all search points are within a sparse grid. By supplementing the generalized method with cluster algorithms for the determination of starting points for derivative-free local search, we end up with a global optimization method based on function evaluations only.

2 - An Algorithm for Multiple Neutral Data Fitting

Mirjam Duer, Department of Mathematics, Darmstadt University of Technology, Schlossgartenstr. 7, D-64289, Darmstadt, Germany, duer@mathematik.tu-darmstadt.de, *Chris Tofallis*

Multiple Neutral Data Fitting is a method to analyse the relationship between a number of variables. In contrast to Least Squares, it possesses several properties that seem desirable for a data fitting method. The basic idea is that a different criterion is chosen to be minimized: Instead of minimizing the sum of the squares of the residuals, we consider the deviations for each variable and multiply them. This leads to a more complicated, nonconvex optimisation problem. In the talk, we analyse the Multiple Neutral Data Fitting optimisation problem and propose an algorithm to solve .

■ WE-34

Wednesday, 16:00-17:30

DEC VR11 V-138

General Systems II

Stream: Systems and Game Theory

Invited session

Chair: *Tatsuo Oyama*, School for Policy Studies, National Graduate Institute for Policy Studies, 7-22-1 Roppongi, Minato-ku, 106-8677, Tokyo, Japan, oyamat@grips.ac.jp

1 - Coordination in discrete review inventory situations

Ana Meca, Operations Research Center , Universidad Miguel Hernández, Avda. Universidad s/n, Edificio Torretamarit, 03202, Elche, Alicante, Spain, ana.meca@umh.es, *Luis Antonio Guardiola Alcala*, *Justo Puerto*

This paper considers a coordination model of discrete review inventory in which agents cooperate to share ordering channels and holding and backlogging technologies. We study the problem of how to allocate the savings that the above cooperation induces among the members of the consortium. The analysis is based on a transferable utility cooperative game which turns out to be totally balanced. Moreover, a family of fair allocations is introduced and related to some others already proposed in the literature of coordination models of inventory.

2 - Is simplification heuristics actually effective for human players?

Naoki Konno, Department of Value and Decision Science, Tokyo Institute of Technology, 2-12-1 Ookayama

meguro-ku, 152-8552, Tokyo, Japan, nkonno@valdes.titech.ac.jp, *Kyoichi Kijima*

The purpose of this paper is to examine effectiveness of simplification heuristics for human players. Simplification heuristics is sometimes adopted even though it contradicts to the rational heuristics like maximization. It is due to limitation of human's reasoning ability. First, we propose a rough reasoning model that describes human imperfect reasoning abilities. Next, by arguing some examples of games, we compare results of simplification-heuristics-based rough reasoning players and rational-heuristics-based rough reasoning players.

3 - Optimization model analyses for measuring the effects of introducing DPGP's into the commercial demand sectors

Tatsuo Oyama, School for Policy Studies, National Graduate Institute for Policy Studies, 7-22-1 Roppongi, Minato-ku, 106-8677, Tokyo, Japan, oyamat@grips.ac.jp, *Miki Tsutsui*

Diversified power generating plants (DPGP) are considered to have the great possibility to innovate the structure of energy supply and demand in Japan. We build a mathematical programming model in order to obtain an optimal introduction of DPGP into commercial demand sectors including such as hotels, schools, sport facilities and hospitals. Criteria includes maximizing the total "saving", maximizing the load factor, and minimizing the effects to the environment. Numerical results obtained from applying the model to a Japanese power company using the actual data are shown.

■ WE-37

Wednesday, 16:00-17:30

DEC VR11 V-156

MAUT based methods

Stream: Multiple Criteria Decision Aiding

Invited session

Chair: *Salvatore Greco*, Department of Economics and Quantitative Methods, University of Catania, Corso Italia 55, 95129, Catania, Italy, salgreco@unict.it

1 - A Preference Disaggregation Methodology for the Development of Smooth Multiattribute Value Functions: An Application in Credit Risk Rating

Michael Doumpos, Dept. of Production Engineering and Management, Technical University of Crete, University Campus, 73100, Chania, Greece, mdoumpos@dpem.tuc.gr, *Constantin Zopounidis*

Credit risk rating systems (CRRSs) are used by credit institutions for credit granting. In this paper a multicriteria approach is applied to a large sample of 32,000 firms for the development of a CRRS in the form of an additive value function. A simple algorithm is proposed to build a smooth model, instead of a piece-wise linear one that is usually assumed in MCDA. The outputs of the model are mapped to default probabilities and a comparative analysis with logistic regression is also presented.

2 - Building A Set Of Additive Utility Functions Representing A Reference Pre-order And Intensities Of Preference

José Rui Figueira, Instituto Superior Tecnico, Technical University of Lisbon, Av. Cavaco Silva, Tagus Park, 2780 - 990 Porto Salvo, 2780 - 990, Lisbon, Portugal, figueira@ist.utl.pt, *Salvatore Greco*, *Roman Slowinski*

We present a methodology called GRIP for building a set of additive utility functions compatible with preference information composed of a reference pre-order and required intensities of preference on a subset of actions, called reference actions, evaluated by multiple criteria. It aims to assess not only the preference relation in the considered set of actions, but also to compare intensities of preference for pairs of actions from this set, for a given DM (Decision Maker). The proposed methodology can be seen as an extension of the UTA method based on ordinal regression.

3 - A Generalized Framework for multicriteria concordance/discordance-based classifiers: An application on FLIR ship imagery

Khaled Jabeur, Decision Support Systems Section, Defence RD Canada - Valcartier (DRDC - Valcartier), 2459 Pie-XI Blvd. North Val-Belair, G3J 1X5, Québec, Canada, khaled.jabeur@drdc-rddc.gc.ca, *Adel Guitouni*

In this paper, we propose a generalized framework for multicriteria classifiers which are based on concordance/discordance concepts to assign objects into predefined and nominal categories. The proposed multicriteria classifiers are discussed and justified. Since the application of multicriteria classifiers requires the use of several parameters, we introduce a machine learning metaheuristics to assess these parameters. Finally, the results of the proposed classifiers are compared, by using a military database, with those obtained by other classifiers (e.g. Dempster-Shafer classifier).

■ WE-38

Wednesday, 16:00-17:30

DEC VR11 V-157

DEA Applications III

Stream: DEA and Performance Measurement (c)

Invited session

Chair: *Inmaculada Sirvent*, Centro de Investigación Operativa, Universidad Miguel Hernández, Avd. del Ferrocarril, s/n, 3202, Elche, Alicante, Spain, isirvent@umh.es

1 - Evaluating the cost efficiency of cooperative banking: A Data Envelopment Analysis

Dong Pham-Phuong, University of Heidelberg/ Global Insight (Deutschland) GmbH, Taubenstraße 7-9, Börsencenter, D-60313, Frankfurt am Main, Germany, dong.pham-phuong@urz.uni-heidelberg.de

Credit cooperatives are mostly small, member-orientated institutions, and thus distinguished from other financial intermediaries. Perhaps because of their small size and share in most services of the financial sector, and because of their specific unique organizational structure, cooperatives have been neglected by banking research. This paper aims at filling in the gap. Its purpose is to measure the technical and allocative cost efficiency of 227 Vietnamese credit cooperatives and to evaluate the determinants of their efficiency ascertained on the basis of the bootstrap regression technique.

2 - Mystery of the Toppled Investment: Immaterialization, Evaporation or Migration?

Elina Berghäll, Public finance, corporations and integration, Government Institute for Economic Research (VATT), P.O.Box 1279, Arkadiankatu 7, 00101, Helsinki, Finland, elina.berghall@vatt.fi, *Teuvo Junka*

The purpose of this paper is to investigate to what extent lower investment levels in Finland is a more general phenomenon related to structural change from capital-intensive to R&D-intensive sectors. Investment trends will be compared to those in other OECD countries. To the extent data is available, factor input elasticities, technical and allocative efficiency, as well as TFP change will be analysed with DEA and/or stochastic frontier methodology to determine the overall efficiency of resource allocation, as well as to evaluate the need for investment incentives.

3 - Using performance indicators of quality to assess the efficiency of the processes at the university

Inmaculada Sirvent, Centro de Investigación Operativa, Universidad Miguel Hernández, Avd. del Ferrocarril, s/n, 3202, Elche, Alicante, Spain, isirvent@umh.es, *Jose L. Ruiz*, *Jesús T. Pastor*

Assessing the performance of the different processes taking place at the university is a problem of great interest. It includes evaluating departments, comparing schools or assessing the different services. In some Spanish universities it is getting very frequent to assess such performances by using different indicators of quality. Moreover, the financing of some of these universities depends to some extent on the achievement of several quality standards. We use DEA as a tool to aggregate these indicators in order to develop indexes of performance of the units managing these processes.

