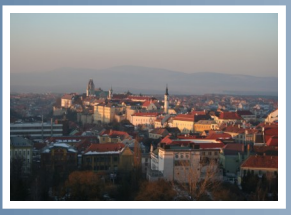

VOCAL 2012

PROGRAM and ABSTRACTS

VOCAL 2012

Program and Abstracts

Sponsors

Faculty of Information Technology, University of Pannonia,
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Faculty of Information Technology, University of Pannonia
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Conference Patron

Ferenc Friedler, Rector of the University of Pannonia, Hungary

Contents

VOCAL 2012

The 5th Veszprém Optimization Conference: Advanced Algorithms is held at the Conference Centre of the University of Pannonia in Veszprém, Hungary, December 11-14, 2012.

Conference scope

The VOCAL conference focuses on recent advances on optimization algorithms: continuous and discrete; complexity and convergence properties, high performance optimization software and novel applications are reviewed as well. We aim to bring together researchers from both the theoretical and applied communities in the framework of a medium-scale event.

Plenary Invited Speakers

Georg Pflug

Department of Statistics and Decision Support Systems, University of Vienna, Austria

Time Consistency in Dynamic Stochastic Optimization

A fundamental principle for dynamic optimization is Bellman's principle, stating that at any initially optimal decision sequence is also optimal at later stages. This time-consistency principle is still valid for stochastic programs if the criterion is to minimize expected costs or to maximize expected profits. However, as simple examples show,

it is not longer valid, if risk-sensitive criteria are chosen such as the optimization of the average value at risk. It turns out that most risk functionals are time inconsistent, e.g., it may happen that today some loss distribution appears to be less risky than another, but looking at the conditional distribution at a later time, the opposite relation holds. We demonstrate that this time inconsistency disappears if the conditional functionals are defined in an extended manner, i.e., are evaluated under a specific change of measure. It follows from our results that, for consistency reasons, the revelation of partial information in time must dramatically change a decision maker's preferences among the remaining courses of action to keep time consistency. We extend conditional risk functionals to allow a temporal decomposition of the initial risk functional in time consistent way. With this extension, a Bellmann principle may be proved. Counterexamples show that without change of measures the only time consistent risk functionals are the expectation and the essential supremum.

Andrea Lodi

DEIS, Department of Electronics, Computer Sciences and Systems, University of Bologna, Italy

MIP Computation and Beyond

The first 50 years of Integer and Mixed-Integer Programming have taken us to a very stable paradigm for solving problems in a reliable and effective way. We run over these 50 exciting years by showing some crucial milestones and we highlight the building blocks that are making nowadays solvers effective from both a performance and an application viewpoint. Finally, we show that a lot of work must still be done for improving the solvers and extending their modeling capability.

Urmila Diwekar

Center for Uncertain Systems: Tools for Optimization and Management, Vishwamitra Research Institute, USA

Role of Optimization in Green Engineering and Sustainability

Green engineering involves green processes, clean products, green energy, and ecofriendly management. Green engineering also involves starting decisions as early as material selection stage on one end, and managing and planning decisions at the other end. However, uncertainties and multiple and conflicting objectives are inherent in such a design process. This leads to multi-objective optimization problems in the face of uncertainties. Specialized algorithms and Number of case studies of green design and green energy will be presented. In industrial ecology, this decision making changes from the small scale of a single unit operation or industrial production plant to the larger scales of an integrated industrial park, community, firm or sector. Then the available management options expand from simple changes in process operation and inputs to more complex resource management strategies, including integrated waste recycling and reuse options. Uncertainties increase further in industrial ecology. Decision making becomes complex in this setting and optimization methods become a necessity. The concept of overall sustainability goes beyond industrial ecology and brings in

time dependent nature of the ecosystem and multi-disciplinary decision making. Optimal control methods and theories from financial literature can be useful in handling the time dependent uncertainties in this problem. Decision making at various stages starting from green design, green energy, to industrial ecology, and sustainability is illustrated for the mercury cycling. Power plant sector is a major source of mercury pollution. In order to circumvent the persistent, bioaccumulative effect of mercury, one has to take decisions at various levels of the cycle starting with greener power systems, industrial symbiosis through trading, and controlling the toxic methyl mercury formation in water bodies and accumulation in aquatic biota.

Plenary Tutorial Speakers

Horand Gassmann

School of Business Administration, Dalhousie University, Halifax, Canada

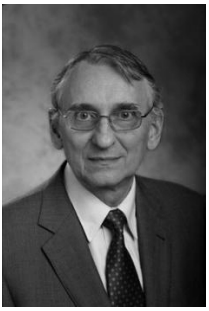
Open-source Software for Optimization: COIN-OR

Open-source optimization software has in recent years developed into a credible alternative to commercial solvers. The main advantages include price and availability of the source, both of which are particularly attractive in an academic setting.

One of the largest repositories of such software is the COIN-OR initiative, which features several dozen solvers for a wide range of problem classes as well as many other infrastructure-related low-level projects. I will describe the general philosophy of COIN-OR, briefly look at some of the solvers, and will describe in some more detail the Optimization Solver software, which acts as a web-aware framework to connect solvers to algebraic modelling language and to facilitate distributed computing.