4 - Indicators Of The Extension In The National University Of Colombia

Gloria Rodriguez Lozano, Faculty of Economic Sciences, National University of Colombia, Carrera 19 # 82-42 Apto. 701, 57, Bogota, Colombia, girodriguez@unal.edu.co

The few indicators that itself tried to develop for this type of activities in Colombia, have been always classical indicators, of such way that itself cannot come establish with clarity an unique measure of efficiency that relate all that central that are dedicated to advance the different modalities of extension inside National University of Colombia. Become to determine one alone and unique measure of the efficiency with which they manage the available resources to progress the extension in the University, getting to result the ranking of different faculties and institutes.

■ WE-39

Wednesday, 16:00-17:30

DEC VR11 V-158

DEA Applications IV

Stream: DEA and Performance Measurement (c)

Invited session

Chair: *Eizo Kinoshita*, urban science, Meijo University, 4-3-3,nijigaoka, 509-0261, Kani, gifu, Japan, kinoshit@urban.meijo-u.ac.jp

1 - Evaluation Of Quality And Efficiency Value

Tatiana Bouzdine - Chameeva, Bordeaux Ecole de Management, 680, cours de la Liberation, 33405, Talence Cedex, France, tatiana.chameeva@bordeaux-bs.edu

The study investigates the results of a systematic approach to measuring an efficiency value of wine chateaux in Bordeaux region in France based on the DEA. Our research details the use of DEA to estimate potential resources of performance quality excellence in the specific context of wine sector and discusses the use of the results obtained for a database of 137 world-known wine-SMEs of Bordeaux. It also highlights certain generic issues related with the use of DEA and more generally performance measurement methods in the wine sector.

2 - A goal programming approach to derive priorities of decision elements from imprecise judgements in the AHP framework

Dimitris Despotis, Department of Informatics, University of Piraeus, 80, Karaoli & Dimitriou Street, 18534, Piraeus, Greece, despotis@unipi.gr

We deal with the problem of priority elicitation in the analytic hierarchy process (AHP) on the basis of imprecise pair-wise comparison judgements on decision elements. We propose a minmax goal programming formulation to derive the AHP priorities in the case that the decision maker provides preference judgements in the form of interval numbers. By applying variable transformations we formulate a linear programming model that is capable of estimating the priorities from both consistent and inconsistent interval judgements. The proposed method is illustrated by numerical examples.

3 - AHP from the Perspective of Bounded Rationality

Eizo Kinoshita, urban science, Meijo University, 4-3-3,nijigaoka, 509-0261, Kani, gifu, Japan, kinoshit@urban.meijo-u.ac.jp

This paper treats human decision making from the perspective of rationality, and defines a Utility Function and Utility Theory as an instrumentally rational decision making theory and AHP as a procedurally rational decision making theory. Then it is shown that, in practical decision making and the behavior of human being, it is more effective to use the AHP. The paper presents a partial interpretation of a lasting debate on the effectiveness of Utility Function and the AHP, a debate that does not seem to be ending anytime soon.

4 - Efficiency of Hospitals' Wards via DEA: The Israeli Case

Lea Friedman, Ben Gurion University, P.o.b. 653, 84105, Beer Sheva, Israel, leaf@bgu.ac.il, Yossi Hadad, Zilla Sinuany-Stern, Dov Chernichovsky

The research analyses the effect of hospitals' size and type of ownership on their efficiency. The information for each hospital is divided into 5 wards. The size of hospitals is measured by the number of beds for 3 types of ownership. The DEA is used to find the efficiency of 21 hospitals in Israel for 1998-2003, totaling 126 observations. We use two DEA models. Model A includes in one run all 5 wards for all hospitals with 15 variables. Model B includes in 5 runs for each ward separately with 3 variables. To summarize results we did not find the same trend of increasing RTS for the 2 models

■ WE-44

Wednesday, 16:00-17:30

FIN Endur Room 2

Stochastic Programming III

Stream: Stochastic Programming (c)

Invited session

Chair: Rüdiger Schultz, Mathematics, University of Duisburg-Essen, Lotharstr. 65, D-47048, Duisburg, Germany, schultz@math.uni-duisburg.de

1 - A Stochastic Shortest Path Approach for the Minefield Navigation Problem

Ruth Luscombe, Dept. of Mathematics and Statistics, University of Melbourne, Parkville, 3010, Melbourne, Victoria, Australia, r.luscombe@ms.unimelb.edu.au

The aim of this project is to develop a path planning assistance tool for making a safe transit of a marine minefield. The minefield is modelled as a cartesian region with suspected mine sites and the transiting vessel has the ability to classify true or false mines at some safe distance. The problem is formulated as a stochastic shortest path problem (SSPP) and is compared with existent SSPP models. The differences in the stochastic structure in these types of problems denies the development of a universal algorithm.

2 - Ambiguity in portfolio selection.

David Wozabal, ISDS, University of Vienna, Bruenner Str. 72, A-1210, Vienna, Austria, david.wozabal@univie.ac.at, Georg Pflug

We present a portfolio selection problem in the classical mean-risk setting where the investor is confronted with ambiguity in the model, that is some of the parameters are neither known precisely nor by a probabilistic model. The problem is formulated in a maximin setting and the solution is approximated by iteratively solving linear programs. The idea is to find a finite number of points that span the relevant parts of the uncertainty set. The results show the tradeoff between return, risk and robustness. As a consequence, a monetary value of information about the model can be determined.

3 - Sample average approximation methods for stochastic variational inequality problem and its applications to supply chain network equilibrium problem

Fanwen Meng, Mathematics, University of Southampton, Highfield, SO17 1BJ, Southampton, United Kingdom, fanwen.meng@gmail.com

In this paper, we study a class of stochastic variational inequality (SVI) problems and introduce sample average approximation (SAA) methods for solving this problem. We derive the exponential convergence of the stationary points of the SAA program as the sample size increases. As an application, we develop a SVI model for a supply chain network equilibrium problem consisting of manufacturers and retailers in which the demands are random. Finally, computational studies involving supply chain networks are presented to highlight the significance of the stochastic model and the SAA approach.

4 - Mean-Risk Stochastic Programs in Energy Systems with Dispersed Generation

Rüdiger Schultz, Mathematics, University of Duisburg-Essen, Lotharstr. 65, D-47048, Duisburg, Germany, schultz@math.uni-duisburg.de

We discuss models, algorithms, and structural investigations for optimization under uncertainty in energy systems with dispersed generation. Emphasis is placed on risk-neutral and risk-averse two-stage stochastic mixed-integer models. Algorithmically, approximation and decomposition are the crucial principles. Case studies from German utilities are presented.

■ WE-46

Wednesday, 16:00-17:30

FIN Endur Room 4

Real Options and Fuzzy Profitability Analysis Methods

Stream: Advanced Investment Analysis Models and Techniques

Invited session

Chair: Mikael Collan, Institute for Advanced Management Systems Research, Åbo Akademi University, Lemminkäisenkatu 14 B 6th floor, 20520, Turku, Finland, mcollan@abo.fi

1 - Management of Business Potential in R&D Project Portfolios

Markku Heikkilä, Institute for Advanced Management Systems Research, Åbo Akademi University, Lemminkäisenk. 14 - 18 B, 20520, Turku, Finland, maheikki@abo.fi

When reviewing industrial development projects R&D management needs to analyse both the operational performance of individual projects and the strategic performance of the total palette of developed projects. Especially, if the resource budgets are limited, the selection of new projects for development is an important management problem. Understanding projects as real options and the total palette of projects as a project portfolio extends the available decision support. This article presents a model for project selection and management and its application in a corporate setting.

2 - Using Real Options Approach in Strategic Management Context: Revolution or Fad?

Kalevi Kyläheiko, Dept. of Business Administration, Lappeenranta University of Technology, Box 20, 53851, Lappeenranta, Finland, kalevi.kylaheiko@lut.fi, Ari Jantunen, Jaana Sandström

In this paper we will look at the pros and cons of using the real options approach as a tool when dealing with some of the most important strategic management issues. In terms of some technology management illustrations we will emphasize some strategic advantages of the use of the real (or strategic) options approach when compared to traditional cash flow-based investment methods. On the other hand, there are also some pitfalls related to the uncritical valuation use of this approach, especially when strategic game-theoretic maneuvers of rivals drastically shape the strategic action space.

3 - FRIV - A Novel Fuzzy Approach to Valuing Large Industrial Investments

Mikael Collan, Institute for Advanced Management Systems Research, Åbo Akademi University, Lemminkäisenkatu 14 B 6th floor, 20520, Turku, Finland, mcollan@abo.fi

Very large industrial real investments are different from financial investments and from small real investments, even so, their profitability is commonly valued with the same methods. Defining characteristics for a group of very large industrial real investments are established. Based on the defined characteristics requirements arising from them for profitability analysis methods are discussed, and a new model that bases on the state of the art of profitability analysis models and uses fuzzy numbers is proposed.

■ WE-47

Wednesday, 16:00-17:30

FIN Endur Room 5

Securities Markets

Stream: Financial Modelling (c)

Invited session

Chair: *Kristján Jónasson*, Dept. of Computer Science, University of Iceland, Hjardarhaga 4, 107, Reykjavík, Iceland, jonasson@hi.is

1 - Croatian Capital Market Volatility

Snjezana Pivac, Faculty of Economics, University of Split, Department of Quantitative Methods in Economics, Matice hrvatske 31, 21000, Split, Croatia, spivac@efst.hr, *Elza Jurun, Josip Arneric*

Many financial time series contain volatility which is time-varying. The most common measure of volatility as dispersion in probability distribution is the standard deviation of a random variable. Total model parameters are estimated using GARCH(1,1) process. Static and dynamic forecasting of standard deviation is done in and out of time horizon. Under influence of new information and environment changes (political, economic, social...) volatility on the Croatian capital market is confirmed with high persistence and relatively weak reaction in comparison to more developed capital markets.

2 - Hedging Corporate Securities With Treasury And

Derivative Instruments

Vesna Bogojevic Arsic, management, Faculty of organizational sciences, Jove Ilica 154, 11000, Belgrade, Serbia and Montenegro, bogojevic@fon.bg.ac.yu

Corporate securities exhibit price volatility on a daily basis. Hedging strategies offer a mechanism to minimize the price volatility of corporate securities. The paper is point out at possibilities of hedging corporate securities using treasury securities, futures and/or interest rate swaps. Treasury securities are the most common hedge instruments but, futures and swaps may be more appropriate instruments for many hedging applications. The aim of this paper is to explain the mechanism of hedging strategies that are developed using the dollar-value-of-a-basis-point approach.

3 - Likelihood evaluation for VARMA models with missing values

Kristján Jónasson, Dept. of Computer Science, University of Iceland, Hjardarhaga 4, 107, Reykjavík, Iceland, jonasson@hi.is

A key aspect for parameter estimation of time series models is efficient evaluation of their likelihood functions. A few recently published algorithms deal with likelihood evaluation for VAR and VARMA models with complete data and univariate ARMA models with missing values, but none to our knowledge treat the general case of VARMA models with missing values. A method that fills this gap, including gradient evaluation, will be presented. The method allows for distributed lags and other types of parameter constraints. Numerical examples of actual parameter estimation will be described.

Adaptive Memory Programming (AMP)

Invited

Cesar Rego
University of Mississippi
crego@bus.olemiss.edu

Track(s): 8 21
3 sessions

Advanced Investment Analysis Models and Techniques

Invited

Mikael Collan
Åbo Akademi University
mcollan@abo.fi

Track(s): 46
1 session

Agent-Based Modeling Methods

Invited

Augusto Rupérez Micola
IMD International
Augusto.RuperezMicola@imd.ch

Track(s): 42
1 session

AI and Neural Networks

Invited

Renato De Leone
Università di Camerino
renato.deleone@unicam.it

Track(s): 37
3 sessions

Applied Probability

Invited

Ulrich Rieder
Universitaet Ulm
rieder@mathematik.uni-ulm.de

Nicole Baeuerle
University of Karlsruhe
baeuerle@stoch.uni-karlsruhe.de

Track(s): 46
5 sessions

Applied Probability/Forecasting (c)

Contributed

Ulrich Rieder
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rieder@mathematik.uni-ulm.de

Nicole Baeuerle
University of Karlsruhe
baeuerle@stoch.uni-karlsruhe.de

Track(s): 46
4 sessions

Approximation Algorithms

Invited

Klaus Jansen
Universität Kiel
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Magnus M. Halldorsson
University of Iceland
magnusmh@gmail.com

Track(s): 23
5 sessions

Auctions

Invited

Karla Hoffman
George Mason University
khoffman@gmu.edu

Track(s): 3
4 sessions

Behavioural and Experimental Economics

Invited

Bernd Brandl
University of Vienna
bernd.brandl@univie.ac.at

Stefan Pickl
Universität der Bundeswehr
München
stefan.pickl@unibw.de

Track(s): 41
4 sessions

Business and Industry OR - Special Track

Invited

Bjarni Kristjansson
Maximal Software, Inc.
bjarni@maximalsoftware.com

Josef Kallrath
BASF-AG
josef.kallrath@t-online.de

Jo van Nunen
RSM Erasmus University
jnunen@rsm.nl

Richard Rosenthal
Naval Postgraduate School
RRRosenthal@nps.edu

Robin Lougee-Heimer
IBM Research
robinlh@us.ibm.com

Track(s): 3
4 sessions

COIN-OR: Open Source Software

Invited

Jp Fasano
IBM Research
jpfasano@us.ibm.com

Robin Lougee-Heimer
IBM Research
robinlh@us.ibm.com

Bjarni Kristjansson
Maximal Software, Inc.
bjarni@maximalsoftware.com

Track(s): 1 27
4 sessions

Combinatorial Optimization

Invited

Silvano Martello
University of Bologna
smartello@deis.unibo.it

Track(s): 23 26
11 sessions

Combinatorial Optimization (c)

Contributed

Martin Zachariassen
University of Copenhagen
martinz@diku.dk

Silvano Martello
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smartello@deis.unibo.it

Marta Pascoal
Universidade de Coimbra,
INESC-Coimbra
marta@mat.uc.pt

Track(s): 23
4 sessions

Complex Societal Problems

Invited

Dorien DeTombe
Chair Euro Working Group
detombe@lri.jur.uva.nl

Track(s): 40
3 sessions

Computational Biology and Bioinformatics*Invited**Jacek Blazewicz*Politechnika Poznanska
jblazewicz@cs.put.poznan.pl*Metin Turkey*Koc University
mturkay@ku.edu.tr**Track(s): 9****4 sessions****Convex Optimization Methods***Invited**Marc Teboulle*Tel Aviv University
teboulle@math.tau.ac.il**Track(s): 32****6 sessions****Cutting and Packing***Invited**Jose Fernando Oliveira*Universidade do Porto
jfo@fe.up.pt**Track(s): 17****4 sessions****Data Mining***Invited**Jacob Kogan*UMBC
kogan@math.umbc.edu*Emilio Carrizosa*Universidad de Sevilla
emilio.carrizosa@gmail.com**Track(s): 9****6 sessions****DEA and Performance Measurement***Invited**Robert Dyson*University of Warwick
R.G.Dyson@warwick.ac.uk**Track(s): 38****5 sessions****DEA and Performance Measurement (c)***Contributed**Maurice Shutler*London School of Economics
maurice.shutler@tiscali.co.uk**Track(s): 38 39****6 sessions****Decision Support Systems***Invited**Pascale Zaraté*Institut de Recherche en
Informatique de Toulouse
zarate@irit.fr*Ulrike Leopold-Wildburger*Karl-Franzens-University
ulrike.leopold@uni-graz.at**Track(s): 39****7 sessions****Decisions for a Sustainable Built Environment***Invited**Patrizia Lombardi*Polytechnic of Turin
patrizia.lombardi@polito.it**Track(s): 39****1 session****Distributed Decision Making***Invited**Rudolf Vetschera*University of Vienna
rudolf.vetschera@univie.ac.at**Track(s): 34****4 sessions****Dynamic Programming***Invited**Moshe Sniedovich*University of Melbourne
m.sniedovich@ms.unimelb.edu.au**Track(s): 1 28****4 sessions****Dynamic Programming (c)***Contributed**Moshe Sniedovich*University of Melbourne
m.sniedovich@ms.unimelb.edu.au**Track(s): 28****2 sessions****Dynamical and Anticipatory Systems***Invited**Marat Akhmet*Middle East Technical University
marat@metu.edu.tr*Hakan Oktem*Middle East Technical University
hoktem@metu.edu.tr*Daniel M. Dubois*HEC Management School -
University of Liege
daniel.dubois@ulg.ac.be**Track(s): 8 21 24****14 sessions****EDDA - EURO Doctoral Dissertation Award***Invited**Jean-Pierre Brans*V.U.B.
jpbrans@vub.ac.be**Track(s): 20****1 session****Electricity Markets***Invited**Heinrich Stigler*Technische Universität Graz
Stigler@TUGraz.at*Eddie Anderson*University of New South Wales
eddiea@agsm.edu.au*Daniel Ralph*Cambridge University
d.ralph@jbs.cam.ac.uk**Track(s): 1 4****7 sessions****Energy/Electricity***Invited**Bjarni Kristjansson*Maximal Software, Inc.
bjarni@maximalsoftware.com**Track(s): 4****1 session****Environmental Planning***Invited**Costas Pappis*University of Piraeus
pappis@unipi.gr**Track(s): 40****2 sessions**

Environmental Planning (c)*Contributed***Track(s): 40****4 sessions****EWG Meetings***Invited*