István Maros

Department of Computer Science, University of Pannonia, Hungary



Linear Optimization: Algorithms and Their Implementations

Implementation of linear optimization methods capable of solving large scale problems is a very complex activity. It requires a deep knowledge of the underlying mathematical algorithms, techniques of computer science and software engineering. Some knowledge of computer architectures is also important. In the tutorial a framework is outlined and examples of selected algorithms, algorithmic procedures and techniques that proved to be efficient in practice are shown in some detail.

Technical Program

December 11, 2012 (Tuesday)

10:00 am – 8:00 pm **Registration Office Open**

2:00 am – 3:00 pm **Plenary Tutorial Session 1**

Open-source Software for Optimization: COIN-OR
Horand Gassmann

3:15 am – 4:15 pm **Plenary Tutorial Session 2**

Linear Optimization: Algorithms and Their Implementations
István Maros

4:30 am – 5:30 pm **Tutorial Session 3**

Constructing and Analyzing MILP Models by IBM ILOG CPLEX Optimization Studio Free Academic Research Edition
Zoltán Süle

December 12, 2012 (Wednesday)

7:00 am – 6:00 pm **Registration Office Open**

9:00 am – 9:30 am **Opening ceremony**

9:30 am – 10:30 am **Plenary Session 1**

Time Consistency in Dynamic Stochastic Optimization
Georg Pflug

10:30 am – 11:00 am **Coffee break**

11:00 am – 12:30 pm **Invited Parallel Session 1A**

Sensitivity Analysis in Multistage Stochastic Optimization Problems Under Model Ambiguity
Bita Analui

Pricing Energy Swing Options via Stochastic Bilevel Programs
Peter Gross, Raimund Kovacevic, Georg Pflug

Estimation, Simulation and Tree Construction for Midterm Power Production Planning
Raimund Kovacevic

11:00 am – 12:30 pm **Parallel Session 1B**

A Method to Approximate the Whole Pareto-optimal Set of Linearly Constrained Convex Multi Objective Optimization Problem
Gábor Lovics, Tibor Illés

An Optimization-based Reconstruction Algorithm for Multivalued Discrete Tomography
László Varga, Péter Balázs, Antal Nagy

Multi-objective PID Controller (2DOF) Tuning for Integral and Time Delay Plants
Radomil Matousek, Stanislav Lang, Petr Minar, Ivan Svarc

12:30 am – 2:00 pm **Lunch**

2:00 pm – 4:00 pm **Parallel Session 2A**

Solving Binary Tomography from Morphological Skeleton via Optimization
Norbert Hantos, Péter Balázs, Kálmán Palágyi

Modeling Variable Demand in Competitive Location Problems
Boglárka G.-Tóth, José Fernández, Csaba Rendek

A Maximum Theorem for Generalized Convex Functions
Zsolt Páles

Verified Localization of Trajectories with Prescribed Behaviour in the Forced Damped Pendulum
Balázs László Lévai, Balázs Bánhelyi

2:00 pm – 4:00 pm **Invited Parallel Session 2B**

Perturbation Analysis of Inhomogeneous Markov Processes
Bernd Heidergott, Georg Pflug, Haralambie Leahu

Optimization of Stochastic Systems through MVD and Response Surface Methodology
Eric Laas-Nesbitt

Sensitivity Analysis and the Greeks by Measure Valued Differentiation
Georg Pflug

Enforcing Semantic Constraints with Derivation Tree Based Genetic Programming
Róbert Ványi

4.00 pm – 4:30 pm **Coffee break**

4:30 pm – 6:00 pm **Parallel Session 3A**

An Optimization Approach for the Eigenvalue Method
János Fülöp

Divinatory and Concurrent Lines: Optimization at TU Budapest Before 1950
Mihály Hujter

Optimization in Letters
Péter Gábor Szabó

4:30 pm – 6:00 pm **Parallel Session 3B**

Solver Communications: Options and Results
Horand Gassmann, Jun Ma, Kipp Martin

Stochastic Decomposition: Motivation, Technology and the Challenges that it Presents
Eldon Ellison, Suvrajeet Sen

Regularization of the Simplex Method
Olga Papp, Csaba Fábián, Krisztián Eretnek

7:00 pm – 8:00 pm **Organ concert (St. Michael's Cathedral)**

December 13, 2012 (Thursday)

8:00 am – 6:00 pm **Registration Office Open**

9:00 am – 10:00 am **Plenary Session 2**

MIP Computation and Beyond
Andrea Lodi

10:00 am – 10:30 am **Coffee break**

10:30 am – 12:30 pm **Parallel Session 4A**

Approximability of the Upper Chromatic Number of Hypergraphs
Csilla Bujtás, Zsolt Tuza

Nontransitive Dice
Sándor Bozóki

Online String Clustering
Emese Bittner, Csanád Imreh, Alexandru Tomescu

Optimal Realization of Imbalance Sequences
Antal Iványi, Shariefuddin Pirzada

10:30 am – 12:30 pm **Parallel Session 4B**

An Improved Heuristic for the Vehicle Routing Problem with Divisible Deliveries and Pickups
Gábor Nagy, Niaz Wassan, Grazia Speranza, Claudia Archetti

Multi-criteria Analysis of Building Evacuation Route Planning by Resorting to the P-graph Framework
Juan C. Garcia Ojeda, Botond Bertók, Ferenc Friedler

On Strongly Polynomial Variants of the MBU-Simplex Algorithm for a Maximum Flow Problem with Nonzero Lower Bounds
Richárd Molnár-Szipai, Tibor Illés