Bjarni Kristjansson
Maximal Software, Inc.
bjarni@maximalsoftware.com

Gerhard-Wilhelm Weber
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gweber@metu.edu.tr

Tuula Kinnunen
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Snjolfur Olafsson
University of Iceland
snjolfur@hi.is

Track(s): 48 49**5 sessions****Excellence in Practice Award***Invited*

Gautam Mitra
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Track(s): 7**2 sessions****Financial Modelling***Invited*

Jaap Spronk
Erasmus University
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Track(s): 47**4 sessions****Financial Modelling (c)***Contributed*

Maurice Shutler
London School of Economics
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Track(s): 47**6 sessions****Generalized Newton Methods***Invited*

Liqun Qi
The City University of Hong Kong
maqilq@polyu.edu.hk

Track(s): 31**3 sessions****Global and Local Derivative Free Optimization***Invited*

Adil Bagirov
University of Ballarat
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Alexander Rubinov
University of Ballarat
a.rubinov@ballarat.edu.au

Track(s): 33**4 sessions****Global Optimization: Deterministic and Stochastic Methods***Invited*

Mirjam Duer
Darmstadt University of Technology
duer@mathematik.tu-darmstadt.de

Track(s): 29 31**11 sessions****Global Optimization: Software and Applications***Invited*

Janos D. Pinter
PCS Inc. Dalhousie University
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Track(s): 33**3 sessions****Graphs (c)***Contributed*

Martin Zachariassen
University of Copenhagen
martinz@diku.dk

Track(s): 27**1 session****Human Centered Processes***Invited*

Gilles Coppin
ENST Bretagne
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Philippe Lenca
GET/ENST de Bretagne
Philippe.Lenca@enst-bretagne.fr

Track(s): 41**3 sessions****Human Centered Processes (c)***Contributed*

Jean-Pierre Brans
V.U.B.
jpbrans@vub.ac.be

Track(s): 41**2 sessions****Industrial Application of Nonlinear Programming Algorithms***Invited*

Klaus Schittkowski
University of Bayreuth
klaus.schittkowski@uni-bayreuth.de

Track(s): 1 31**6 sessions****Linear Optimization***Invited*

Petra Huhn
Technical University Clausthal
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Theodore Trafalis
University of Oklahoma
ttrafalis@ou.edu

Track(s): 28**4 sessions****Linear Semi-Infinite Optimization***Invited*

Miguel Goberna
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Marco A. López-Cerdá
Alicante University
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Maxim Todorov
Universidad de las Americas
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Track(s): 30**5 sessions****Locational Analysis***Invited*

Frank Plastria
Vrije Universiteit Brussel
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Track(s): 18**9 sessions****Long Term Financial Decisions***Invited*

Thomas Burkhardt
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Track(s): 1 44**7 sessions**

Maritime Transportation*Invited*

Marielle Christiansen
Norwegian University of Science
and Technology
Marielle.Christiansen@iot.ntnu.no

Track(s): 13**6 sessions****Marketing (c)***Contributed***Track(s): 7****1 session****Mathematical Programming***Invited*

Raphael Hauser
Oxford University
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Mustafa C. Pinar
Bilkent University
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Sandor Zoltan Nemeth
The University of Birmingham
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Track(s): 25**9 sessions****Metaheuristics***Invited*

Marc Sevaux
University of South Brittany
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Kenneth Sörensen
University of Antwerp
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Track(s): 20**6 sessions****Metaheuristics (c)***Contributed*

Marino Widmer
Université de Fribourg
marino.widmer@unifr.ch

Martin Zachariasen
University of Copenhagen
martinz@diku.dk

Track(s): 20**2 sessions****Mining Applications***Invited*

Alexandra Newman
Colorado School of Mines
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Track(s): 5**1 session****Modeling Social Systems***Invited*

Markus Schwaninger
Universität St.Gallen
markus.schwaninger@unisg.ch

Track(s): 42**4 sessions****Modelling of Economies and Societies in Transition (c)***Contributed*

Gerhard-Wilhelm Weber
Middle East Technical University
gweber@metu.edu.tr

Track(s): 42**3 sessions****Models and Tools for Financial Planning***Invited*

Gautam Mitra
Brunel University
gautam.mitra@brunel.ac.uk

Track(s): 45**2 sessions****Models and Tools for Financial Planning (c)***Contributed***Track(s): 45****1 session****Multicriteria Decision Analysis***Invited*

Theodor Stewart
University of Cape Town
tjstew@stats.uct.ac.za

Valerie Belton
University of Strathclyde
val.belton@strath.ac.uk

Track(s): 36**6 sessions****Multicriteria Decision Analysis (c)***Contributed*

Jean-Pierre Brans
V.U.B.
jpbrans@vub.ac.be

Track(s): 36**2 sessions****Multiple Criteria Decision Aid (c)***Contributed*

Jean-Pierre Brans
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jpbrans@vub.ac.be

Track(s): 37**2 sessions****Multiple Criteria Decision Aiding***Invited*

José Rui Figueira
Technical University of Lisbon
figueira@ist.utl.pt

Track(s): 37**5 sessions****Multiple Objective Optimization***Invited*

Kathrin Klamroth
University of Erlangen-Nuremberg
klamroth@am.uni-erlangen.de

José Rui Figueira
Technical University of Lisbon
figueira@ist.utl.pt

Track(s): 1 22**9 sessions****Network Optimization***Invited*

Bernard Fortz
Université Catholique de Louvain
bfortz@euro-online.org

Track(s): 25**1 session****Nonlinear Semi-Infinite Optimization***Invited*

Oliver Stein
RWTH Aachen University
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Jan-J. Rückmann
Universidad de las Americas, Puebla
janj.ruckmann@udlap.mx

Track(s): 1 30**5 sessions****Operations Management / Revenue Management***Invited*

Armann Ingolfsson
University of Alberta
Armann.Ingolfsson@UAlberta.Ca

Ioana Popescu
INSEAD
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Track(s): 14**8 sessions**

Optimization in Financial Mathematics*Invited**Ralf Korn*University of Kaiserslautern
korn@mathematik.uni-kl.de*Mustafa C. Pinar*Bilkent University
mustafap@ie.bilkent.edu.tr**Track(s): 1 45****6 sessions****Optimization in Postal Logistics***Invited**Hans-Jürgen Sebastian*RWTH Aachen University
sebastian@or.rwth-aachen.de**Track(s): 1 6****5 sessions****OR - The Profession: 70th Anniversary***Invited**Jakob Krarup*University of Copenhagen
krarup@diku.dk*Jean-Pierre Brans*V.U.B.
jpbrans@vub.ac.be**Track(s): 10****3 sessions****OR - The Profession: Ethics in OR***Invited**Jean-Pierre Brans*V.U.B.
jpbrans@vub.ac.be**Track(s): 10****4 sessions****OR and Strategy***Invited**Maureen Meadows*The Open University
m.meadows@open.ac.uk**Track(s): 35****3 sessions****OR Education***Invited**Armann Ingolfsson*University of Alberta
Armann.Ingolfsson@UAlberta.Ca*Ioana Popescu*INSEAD
ioana.popescu@insead.edu**Track(s): 8****7 sessions****OR Education (c)***Contributed***Track(s): 8****1 session****OR in Agriculture and Forest Management***Invited**LluisM Pla*University of Lleida
lmp1a@matematica.udl.es*Manfred Gronalt*University of Natural Resources and
Applied Life Sciences

Manfred.Gronalt@boku.ac.at

Track(s): 5**6 sessions****OR in Agriculture and Forest Management (c)***Contributed**LluisM Pla*University of Lleida
lmp1a@matematica.udl.es**Track(s): 5****2 sessions****OR in Developing Countries***Invited**Fernando Crespo*

facrespo@puc.cl

*Eric Soubeiga*KPMG UK
eric.soubeiga@kpmg.co.uk*Sethuraman Janardhanan*IIM Calcutta
sethuraman@iimcal.ac.in*Leroy White*University of Bristol
leroy.white@bris.ac.uk**Track(s): 7****2 sessions****OR in Fisheries (c)***Contributed***Track(s): 7****1 session****OR in Health Care***Invited**Jan Vissers*Eindhoven University of Technology
j.m.h.vissers@tm.tue.nl*Sally Brailsford*University of Southampton
s.c.brailsford@soton.ac.uk**Track(s): 2****10 sessions****OR in Sports***Invited**Michael Trick*Carnegie Mellon University
trick@cmu.edu**Track(s): 7****3 sessions****OR in the Public Sector***Invited**Michael Pidd*Lancaster University
m.pidd@lancaster.ac.uk**Track(s): 6****5 sessions****Plenary Sessions***Invited**Tuula Kinnunen*

euro@tuulakinnunen.fi

*Snjolfur Olafsson*University of Iceland
snjolfur@hi.is**Track(s): 1****2 sessions****Poster - Discussion Presentations***Contributed**Valerie Belton*University of Strathclyde
val.belton@strath.ac.uk**Track(s): 50****7 sessions****Problem Structuring Methods / Soft OR***Invited**Sue Merchant*Blue Link Consulting
suemerchant@hotmail.com*L. Alberto Franco*University of Warwick
alberto.franco@warwick.ac.uk**Track(s): 35****6 sessions**

Production and Inventory (c)*Contributed***Track(s): 17****3 sessions****Project Management & Scheduling (c)***Contributed**Rainer Kolisch*

Technical University of Munich

rainer.kolisch@wi.tum.de

Track(s): 19**2 sessions****Project Management and Scheduling***Invited**Rainer Kolisch*

Technical University of Munich

rainer.kolisch@wi.tum.de

Track(s): 19**4 sessions****Quality Management (c)***Contributed***Track(s): 19****1 session****Queuing Theory with Applications***Invited**Douglas Down*

McMaster University

downd@mcmaster.ca

Sunil Kumar

Stanford University

skumar@stanford.edu

Track(s): 19**2 sessions****Queuing Theory/Stochastic Process (c)***Contributed***Track(s): 19****1 session****Realistic Production Scheduling***Invited**Ruben Ruiz*

Universidad Politecnica de Valencia

rruiz@eio.upv.es

Track(s): 14**2 sessions****Scheduling***Invited**Chris Potts*

University of Southampton

C.N.Potts@maths.soton.ac.uk

Track(s): 16 17**13 sessions****Semi-Plenary Sessions***Invited**Gerhard-Wilhelm Weber*

Middle East Technical University

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Tuula Kinnunen

euro@tuulakinnunen.fi

Track(s): 1 2 3 4 5**14 sessions****Semidefinite Programming***Invited**Miguel Anjos*

University of Waterloo

anjios@stanfordalumni.org

Miguel Anjos

University of Waterloo

anjios@stanfordalumni.org

Track(s): 32**3 sessions****Simulation (c)***Contributed**Marino Widmer*

Université de Fribourg

marino.widmer@unifr.ch

Track(s): 28**1 session****Software for OR/MS***Invited**Robert Fourer*

Northwestern University

4er@iems.northwestern.edu

Bjarni Kristjansson

Maximal Software, Inc.

bjarni@maximalsoftware.com

Track(s): 27**5 sessions****Stochastic Programming***Invited**Georg Pflug*

University of Vienna

georg.pflug@univie.ac.at

Alexander Shapiro

Georgia Institute of Technology

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Werner Römisch

Humboldt-Universität zu Berlin

romisch@mathematik.hu-berlin.de

Track(s): 43**9 sessions****Stochastic Programming (c)***Contributed***Track(s): 44****3 sessions****Supply Chain Management***Invited**Georgios Doukidis*

Athens University of Economics and

Business

gjd@aueb.gr

Track(s): 15**4 sessions****Supply Chain Management (c)***Contributed**Marino Widmer*

Université de Fribourg

marino.widmer@unifr.ch

Track(s): 15**5 sessions****Systems and Game Theory***Invited**Stefan Pickl*

Universität der Bundeswehr

München

stefan.pickl@unibw.de

Track(s): 34**6 sessions****Telecommunications (c)***Contributed**Martin Zachariasen*

University of Copenhagen

martinz@diku.dk

Track(s): 4**2 sessions**

Transportation*Invited**Maurizio Bielli*Institute of Systems Analysis and
Informatics

bielli@iasi.cnr.it

Track(s): 11 12**17 sessions****Transportation/Transport
Industry (c)***Contributed**Maurizio Bielli*Institute of Systems Analysis and
Informatics

bielli@iasi.cnr.it

Track(s): 12**2 sessions****Vector and Set-Valued
Optimization***Invited**Vicente Novo*Universidad Nacional de Educacion
a Distancia

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Track(s): 22**1 session****Vehicle Routing***Invited**Daniele Vigo*University of Bologna
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 Garloff, Juergen MD-29
 Gasimov, Rafail TA-33
 Gass, Saul WD-01
 Gassmann, Gus WB-44
 Gaston, Kevin TB-18
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 Gay, David M. TB-27
 Gaygisiz, Esma TD-04, WE-04, MA-45
 Gaytan, Juan TE-15
 Ge, Lan MD-05
 Ge, Liping TB-15
 Gehring, Hermann WB-17
 Geipele, Ineta TA-40
 Genoese, Massimo WA-42
 Gentile, Guido TD-12
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 Gerdts, Matthias MA-31
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 Ghosh, Moumita TE-33
 Giaglis, George ME-15
 Giesen, Gerard TD-05
 Gillenkirch, Robert TB-34
 Gimadi, Edward TE-23
 Glass, Celia TA-16
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 Glover, Fred MA-21, ME-21, TA-26
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 Goberna, Miguel MA-30, MD-30, ME-30, TA-30
 Godinho, Maria Teresa MD-10, TE-13
 Goffin, Jean-Louis TA-32
 Gökmen, Ali WB-40, TB-50
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 Golden, Bruce MA-10, TE-23
 Goldfarb, Donald TB-25
 Golenko-Ginzburg, Dimitri WB-19
 Gomes Junior, Silvio Figueiredo TD-07
 Gomes, A. Miguel TA-17
 Gomes, Alvaro MD-22
 Gomes, Carla P. MD-26
 Gomez Gonzalez, Daniel TA-36
 Gomez, Soraya TB-30
 Gomez-Sanchez, Miguel WA-45
 Gómez-Senent, Francisco J. TB-30
 Gonçalves, José Fernando TB-19
 Gondzio, Jacek MD-28
 Gonik, Aharon WA-16
 Gonzalez, Avelino TD-41
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| González-Pachón, Jacinto | TD-05 | Hahn, Heiko | TA-41 | Hirotsu, Nobuyoshi | TE-07 |
| Goossens, Dries | TA-03 | Hahn, Peter | WE-26 | Hirsch, Michael | MA-26 |
| Goovaerts, Marc | TB-46 | Haight, Daniel | ME-08 | Hirschhausen, Christian von | MA-25 |
| Göran, Anders | TB-31 | Haijema, René | MA-12 | Hisari, Yoshio | WE-11 |
| Gordillo, José | TD-09 | Hakanen, Jussi | TA-22 | Hizir, Ahmet Esat | MA-11 |
| Gori, Stefano | TE-11 | Hakkert, Shalom | TB-06 | Hjardar, Bjarni | MA-07, WE-08,
WA-18 |
| Goto, Hisanori | WA-04 | Hakonen, Henri | WB-37 | Hjortsø, Carsten Nico | TD-35 |
| Gould, Nicholas | MD-25 | Halabi, Ana | ME-08 | Hnich, Brahim | MA-04 |
| Gourdin, Eric | WE-25 | Halldorsson, Magnus M. | WB-23 | Hochbaum, Dorit | MC-04 |
| Gouveia, Luis | MD-10, ME-11,
TE-13, TE-17, WE-25 | Hallerbach, Winfried | MA-47 | Hochreiter, Ronald | MD-43, ME-43 |
| Govaert, Gerard | TE-09 | Halova, Jaroslava | TE-02 | Hoemberg, Dietmar | ME-31 |
| Grabisch, Michel | TB-36 | Hamadi, Youssef | TA-26 | Hoffman, Karla | TD-03 |
| Grainger, Daniel | MD-26 | Hammer, Peter L. | TB-10, WA-26 | Höhn, Andrea | WA-20 |
| Grant, Michael | ME-25, MD-32 | Hanafi, Said | MD-18 | Hohzaki, Ryusuke | TE-25 |
| Grappone, Arturo Graziano | TB-21 | Hans, Erwin W. | WB-02, WE-02 | Holmberg, Stig C | MD-24, ME-24,
TA-42 |
| Grau, Juan B | WB-47 | Hansen, Merete Stenner | MD-05 | Holmström, Kenneth | WA-29, TB-31,
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| Greco, Salvatore | WA-37, WE-37 | Hansmann, Karl-Werner | ME-40 | Holz, Franziska | MA-25 |
| Green, Colin | TB-02 | Harmse, Marthi | TA-15 | Homberger, Jörg | WB-17 |
| Green, Linda | ME-06 | Harnos, Zsolt | TD-46 | Homem-de-Mello, Tito | WB-43 |
| Greenberg, Doron | WB-19 | Harper, Paul | TA-07, TB-50 | Hong, Tzung-Pei | TD-16 |
| Greistorfer, Peter | MD-08, TB-20 | Harren, Rolf | WE-23 | Hong, Yushin | WA-15 |
| Grigoroudis, Evangelos | TA-37 | Hartl, Richard | TB-17, WB-17 | Honma, Yudai | WE-11 |
| Grippio, Luigi | TB-29, TE-29 | Hartman, Joseph | WA-28 | Hoos, Holger | TA-26 |
| Grolmusz, Vince | TA-09, MA-29 | Haruna, Ryo | TA-25 | Horn, Wayne | ME-14 |
| Gronalt, Manfred | MA-05 | Hasani Zonoozi, Mahboobeh | TB-37 | Hosoe, Nobuhiro | WB-34 |
| Grønhaug, Roar | MA-13 | Hasegawa, Toshiharu | TA-11, WE-11 | Howick, Susan | TE-40 |
| Grosset, Luca | WB-07 | Hasenjäger, Martina | TE-22 | Hsieh, Chung-Chi | TD-15 |
| Grötschel, Martin | MB-01 | Hasle, Geir | WB-06 | Hu, Xinmin | TA-04 |
| Grushka-Cockayne, Yael | TE-36 | Hassin, Refael | ME-23 | Huang, Hsiao-Lan | WA-17 |
| Gruszka, Iwona | TB-39 | Hasuike, Takashi | TA-25 | Huang, Pei-Ying | TD-16 |
| Grünert, Tore | TE-06 | Haugen, Øyvind | MA-13 | Huang, Sui | MA-28 |
| Guadix, José | TD-12, TD-24, TB-28,
WA-39 | Haumer, Peter | MD-45 | Huchzermeier, Arnd | TD-08, MD-15 |
| Guardiola Alcala, Luis Antonio | WE-34 | Hauser, Raphael | MD-28 | Hughes, Aidan | WB-39 |
| Guarino Lo Bianco, Corrado | WE-30 | Haydock, Michael | TD-03, TE-09 | Hughes, Georgie | TB-02 |
| Gudlaugsdóttir, Sigurbjörg | ME-29 | Hector, Donald | WB-40 | Hugot, Hadrien | WA-25 |
| Gudmundsson, Runolfur | MA-07 | Hector, Donald | WB-40 | Huirne, Ruud | MD-05, TD-05 |
| Guenduez, Halil Ibrahim | WE-06 | Heidenberger, Kurt | ME-41 | Hujala, Teppo | TE-05 |
| Guerassimoff, Gilles | TE-04 | Heikkilä, Markku | WE-46 | Hung, Yi-Ting | MD-18 |
| Guessow, Jens | MA-43 | Heil, Robert | WB-02, TA-19 | Hunka, Frantisek | TA-24 |
| Gugat, Martin | ME-31 | Heilala, Juhani | TD-15 | Hurink, Johann | WE-02, ME-16 |
| Guignard-Spielberg, Monique | WE-26 | Helleberg Lund, Erik | MA-13 | Hutter, Frank | TA-26 |
| Guillén Solorzano, Eduardo | WE-17,
WA-19 | Hellman, Fredrik | WA-29 | Huygens, David | MA-20 |
| Guillén, Servio Tulio | TA-07, TE-18 | Henderson, Shane | MD-14, TA-14 | Hübner, Georges | TB-26 |
| Guitouni, Adel | WE-37 | Hendriks, Theo H.B. | ME-39 | Håkansson, Anita | ME-42 |
| Gunel, Gokce | MA-41 | Hennig, Frank | ME-13 | | |
| Gunn, Eldon | MA-07 | Hentous, Hamid | TD-16 | I | |
| Gunnarsson, Helene | MA-05 | Hentschke, Paul | TA-16 | Iannoni, Ana | MA-02 |
| Gurkan, Gul | TA-11 | Herbots, Jade | TA-19 | Ianovsky, Eduard | MA-19 |
| Guschinsky, Nikolai | WE-16 | Hermanns, Christoph | TD-06 | Iaquinta, Gaetano | TE-47 |
| Gustafson, Sven-Ake | ME-30 | Hermans, Carolyn | TB-37 | Ibáñez, J. Nicolás | TD-12, TD-24,
TB-28, WA-39 |
| Gutierrez Franco, Edgar | TA-05 | Hermawan, Pri | ME-35 | Ibáñez, Javier | TB-05 |
| Gutiérrez, César | MA-22 | Hernández R., José G. | TB-50 | Ibaraki, Toshihide | TB-26 |
| Gutjahr, Walter | WB-17, MD-22,
MD-41 | Hernández, Elvira | MA-22 | Illes, Tibor | MA-28 |
| Günther, Maik | WA-20 | Hernandez-Rebollar, Lidia-Aurora | ME-30 | Imamichi, Takashi | TB-26 |
| Günther, Markus | MD-22, ME-41 | Herrmann, Sascha | WB-16 | Improta, Gennaro | ME-11 |
| | | Herrmann, Thomas M. | TD-11 | Ingolfsson, Armann | TB-08, TA-14 |
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| Hadad, Yossi | WE-39 | Hétreux, Gilles | ME-39 | Inui, Koji | TD-47 |
| Haeringer, Guillaume | TE-25 | Heyde, Frank | WB-22 | Ioannou, George | MA-15, ME-15 |
| | | Heyerdahl, Reidunn Døving | ME-41 | Iori, Manuel | TB-17, MA-20, WB-26 |
| | | Hightower, William | WE-26 | Irnich, Stefan | WA-01, WB-06 |
| | | Hilli, Petri | MD-43 | | |
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| | | Hinojosa, Miguel A. | TE-25 | | |
| | | Hinz, Juri | TD-04 | | |