The Locomotive Assignment Problem in Freight Transportation
Zsuzsanna Barta, Attila Egri, Tibor Illés, Zoltán Kelemen, Richárd Molnár-Szipai

10:30 am – 12:30 pm **Parallel Session 4C**

An Algorithm for Automatic Drawing of Connections in BPMN Diagrams
Vytautas Jančauskas

Optimal Design of Process Networks Involving Subsystems with Variable Composition Streams
Adrián György Szlama, István Heckl, Botond Bertók

Modeling, Simulation and Optimization of Robotic Arm Motion Using RRTs Algorithm
Irina Gulina, Radomil Matousek

Combinatorial Tool for Cyclic Scheduling of Batch Processes: S-graph Approach
Máté Hegyháti, András Szoldatics, Olivér Ősz, Ferenc Friedler

12:30 am – 2:00 pm **Lunch**

2:00 pm – 4:00 pm **Invited Parallel Session 5A**

Models for the Optimal Management of Medium-voltage AC Network with Distributed Thermal and RES Generation and Storage Devices
Maria Teresa Vespucci, Alessandro Bosisio, Diana Moneta, Stefano Zigrino

Dynamic Sequencing and Cut Consolidation for the Parallel Hybridcut Nested L-shaped Method
Achim Koberstein, Christian Wolf

Computational Aspects of Risk-averse Optimization
Csaba Fábián

Stochastic Quadratic Assignment Problem
Radomil Matousek, Eva Mrazkova

2:00 pm – 4:00 pm **Parallel Session 5B**

Adaptive Multilevel SQP Method for State Constrained Optimization with PDEs
Stefanie Bott, Stefan Ulbrich, Jan Carsten Ziems

Preprocessing Nonlinear Optimization Problems by Symbolic Computation Techniques
Elvira Antal, Tibor Csendes

A New Interpretation of the Logarithmic Least Squares Method (LLSM)
László Csató

An On-line Robust MPC Based on Nominal Optimization and Parameter-depended Lyapunov Functions
Monika Bakosova, Juraj Oravec

2:00 pm – 4:00 pm **Parallel Session 5C**

New 0-1 Reformulations for the Maximum Clique Problem
Sándor Szabó

The Shapley Value for Irrigation Games
Anna Ráhel Radványi, Judit Márkus, Miklós Pintér

Promising GAHC and HC12 Algorithms in Quadratic Assignment Problem Tasks
Radomil Matousek

Different Coloring Methods in Maximum Clique Search
Bogdan Zavalnij

4:00 pm – 4:30 pm **Coffee Break and Poster Session**

A Comparison of Refined Descriptive Sampling and Simple Random Sampling and Their Application on a Vibrating String Model
Sofia Guebli, Megdouda Ourbih-Tari

Implementing Refined Descriptive Sampling into Three Phase Discrete-Event Simulation Systems
Latifa Ourbih, Megdouda Ourbih-Tari, Abdelnasser Dahmani

Empirical Analysis of Methods and Software Tools for Batch Process Scheduling
Éles András, Balázs Kovács, Benjámin Tóth, Máté Hegyháti

Global Branching Tree for Throughput Maximization with the S-graph Framework
Tibor Holczinger, Ákos Orosz, Ferenc Friedler

4:30 pm – 6:00 pm **Parallel Session 6A**

Applying Mathematical Models and Methods to Some Planning Problems of TESCO
Zsanett Orlovits, Tamás Pröhle

Application of the newsvendor problem
Attila Egri, Tibor Illés, Gábor Lovics

Minimum Conditional Entropy Based Inventory Control and its Application
Tamás Szántai, Edith Kovács, Attila Egri

4:30 pm – 6:00 pm **Parallel Session 6B**

A Class of Distributed Optimization Methods with Event-triggered and Local Communication
Martin Meinel, Michael Ulbrich

NLP-based Derivation of Bounded Convex PWA Functions: Application to Complexity Reduction in Explicit MPC
Bálint Takács, Juraj Holaza, Michal Kvasnica

Adaptronic Systems
Carsten Schäfer

7:00 pm – 10:00 pm **Banquet (Villa Medici Hotel)**

December 14, 2012 (Friday)

8:00 am – 6:00 pm **Registration Office Open**

9:00 am – 10:00 am **Plenary Session 3**

Role of Optimization in Green Engineering and Sustainability
Urmila Diwekar

10:00 am – 10:30 am **Coffee break**

10:30 am – 12:30 pm **Session 7D**

Consistent Conjectural Variations Equilibrium in a Mixed Oligopoly Electricity Market
Vyacheslav Kalashnikov, Nataliya Kalashnykova

Determining the Optimal Number of Cycles in Electronic Repair Processes
Tamás Jónás, Noémi Kalló, Zsuzsanna Eszter Tóth

Optimisation of the HEN Design over Full Life-span with a Simultaneous Risk Assessment
Andreja Nemet, Jiri Jaromir Klemes, Zdravko Kravanja

Safety Considerations for Process Network Synthesis Problems
Csaba Holló

12:30 am – 2:00 pm **Lunch**

2:00 pm – 3:30 pm **Session 8D**

Symmetry Reduction of Semidefinite Relaxation with RLT Cuts
Etienne De Klerk, Marianna E.-Nagy, Renata Sotirov, Uwe Truetsch

The Practical Behavior of the Homogeneous Self–Dual Formulations in Interior Point Methods
Csaba Mészáros

Efficient Product Form of the Inverse for the Simplex Method
Péter Tar, István Maros