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| Isaac, Akkanad | TD-39 | Kao, Cheng-Yan | TD-16 | Körnert, Jan | TB-44 |
| Isac, George | MA-25 | Kapelko, Magdalena | WB-38 | Korsvik, Jarl Eirik | MD-13 |
| Ishii, Hiroaki | WE-08, WB-18, TA-25 | Kaplanoglu, H. Dilek | WA-36 | Kortsarz, Guy | ME-23 |
| Ishii, Yasuhiro | WE-11 | Karaesmen, Fikri | ME-14, TD-15 | Korukonda, Appa Rao | MD-03 |
| Ishii, Yukako | WE-08 | Karagiannaki, Aggeliki | ME-15 | Kosslers, Björn | MA-34 |
| Ittmann, Hans.W. | TA-07 | Karali, Nihan | ME-40 | Kostoglou, Vassilis | WB-41 |
| Iusem, Alfredo | WA-31, TD-32 | Karasmaa, Nina | TA-40 | Kostyukova, Olga | MD-30, ME-30 |
| Ivorra, Carlos | WB-18 | Karasozen, Bulent | TE-33 | Kotowski, Jerzy | WA-24 |
| Iwamoto, Seiichi | TE-28 | Karlsson, Ragnar | WB-23 | Kotsialos, Apostolos | WA-11 |
| Iyengar, Garud | TB-25, ME-43 | Karpinski, Marek | WB-23 | Kotze, Lynette | TA-12 |
| Iyer, Ananth | MD-15 | Kascelan, Ljiljana | TB-47 | Kourbanova, Evelina | ME-04 |
| Izquierdo, Josep M | MD-34 | Kascelan, Vladimir | TE-42 | Kovacevic, Raimund | MD-45 |
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| J. W. James, Ross | TB-20 | Kasprzak, Marta | MD-09 | Kovacevic-Vujcic, Vera | TE-20 |
| Jabeur, Khaled | WE-37 | Katsaliaki, Korina | MD-02 | Krabbe, Jon | TA-10 |
| Jablonski, Bartosz | WB-24 | Katsurayama, Daniel | TD-17 | Kraft, Holger | TD-45 |
| Jablonsky, Josef | WA-38 | Kawano, Hiroyuki | WE-11 | Krajewska, Marta Anna | TE-06, TA-12 |
| Jalonen, Erkkka | TE-37 | Kaynar, Bahar | TB-45 | Krarup, Jakob | TA-10 |
| James, Tabitha | MA-21, TA-26 | Kazakov, Vladimir | WE-04 | Krasnogor, Natalio | ME-09 |
| Jankovic, Marija | TA-39 | Kelley, Lawrence | MD-09 | Kreimer, Joseph | MA-19 |
| Janovjak, Matej | MA-42 | Kempener, Ruud | WA-42 | Kremer, Mirko | TD-34 |
| Jansen, Klaus | MD-23, WE-23 | Kettunen, Janne | MA-47 | Kress, Moshe | TA-02 |
| Janssen, Ron | TD-36 | Kijima, Kyoichi | WE-34, ME-35 | Krislock, Nathan | TA-32 |
| Jantunen, Ari | WE-46 | Kijima, Masaaki | TD-47 | Kristensen, Anders | MD-05, WB-28 |
| Jaramillo, Gloria Patricia | MA-40 | Kilgour, Marc | ME-35 | Kristinsdottir, Birna | MB-01 |
| Jarboui, Slaheddine | MD-18 | Kindler, Eugene | TA-24 | Kristjansson, Bjarni | TD-03, TA-27, TE-27 |
| Jaroszewski, Marcin | MD-09 | King, Alan | TD-01, WA-27 | Kristoffersen, Trine Krogh | MA-43 |
| Jaskiewicz, Anna | WA-46 | Kinnunen, Tuula | MB-01, WD-01 | Krivy, Ivan | TA-24 |
| Jean-Pierre, Le Cadre | WA-20 | Kinoshita, Eizo | WE-39 | Krokhmal, Pavlo | WB-45 |
| Jensson, Pall | MA-07, WB-16, TE-17 | Kioses, Lefteris | ME-15 | Kronek, Louis-Philippe | MA-09 |
| Jere-Lazanski, Tadeja | TD-24 | Kirkbride, Christopher | WA-46 | Krug, Heike | TE-16 |
| Jiang, Houyuan | TB-14 | Kis, Tibor | MA-41, TB-42 | Kruger, Alexander | TB-33 |
| Jimenez, Bienvenido | MA-22 | Kise, Hiroshi | WE-17 | Kruk, Serge | TA-32 |
| Johnsen, Trond A. V. | TA-13 | Klamroth, Kathrin | TB-02, TE-18, TB-22 | Kryder, Chris | ME-02 |
| Johnson, Neil | ME-42 | Klein Haneveld, Wim | WB-13 | Kråkenes, Tony | MD-35 |
| Jónasson, Kristján | WE-47 | Klempous, Ryszard | WA-24, WB-24 | Kubiak, Wieslaw | TE-26 |
| Jongen, Hubertus Th. | TE-01 | Klijn, Flip | TE-25 | Kumar, Satyendra | TD-15 |
| Jorge, Alípio | WE-11 | Kljajic, Mirosljub | TB-24 | Kumar, Sunil | MD-19 |
| Jornet, Valentín | MD-30 | Klopfenstein, Olivier | WE-25 | Kumbaroglu, Gürkan | ME-40 |
| Joro, Tarja | TA-14 | Kloster, Oddvar | WB-06, MD-13, TD-26 | Kumiega, Andrew | WB-19 |
| José, Antomil | MA-47 | Knight, Peter | MD-02 | Kunsch, Pierre | WA-10, MD-36, TB-44 |
| Jovanovic, Miomir | WA-05 | Ko, Hong Seung | MA-04 | Kuper, Gerard | TD-07 |
| Juan, Angel A. | TB-28 | Kocabiyikoglu, Ayse | TB-14 | Kurita, Osamu | WE-11 |
| Judice, Joaquim | TD-29, MD-33 | Koch, Othmar | TD-21 | Kuzmina, Lyudmila | TA-24 |
| Jungwattanakit, Jitti | TD-16 | Kochenberger, Gary | TA-26 | Kwon, Roy | ME-03 |
| Junka, Teuvo | WE-38 | Kochetov, Yuri | ME-20 | Kyläheiko, Kalevi | WE-46 |
| Jurun, Elza | WB-47, WE-47 | Kocvara, Michal | TA-31, WB-32 | Kyriazopoulos, Panagiotis | TA-37 |
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| Kaandorp, Guido | TD-02 | Koenigsberg, Oded | WB-34 | Kyung Bok, Yoon | TE-46 |
| Kabak, Özgür | ME-37, TE-41 | Kofja, Davorin | TB-24 | L | |
| Kajendran, Thusinthan | MA-34 | Koga, Yuichi | TB-26 | L'Écuyer, Pierre | ME-14, WB-43 |
| Kalagnanam, Jayant | MA-03 | Kogan, Jacob | TE-09 | Labbé, Martine | MA-18 |
| Kalic, Milica | WB-12 | Kogetsidis, Harrys | MA-15 | Labeled, Abdenour | TD-16 |
| Kalika, Marek | TD-50 | Koios, Kiros | TB-50 | Lackner, Andreas | WB-13, WA-20 |
| Kalikova, Jana | TD-50 | Koivu, Matti | TB-43 | Lacomme, Philippe | TB-12 |
| Kallehauge, Brian | ME-13, WE-13 | Kojadinovic, Ivan | TB-36 | Ladanyi, Laszlo | TE-27 |
| Kaminski, Kathryn | TD-44 | Kokkinaki, Angelika | MA-15 | Lagoa, Constantino | ME-43 |
| Kampas, Frank | MA-33 | Kolesar, Peter | TB-40 | Lahdelma, Risto | WB-37 |
| Kan, Wing Hong | MD-14 | Kolisch, Rainer | WB-02, TA-19 | Lamboray, Claude | TD-50 |
| Kane, Michael | ME-02 | Kommer, Geert-Jan | TA-02 | Lambrechts, Olivier | TE-19 |
| Kane, Stephen | TE-47 | Konno, Naoki | WE-34 | Lambrou, Maria | TB-13 |
| Kangas, Annika | ME-05 | Konnov, Igor | ME-04 | Lammoglia, Nelson | ME-42 |
| Kangas, Jyrki | MA-05, ME-05 | Koole, Ger | TD-02 | Lancia, Giuseppe | TA-09 |
| Kankova, Vlasta | TD-43 | Kopfer, Herbert | TE-06, TA-12 | Landa Silva, Dario | MD-20 |
| | | Koprivnjak, Olivera | TE-05 | | |
| | | Korn, Ralf | ME-01 | | |

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Lardeux, Benoit	MD-04	Lohmander, Peter	ME-05	Marchiori, Elena	MD-14
Lari, Isabella	ME-18	Lohscheller, Jörg	TB-02	Marchitto, Emilia	MD-20
Larrañaga, Pedro	WB-09	Loiseau, Irene	TB-11	Mardle, Simon	TD-05
Larsen, Jesper	MA-16	Lok, Reinder B.	MA-03	Maréchal, Pierre	ME-32
Lasdon, Leon	MA-21, ME-33	Lokketangen, Arne	MD-10, TB-20	Mareschal, Bertrand	MD-36, ME-36
Lassudrie, Claire	TB-41	Lombardi, Patrizia	MD-39	Margeirsson, Sveinn	MA-07
Laturi, Jani	ME-05	Lopes, Rui Borges	MD-18, TD-50	Margonis, Ioannis	WA-11
Laukkanen, Sanna	ME-05	López-Cerdá, Marco A.	MA-30,	Margono, Edric	TE-15
Lauro Facó', Joao	TD-50		TA-30	Mariano, Jimenez-Lopez	MA-47
Lazzari, Cinzia	TB-09	Lorenz, Mathias	TD-34	Marichal, Jean-Luc	TD-50
Le Cun, Bertrand	WE-26	Losievskaja, Elena	WB-23	Marín, Alfredo	MA-18, WB-26
Le Gallic, Bertrand	TD-05	Lougee-Heimer, Robin	TD-01,	Marín, Ángel	TE-12
Le Menestrel, Marc	TE-10		TE-27, WB-27	Marinelli, Fabrizio	TD-17
Leahu, Lucian	MD-26	Loukil, Zied	TE-39	Marins, Fernando	WB-15
Leal, Rogério	WA-25	Lourenço, Helena	Ramalhinho	Mármol, Amparo	TE-25
Lee, Gregory	TA-07		TB-20	Maros, Istvan	MD-28
Leggieri, Valeria	TB-23	Louta, Malamati	MD-37	Maroto, Concepcion	TB-19
Legna, Carlos	TB-24	Lozano, Sebastián	MA-40, ME-40	Marques, Inês	TA-23
Leleur, Steen	TB-39	Lozovanu, Dmitrii	WB-34	Marques, Joan Manuel	TB-28
Lemaire, Pierre	MA-09	Lucas, Cormac	TB-43	Marques, Rui	TA-06
Lemalade, Jean-Luc	TB-05	Lucidi, Stefano	MA-29, WB-31	Marquis, Pierre	TE-39
LeMoing, Monique	TD-38	Lucietti, Luca	TD-12	Martein, Laura	TB-25
Lemonidis, Panayiotis	WA-30	Lukac, Zrinka	ME-20	Martello, Silvano	MD-26, WB-26
Lenca, Philippe	TB-41, TE-41	Lundy, Patrick	ME-02	Martens, David	MA-37, ME-37,
Leopold-Wildburger, Ulrike	TA-41	Luo, Zhi-Quan	TB-29		WB-47
Lera-Lopez, Fernando	ME-12	Luque, Mariano	TA-22, TD-22	Martin, Kipp	WA-27, WB-44
Leskelä, Riikka-Leena	TA-03	Lusa, Amaia	WB-44	Martin-Barragan, Belen	WB-09
Leskinen, Pekka	TE-05	Lusby, Richard	MA-16	Martin-Clouaire, Roger	TA-05
Leslie, Nichola	TB-38	Luscombe, Ruth	WE-44	Martinez Cirre, Cristina	Rogelia
Lessmann, Stefan	TB-09	Lust, Thibaut	ME-22		WB-24
Letchford, Adam	MD-26, ME-26,	Luz, Carlos	TB-32	Martinez de Albeniz, Javier	WA-34
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Letmathe, Peter	TB-40	Lyridis, Dimitrios	TB-13	Martinez, Manuel	WE-17, WA-19
Leugering, Günter	TB-02, MA-31	Lysgaard, Jens	MD-13, TD-26	Martinez, Mario Ernesto	TA-05
Leung, Janny	MA-16	Lüthi, Hans-Jakob	TD-04	Martins, António	MD-22
Leus, Roel	TA-19	Lyumkis, Victor	WB-44	Martins, Isabel	TE-05
Levin, Genrikh	WE-16			Mascia, Antonio	ME-24
Levin, Yuri	TB-14			Mason, Andrew J	TA-14
Lewis, Mark	ME-19			Mason, Licister	TB-31, MA-33,
Leyton-Brown, Kevin	TA-26				TE-33
Li, Jian	MA-32	Ma, Jun	WA-27, WB-44	Massimo, Marciani	TD-12
Liberti, Leo	ME-25	Macharis, Cathy	WA-10	Massmann, Matthias	WB-18
Liern, Vicente	WB-18, WA-41	MacLean, Leonard	TA-01, TE-43	Matarazzo, Benedetto	WA-37
Lijun, Li	MA-34	Macq, Jean-François	ME-14	Mateo, Manuel	MD-16
Lin, Bertrand	WA-17	Madas, Michael	TE-12	Mateus, Geraldo	WA-25
Lin, Hui-Shin	TE-02	Maenhout, Broos	WA-02	Matos, Ana	WE-17
Lin, Ka Yuk Carrie	WE-13	Maggioni, Francesca	TD-43	Matos, Manuel	WA-25
Lin, Sheldon	MD-46	Magnanti, Thomas	MD-10, TE-13	Mattia, Sara	WE-04
Linares Fleites, Gladys	WA-45	Mahjoub, Ali Ridha	WE-25	Mavrellis, Achilleas	TA-40
Listes, Ovidiu	TA-11, TD-27	Mahoney, Michael	WE-09	Mawhin, Jean	TE-21
Little, James	TD-02, TB-03	Maimon, Oded	ME-37	Mayer, Barbara	MD-41
Liu, Wenbin	MD-38	Maiza, Mohamed	TD-16	Mayoral, Silvia	TD-47
Liu, Zugang	TE-24	Maïzi, Nadia	ME-04, TE-04	Mazauric, Vincent	ME-04
Liuzzi, Giampaolo	MA-29, WB-31	Makkonen, Simo	WB-37	Mbangala, Mapapa	TA-21
Ljubic, Ivana	MD-04	Malaguti, Enrico	MA-26	McCollum, Barry	TE-16
Llerena, Francesc	MD-34, WA-34	Malerud, Stein	MD-35	McComb, Sara	WA-41
Llewellyn, Donna	WB-08	Malvisi, Lucia	WE-08	McGill, Jeffrey	TB-14
Llorca, Natividad	MA-30	Mammadov, Musa	TB-33	McGreevy, Mark	TE-16
Lo, Andrew	TD-44	Mamon, Rogemar	WA-45	McKay, Melissa	MA-33
Lobe, Sebastian	ME-44	Mandal, Abhijit	TE-35	McNickle, Don	WA-04
Locatelli, Marco	TD-29, WB-29,	Manger, Robert	TD-23, WE-27	Meadows, Maureen	TE-35, WA-35
	WE-29	Mannino, Carlo	ME-07	Meca, Ana	WE-34
Lodi, Andrea	MD-26	Mar, Arenas Parra	MA-47	Mehnen, Jörn	MA-34
Loeber, Gerrit	TD-38	Maravalle, Maurizio	WA-09	Melian Batista, Belen	TD-09, TA-20
		Marc, Almiñana	TE-13		
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Paías, Ana MD-10, WE-25
Palagi, Laura TB-29, TE-29
Pallaschke, Diethard TD-33
Pallis, Athanasios TB-13
Pan, Feng MD-07
Pandey, Rudra ME-02
Pankova, Vaclava TD-42
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Papadaki, Katerina TE-16, WE-28
Papageorgiou, Lazaros TD-31
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- Multiple Objective Optimization
- Industrial Application of Nonlinear Programming Algorithms
- Optimization in Financial Mathematics
- Long Term Financial Decisions
- Dynamic Programming
- COIN-OR: Open Source Software
- Nonlinear Semi-Infinite Optimization
- Optimization in Postal Logistics
- Electricity Markets