3:30 pm – 3:45 pm **Coffee break**

3:45 pm – 5:15 pm **Session 9D**

Automated Failure Detection of Air Conditioners Based on Sensor Signal Classification
Balázs Bánhelyi, Balázs László Lévai

New MILP Models for Real Production Line Optimization
Tamás Hajba, Zoltán Horváth

A General Purpose Module Using Refined Descriptive Sampling for Installation in Simulation Systems
Abdelouhab Aloui, Megdouda Ourbih-Tari

Abstracts

Constructing and Analyzing MILP Models by IBM ILOG CPLEX Optimization Studio Free Academic Research Edition

Zoltán Süle
University of Pannonia, Hungary

After acquisition of leading optimization software developer ILOG, IBM has changed the license policy and made the most important ILOG optimization tools available for academic research for free of charge. The presentation shows how to register for, download, install, and utilize IBM ILOG CPLEX Optimization Studio Academic Research Edition. Data independent model development, importing data from databases, analyzing and visualizing results for various data sets will be demonstrated as well.

Sensitivity Analysis in Multistage Stochastic Optimization Problems Under Model Ambiguity

Bita Analui
University of Vienna, Austria

A multistage stochastic optimization problem with uncertainty about the underlying model is considered. In this paper and for the first time we introduce and develop an approach that explicitly takes into account the ambiguity in probability model for the real world class of multistage stochastic optimization problems where the robustness of the decisions are highly expected. This is done by studying and developing the concept of ambiguity of dynamic trees and related results for multistage stochastic optimization problems incorporating the results from multistage distance. In the absence of complete knowledge about the model one approach is to study a set of possible models in which the true model sits. In this line, we define this set as a ball around a reference measure P with respect to a multistage distance dl and therefore robustify the original problem by a worst case approach with respect to this ambiguity neighborhood. This way we analyze the sensitivity with respect to model changes.

Pricing Energy Swing Options via Stochastic Bilevel Programs

Peter Gross
Universität Wien, IK Computational Optimization, Austria
Raimund Kovacevic
Universität Wien, ISOR, Austria
Georg Pflug
Universität Wien, ISOR, Austria

Energy swing options are delivery contracts, where variable amounts are delivered for a fixed strike price (per unit). Due to properties of the energy markets, the replication approaches widely used in finance are not suitable for pricing energy swing options. Thus, to determine the optimal strike price while adressing special features of the energy markets, a game-theoretic approach to pricing was developed. In this model, the exercise price set by the seller anticipates the exercise strategy of the buyer that will be triggered by this particular exercise price. The special, case where constraints on the seller's risk are included in the model, we call risk averse bilevel problem. This particular type of bilevel problem where the seller's constraints depend on the buyer's exercise strategy has so far received little attention, since in general it leads to a nonconvex optimization problems where the feasible set even may be nonconnected. We demonstrate the properties and particular difficulties of this problem and present a tailored iterative solution algorithm. We apply the algorithm to a small problem and investigate the numerical behavior.

Estimation, Simulation and Tree Construction for Mid-term Power Production Planning

Raimund Kovacevic
University of Vienna, Austria

Dealing with the stochasticity of prices is a key issue in contemporary energy markets and connot be neglected by the producers of electrical power. We propose a stochastic programming model for mid-term planning which involves mixture of fuels and the effect of CO2-prices. The first goal is to find a joint simulation model for European gas, oil and emission allowances (EUA) spot prices. Given the patterns from descriptive statistics we apply a geometric brownian motion with jump model to gas, oil and EUA, while electricity spot prices are modeled by a regime switching model, that takes into account seasonal effects as well as jumps and spikes. Given the estimated models we simulate scenario paths and use a novel approach, based on a multiperiod generalizatoion of the Wasserstein distance, for tree construction. The stochastic trees than are used to solve a one year planning problem for a ficticious configuration of thermal units, optimized against the markets.

A Method to Approximate the Whole Pareto-optimal Set of Linearly Constrained Convex Multi Objective Optimization Problem

Gábor Lovics
Budapest University of Technology and Economics, Hungary
Tibor Illés
Budapest University of Technology and Economics, Hungary

In economic and engineering application of mathematics sometimes we need to optimize more than one objective function at the same time. In this type of problems we need to find solutions, where one of the objectives can not be improved without worsen the other. These solutions are called Pareto-optimal solutions, and since 1952 such methods are known that compute one of the Pareto-optimal solutions.

Recently, for unconstrained multi objective optimization problems such algorithm has been developed by Oliver Schütze at al. (2003) that try to approximate the whole set of the Pareto-optimal solutions. In this talk we generalize the subdivision algorithm of Schütze and others for linearly constrained multi objective optimization problem. The objective functions in our case need to be differentiable convex functions. The main idea of the method to find feasible joint decreasing direction, for the objective functions. Further generalization of the more general class of problems (convex constrained and convex objective function for minimize problem) seems to be possible. Practical applicability of the new algorithm has tested on the Markowitz portfolio optimization problem.

An Optimization-based Reconstruction Algorithm for Multivalued Discrete Tomography

László Varga

University of Szeged, Department of Image Processing and Computer Graphics, Hungary

Péter Balázs

University of Szeged, Department of Image Processing and Computer Graphics, Hungary

Antal Nagy

University of Szeged, Department of Image Processing and Computer Graphics, Hungary

The field of *transmission tomography* deals with the reconstruction of the inner structure of objects from their projections. The process usually starts by exposing the object of study to some type of radiation, and then measures the transmitted energy on the other side. The object will absorb some fraction of the radiation and from this, one can derive the summed density of the object along the paths of the beams. By taking such projections from many different directions it is possible to reconstruct the inner structure of the object.

In *discrete tomography* one also assumes that the object of study consists of only few known materials. With this information it is possible to significantly reduce the number of required projections. This can be useful in practical applications where the projection acquisition is cost-, or time-consuming, or when the high amount of radiation caused by taking many projections can damage the object of study.

We developed a new reconstruction algorithm that can provide accurate reconstructions of objects in the binary and non-binary case of discrete tomography. The proposed algorithm uses a modified version of the D.C. programming algorithm.

We defined an energy function that contains two terms, one for formulating the continuous reconstruction problem, and one for forcing discrete results. With this energy function, we proposed an optimization approach, that can produce a solution of the discrete reconstruction problem, by performing a gradient descend process,

while applying an adaptive weighting between the two terms of the energy function.

We validated the performance of our proposed method by comparing it to other reconstruction algorithms, using a set of software phantoms.

Multi-objective PID Controller (2DOF) Tuning for Integral and Time Delay Plants

Radomil Matousek
Brno University of Technology, Czech Republic
Stanislav Lang
Brno University of Technology, Czech Republic
Petr Minar
Brno University of Technology, Czech Republic
Ivan Svarc
Brno University of Technology, Czech Republic

The paper describes two-degree of freedom PID controllers tuning for integral and time delay plants by means of new techniques for multi-objective design. The PI and PID controllers tuning for integral plus time delay plants belong to demanding problems. It is caused by existence of two integrators in the control loop and thereby by the great predisposition to large overshoots, eventually to oscillation and stability loss. The use of the two-degree of freedom (2DOF) controllers seems to be suitable in these case. The optimization techniques is based on metaheuristic which is compared with classical control design methods. The effectiveness of the proposed techniques is shown in the examples.

Solving Binary Tomography from Morphological Skeleton via Optimization

Norbert Hantos
University of Szeged, Hungary

Péter Balázs
University of Szeged, Hungary

Kálmán Palágyi
University of Szeged, Hungary

Binary Tomography (BT) aims to reconstruct binary images from their projections. In the most common applications of BT usually just few projections of the object can be measured. Owing to the small number of projections the binary reconstruction can be extremely ambiguous.

In this talk we investigate the morphological skeleton as prior information of the image to be reconstructed. The skeleton of a discrete binary image can be characterized via morphological operations. An interesting property of the morphological skeleton is that the original binary image can be exactly reconstructed from the skeletal subsets. In this work, we deal with the reconstruction problem in which the entire morphological skeleton (instead of the individual skeletal subsets) and two projections of the original image are known.

In the reconstruction process the prior knowledge is often incorporated into an energy function, thus the reconstruction task is equivalent to a function minimization problem. We show how to use optimization for the binary reconstruction problem using the information of the projections and the skeletal points.

This research was supported by the European Union and cofinanced by the European Regional Development Fund within the project TÁMOP-4.2.1/B-09/1/KONV-2010-0005. The work of the second author was also supported by the János Bolyai Research Scholarship of the Hungarian Academy of Sciences and by the OTKA PD100950 project of the National Scientic Research Fund.

Modeling Variable Demand in Competitive Location Problems

Boglárka G.-Tóth

Budapest University of Technology and Economics, Institute of Mathematics, Hungary

José Fernández

University of Murcia, Institute of Mathematics, Dpt. of Statistics and Operations Research, Spain

Csaba Rendek

Budapest University of Technology and Economics, Institute of Mathematics, Hungary

In most competitive location models investigated in the literature, it is assumed that the demand is fixed independently of goods or market conditions. Nonetheless, demand may vary depending on quality, availability, distances to the facilities, or other factors. Principally it happens when goods are inessential, or surrogate goods are available.

Depending on the properties of the market and the goods, the demand may vary differently. Defining the utility of a facility for a demand point by their distance and quality, variable demand can be given as a function of the total utility. This function can be concave, convex, linear or even other type depending on the above mentioned details.

In this work the different types of demand functions are studied and compared to the fixed demand model and to each other. For a real problem the solutions for the different models are analyzed.

A Maximum Theorem for Generalized Convex Functions

Zsolt Páles
University of Debrecen, Hungary

The classical Maximum Theorem for convex functions states that *if D is a convex set of a linear space and and $f_1, \dots, f_n : D \to \mathbb{R}$ are convex functions such that*

$$0 \leq \max(f_1(x), \dots, f_n(x)) \qquad (x \in D),$$

then there exist $\lambda_1, \dots, \lambda_n \geq 0$ with $\lambda_1 + \cdots + \lambda_n = 1$ such that

$$0 \leq \lambda_1 f_1(x) + \cdots + \lambda_n f_n(x) \qquad (x \in D).$$

Given a nonempty set X, a binary operation $\circ : X^2 \to X$, and two positive real constants a, b, a function $f : X \to \mathbb{R}$ is called $(\circ, a, b)$-convex if

$$f(x \circ y) \leq af(x) + bf(y) \qquad (x, y \in X).$$

Clearly, convex and subadditive functions are convex in this generalized sense. The main results of the talk extend the conclusion of the classical Maximum Theorem to the setting of $(\circ, a, b)$-convexity. Applications to optimization problems are also given.