Track 2 - APP Askja N-131

- OR in Health Care

Track 3 - APP Askja N-130

- Auctions
- Business and Industry OR - Special Track

Track 4 - APP Askja N-129

- Telecommunications (c)
- Energy/Electricity
- Electricity Markets

Track 5 - APP Askja N-128

- OR in Agriculture and Forest Management
- OR in Agriculture and Forest Management (c)
- Mining Applications

Track 6 - APP Askja N-121

- OR in the Public Sector
- Optimization in Postal Logistics

Track 7 - APP Askja N-120

- OR in Fisheries (c)
- Excellence in Practice Award
- OR in Developing Countries
- OR in Sports
- Marketing (c)

Track 8 - EDU Oddi 101

- Dynamical and Anticipatory Systems
- Adaptive Memory Programming (AMP)
- OR Education
- OR Education (c)

Track 9 - IT Oddi 106

- Computational Biology and Bioinformatics
- Data Mining

Track 10 - OR Oddi 201

- Vehicle Routing
- OR - The Profession: 70th Anniversary
- OR - The Profession: Ethics in OR

Track 11 - TRANS Oddi 202

- Transportation

Track 12 - TRANS Oddi 205

- Transportation
- Transportation/Transport Industry (c)

Track 13 - TRANS Oddi 206

- Maritime Transportation
- Vehicle Routing
- Vehicle Routing (c)

Track 14 - PROD Arnag 101

- Operations Management / Revenue Management
- Realistic Production Scheduling

Track 15 - PROD Arnag 201

- Supply Chain Management
- Supply Chain Management (c)

Track 16 - PROD Arnag 301

- Scheduling

Track 17 - PROD Arnag 303

- Production and Inventory (c)
- Cutting and Packing
- Scheduling

Track 18 - PROD Arnag 304

- Locational Analysis

Track 19 - PROD Arnag 311

- Queuing Theory/Stochastic Process (c)
- Queuing Theory with Applications
- Project Management and Scheduling
- Project Management Scheduling (c)
- Quality Management (c)

Track 20 - HEUR Arnag 422

- EDDA - EURO Doctoral Dissertation Award
- Metaheuristics
- Metaheuristics (c)

Track 21 - HEUR Arnag 423

- Adaptive Memory Programming (AMP)
- Dynamical and Anticipatory Systems

Track 22 - OPT Adal 050

- Vector and Set-Valued Optimization
- Multiple Objective Optimization

Track 23 - OPT Adal 051

- Combinatorial Optimization
- Combinatorial Optimization (c)
- Approximation Algorithms

Track 24 - OPT Adal 052

- Dynamical and Anticipatory Systems

Track 25 - OPT Adal I-111

- Mathematical Programming
- Network Optimization

Track 26 - OPT Adal III=231

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Track 27 - OPT Adal V=229

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- COIN-OR: Open Source Software
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Track 28 - OPT Adal VI=207

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Track 29 - OPT Adal VII=225

- Global Optimization: Deterministic and Stochastic Methods

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Track 33 - NONL Adal A=313

- Global Optimization: Software and Applications
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Track 34 - DEC VR II V-138

- Systems and Game Theory
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Track 35 - DEC VR II V-147

- Problem Structuring Methods / Soft OR
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Track 36 - DEC VR II V-155

- Multicriteria Decision Analysis
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Track 37 - DEC VR II V-156

- AI and Neural Networks
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- Multiple Criteria Decision Aiding

Track 38 - DEC VR II V-157

- DEA and Performance Measurement
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Track 39 - DEC VR II V-158

- Decisions for a Sustainable Built Environment
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Track 40 - SOC VR II V-257

- Environmental Planning
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Track 41 - SOC VR II V-258

- Behavioural and Experimental Economics
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Track 42 - SOC VR II V-261

- Modeling Social Systems
- Modelling of Economies and Societies in Transition (c)
- Agent-Based Modeling Methods

Track 43 - FIN Endur Room 1

- Stochastic Programming

Track 44 - FIN Endur Room 2

- Long Term Financial Decisions
- Stochastic Programming (c)

Track 45 - FIN Endur Room 3

- Optimization in Financial Mathematics
- Models and Tools for Financial Planning (c)
- Models and Tools for Financial Planning

Track 46 - FIN Endur Room 4

- Applied Probability
- Applied Probability/Forecasting (c)
- Advanced Investment Analysis Models and Techniques

Track 47 - FIN Endur Room 5

- Financial Modelling
- Financial Modelling (c)

Track 48 - EWG Logberg 102

- EWG Meetings

Track 49 - EWG Logberg 103

- EWG Meetings

Track 50 - DISCUSS Adal 1

- Poster - Discussion Presentations