Verified Localization of Trajectories with Prescribed Behaviour in the Forced Damped Pendulum

Balázs László Lévai
University of Szeged, Hungary
Balázs Bánhelyi
University of Szeged, Hungary

In mathematics, it is quite difficult to define exactly what chaos really means. In particular, it is easier to prepare a list of properties which describe a so called chaotic system than give a precise definition. A dynamic system is generally classified as chaotic if it is sensitive to its initial conditions. Chaos can be also characterized by dense periodic orbits and topological transitivity.

While studying computational approximations of solutions of differential equations, it is an important question is whether the given equation has chaotic solutions. The nature of chaos implies that the numerical simulation must be carried out carefully, considering fitting measures against possible distraction due to accumulated rounding errors. Unfortunately except a few cases, the recognition of chaos has remained a hard task that is usually handled by theoretical means.

In our present studies, we investigate a simple mechanical system, Hubbard's sinusoidally forced damped pendulum. Applying rigorous computations, his 1999 conjecture on the existence of chaos was proved in 2008 but the problem of finding chaotic trajectories remained entirely open. This time, we present a fitting verified numerical technique capable to locate finite trajectory segments theoretically with arbitrary prescribed qualitative behaviour and thus shadowing different types of chaotic trajectories with large precision. For example, we can achieve that our pendulum goes through any specified finite sequence of gyrations by choosing the initial conditions correctly.

To be able to provide solutions with mathematical precision, the computation of trajectories has to be executed rigorously. Keeping in mind this intention, we calculated the inclusion of a solution of the differential equation with the VNODE algorithm and based on the PROFIL/BIAS interval environment. The search for a solution

point is a global optimization problem to which we applied the C version of the GLOBAL algorithm, a clustering stochastic global optimization technique. This method is capable to find the global optimizer points of moderate dimensional global optimization problems, when the relative size of the region of attraction of the global minimizer points are not very small.

Perturbation Analysis of Inhomogeneous Markov Processes

Bernd Heidergott
VU University Amsterdam, The Netherlands

Georg Pflug
University Vienna, Austria

Haralambie Leahu
TU Eindhoven, The Netherlands

The assumption of time-homogeneity of Markov processes is often violated in applications. For example, in a call center we are interested in the system behavior over a fixed time period of length T. The arrival rate is typically time dependent. This can be modeled as a inhomogeneous Poisson process, and the resulting Markov process modeling the system process becomes an inhomogeneous Markov process whose generator matrix is time dependent.

In this talk we will extend the results on perturbation analysis of homogeneous Markov processes to inhomogeneous Markov processes. Based on a result by Massey and Whitt (1998), we provide a representation for the sensitivity of the transition probability over time interval [0 , T]. In addition, show how this formula can be used to derive a simple gradient estimator where we make use of the fact that the derivative of a generator matrix can be written as re-scaled difference of two Markov transition probability matrices. Provided that the derivative of the generator matrix of the Markov process commutes in a suitable way with transition probability of the Markov process our derivative formulas can be significantly simplified. We will illustrate our approach with models from biology, finance and the call-center model.

Optimization of Stochastic Systems through MVD and Response Surface Methodology

Eric Laas-Nesbitt
University of Vienna, Austria

We combine two approaches to stochastic optimization: measure-valued differentiation (MVD) and response surface methodology (RSM). The latter fits, in each iteration, a low-order polynomial to a number of function evaluations within a trust region, and takes the optimal value as starting point for the next iteration. Since function evaluations by simulation are costly, limiting them to one point and using derivative information to estimate a polynomial should reduce computing time. This derivative information is based on MVD. An algorithm is presented and tested on a few examples, and comparisons are drawn to competing alternatives.

Sensitivity Analysis and the Greeks by Measure Valued Differentiation

Georg Pflug
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After a general introduction into measure valued differentiation (MVD)and characteristic functions, we demonstrate how derivatives can be estimated for certain classes of discrete-time Levy processes both under the real measure and under the mean-corrected martingale measure. As application, we show results for calculating the sensitivities for option prices, where a special emphasis is put on options with noncontinuous payoff (digital options). A comparison with competing methods exhibits the advantages of MVD.

Enforcing Semantic Constraints with Derivation Tree Based Genetic Programming

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Grammar guided genetic programming is a relatively new, but very popular area in the field of evolutionary computation. It covers approaches that employ context-free grammars to guide or restrict the evolutionary process. Most GGGP methods use some kind of representaton of the derivations over the grammar as genotypes, maintaining the syntactic constraints during the evolutionary process. A tree based GGGP method is derivation tree based genetic programming (DTGP). It differs from other tree based GGGP methods in that it uses an extended data structure: at each node of the derivation tree various properties are stored to improve node selection and to speed-up evaluation.

Since these properties often contain semantic information, it raises the quiestion if it is possible to use them to introduce semantic constraints. In fact, it is possbile, and DTGP can be extended to not only apply the syntactic constraints defined by the context-free grammar, but also use semantic constraints defined by the so-called forced synthesized attributes.

An Optimization Approach for the Eigenvalue Method

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Pairwise comparison matrices play an important role in multiattribute decision making; they are applied to derive priorities or implicit weights for a given set of decision alternatives. Several approaches exist regarding how to derive a suitable vector of weights from a pairwise comparison matrix. Saaty proposed the eigenvector method in which the principal eigenvector of the pairwise comparison matrix serves as the vector of weights. Another class of approaches is based on optimization methods and proposes different ways for minimizing the difference between the pairwise comparison matrix and the consistent matrix constructed from the weights. In the talk, based on Perron-Frobenius theorem, we show that eigenvector method also can be considered from the aspect of the optimization approach. Namely, the principal eigenvector can be obtained as the optimal solution of a convex optimization problem. We show that this approach is very useful in the case of incomplete pairwise comparison matrices. Computational experience is also presented.

Divinatory and Concurrent Lines: Optimization at TU Budapest Before 1950

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Professors Hunyady, J.König, L.Klug, Rados, Kürschák, D.König, Egerváry, Hajós, Gallai and others have created an important center of applied mathematics at TU Budapest. Many famous results of them concern concurrent and/or optimally positioned lines in two ore more dimensions.

During the presentation we walk around these conjunctions. We study the old problems and famous results from the modern points of view, as well.

Optimization in Letters

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In our project, we published four books based on correspondence of mathematicians in Hungary in the 20th century [1-4]. The books contain more than one thousand letters with two thousand comments and many other documents, photos, and biographical data. These letters arise from Lipót Fejér's, László Kalmár's, Frigyes Riesz's and Marcel Riesz's scientific legacies. These legacies are important sources of the History of Mathematics. The letters contain several interesting mathematical problems, and some optimization problems too. In our talk, we would like to show them.

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Solver Communications: Options and Results

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Much has been written about optimization instance formats. The MPS standard for linear mixed-integer programs is well known and has been around for many years. Other extensible formats are available for other optimization categories such as stochastic and nonlinear programming. However, the problem instance is not the only piece of information shared between the instance generator and the solver. Solver options and solver results must also be communicated. To our knowledge there is no commonly accepted format for representing either solver options or solver results. In this talk we propose a framework and theory for solver option and solver result representation in a modern distributed computing environment. A software implementation of the framework is available as an open-source COIN-OR project.

Stochastic Decomposition: Motivation, Technology and the Challenges that it Presents.

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USC, USA

Stochastic Decomposition (SD), applied to linear, 2-stage recourse problems, is a way of examining potential solutions statistically with a view to reaching an acceptable solution with a minimum of sampling. Observations of the 2nd stage are obtained by Monte-Carlo sampling - applicable equally to continuous as to discrete distributions. We use these observations one at a time using L-shaped methodology to obtain cuts, and, after a certain minimum period, test every solution for the stability that should ensure a good approximation. For convergence a method of regularisation must be chosen, and this may be critical - particularly as the statistical nature of the method means that multiple runs are needed with different start-seeds for the pseudo-random number sequence. The utility of the method is illustrated by the original regularised decomposition method of Ruszczynski, adapted for SD by Sen. Research remains to be done using the Trust Region approach of Linderoth and Wright, also using the Level Method approach of Lemarechal et al. and Fabian.

Regularization of the Simplex Method

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There is a special problem class, finding the largest ball that fits into a given polyhedron, where by applying a special pricing rule, the simplex method can be interpreted as a cutting-plane method that approximates a convex polyhedral objective function. We present a regularization of this method using the level method of Lemaréchal, Nemirovskii and Nesterov. The regularized method is applied in the dual space, it only affects the process through pricing, hence it steps along basic solutions. Test results are presented for this simplex method. For general linear programming problems, we propose a Newton-type approach which requires the solution of a sequence of special problems.

Approximability of the Upper Chromatic Number of Hypergraphs

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We study a hypergraph coloring invariant which was first introduced by Berge in the early 1970's and later independently in different contexts by further authors. A hypergraph $\mathcal{H} = (X, \mathcal{E})$ is a set system $\mathcal{E}$ on the underlying vertex set X. An assignment $\varphi : X \to \mathbb{N}$ is a C-coloring of $\mathcal{H}$ if each edge $E \in \mathcal{E}$ has two vertices assigned to the same number (i.e. color). Equivalently, a C-coloring is a partition of the underlying set X where no edge $E \in \mathcal{E}$ is completely sliced by the partition. The upper chromatic number $\overline{\chi}(\mathcal{H})$ of $\mathcal{H}$ is the possible maximum number of partition classes which can be achieved under this condition. We use the notation $n = |X|$ and $m = |\mathcal{E}|$ for the number of vertices and edges, respectively, in a generic input hypergraph $\mathcal{H} = (X, \mathcal{E})$.

- For the general case we prove a guaranteed approximation ratio for the difference $n - \overline{\chi}(\mathcal{H})$.

A hypertree is a hypergraph $\mathcal{H} = (X, \mathcal{E})$ for which a 'host tree' graph $T = (X, F)$ exists with the property that each edge of $\mathcal{H}$ induces a connected subgraph in T. We prove the following results on hypertrees:

- $\overline{\chi}(\mathcal{H})$ does not have an $\mathcal{O}(n^{1-\epsilon})$-approximation in polynomial time (unless $\mathsf{P} = \mathsf{NP}$).
- $\overline{\chi}(\mathcal{H})$ cannot be approximated within additive error $o(n)$ in polynomial time, even if each edge of $\mathcal{H}$ contains at most 7 vertices (unless $\mathsf{P} = \mathsf{NP}$).

Our positive result is an algorithm proving the following claim:

- The problems of determining $\overline{\chi}(\mathcal{H})$ and finding a $\overline{\chi}(\mathcal{H})$-coloring are fixed-parameter tractable in terms of maximum degree on the class of hypertrees.

Finally, we give some conditions under which any coloring problem is polynomial-time solvable on the class of hypertrees.

Nontransitive Dice

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The problem of a multiple player dice tournament is discussed. A die has a finite number of faces with integers written on each. We introduce dice sets which have the following property, defined by Schütte for tournaments: for an arbitrary subset of k dice there exists at least one die in the set that beats each of the k with a probability greater than $1/2$. It is shown that the proposed dice set realizes a Paley tournament, that is, a complete directed graph of p vertices without loops, where $p = 4m+3$ is a prime number. If $j-i$ is a quadratic residue modulo p, then a directed edge is drawn from vertex i to vertex j, otherwise it is drawn in the opposite direction. Paley tournament is known to have Schütte property (for a given k) if the number of vertices is large enough.

Online String Clustering

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In online clustering problems, the classification of data into sets (called clusters) is done in an online fashion. In many applications we have to cluster points from an Euclidean space and the clusters are balls and we have to cover the requests by them. There are different models. If the balls have fixed size then the goal is to minimize the number of the used balls. In some other models we can use a given number of balls and the goal is to minimize the maximal diameter. In the case of variable sized clusters the cost of a cluster is the sum of a fixed set-up cost and a service cost which depends on the diameter.

Here we study online clustering of strings. The strings arrive one by one and after the arrival we have to assign the string into the cluster to clusters at the time of arrival without any information about the further strings. A string can be assigned to an existing cluster, or a new cluster can be opened for it. We define some objective function depending on the Hamming distance diameter of the clusters and present the first online algorithms for the solution of these problems. As it is usual in the area of online algorithms we measure the performance of the algorithms by the competitive analysis. An algorithm is C-competitive if its cost is at most C-times the optimal cost.

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Optimal Realization of Imbalance Sequences

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The imbalance [1,2] of a vertex in a digraph D is defined as the difference of the outdegree and indegree of the given vertex. The imbalance sequence A of a digraph D is formed by listing imbalances in nondecreasing order. A digraph D is an r-realization of A, if the imbalance sequence of D is A and the maximal number connecting two vertices of D equals to r. An r-realization of A is arc minimal, if A has no other realization containing less arcs. An r-digraph as a realization of A is connection minimal if A has no q-digraph as realization with $q < r$. An r-digraph D is cycle minimal realization of A if D contains zero or one directed cycle and if it contains a directed cycle then its removal disconnects D.

In the lecture we analyze the problems of constructing arc minimal, connection minimal and cycle minimimal realizations of prescribed imbalance sequences.

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An Improved Heuristic for the Vehicle Routing Problem with Divisible Deliveries and Pickups

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The vehicle routing problem with divisible deliveries and pickups (VRDDP) is a little-known but useful model within reverse logistics. It belongs to the class of vehicle routing problems with deliveries and pickups, where customers may both receive and send goods. We compare the VRPDDP to its better-known sister problem, the VRP with Simultaneous Deliveries and Pickups (VRPSDP). Here, an assumption is made that each customer must receive its delivery and pickup in a single visit by a single vehicle; the VRPDDP does not make this assumption. In this regard, the VRPDDP is somewhat similar to the VRP with Split Deliveries. We show that the optimal solution to the VRPDDP can be twice as good as a VRPSDP solution and the bound is tight. We solve the VRPDDP using a reactive tabu search metaheuristic. Observations will be presented on (1) the problems for which the VRPDDP is an appropriate model, (2) the characteristics of customers whose deliveries and pickups are served separately, and (3) on the shapes of the vehicle routes. We also show how these observations can help us improve the solution algorithm.

Multi-criteria Analysis of Building Evacuation Route Planning by Resorting to the P-graph Framework

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The P-graph framework is proven to be highly effective in solving Process Network Synthesis. In the present work, the P-graph framework has been adopted for solving the routing and scheduling of individuals, facing a life-threatening situation inside a construction (e.g., edifice, house) . First the building evacuation problem is represented by means of a P-graph model, which is then transformed into a time-expanded process network synthesis (PNST) problem that can be algorithmically handled by the P-graph framework (García-Ojeda et. al, 2012). In the proposed method, each location in the building and their passages are given by a set of attributes to be taken in the evacuation route planning. In addition to the globally optimal solution of the assignment problem, the P-graph framework provides the n-best suboptimal solutions that can be ranked according to multiple criteria (Han et. al, 2007), when computational possible. The viability of the proposed method is illustrated by an example.

On Strongly Polynomial Variants of the MBU-Simplex Algorithm for a Maximum Flow Problem with Nonzero Lower Bounds

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Our work is concerned with maximum flow problems with non-zero lower bounds. The usual approach to this problem is transforming the network into a bigger one with zero lower bounds, whose solution yields a feasible solution to the original problem and then using one of the established methods for maximum flow problems with little to no modifications. Expanding upon the labeling techniques of Goldfarb and Hao we show that a variant of the monotonic build-up simplex algorithm runs in strongly polynomial time on the original network. The main characteristic of the MBU algorithm is that starting from an arbitrary basis solution it decreases the number of infeasible variables monotonically, without letting any feasible variables turn infeasible in the process. We show that this algorithm terminates after at most $|V|^2|A|$ pivots which makes it the first strongly polynomial pivot algorithm that solves the problem without transforming the network. We also give computational results on real world instances.

The Locomotive Assignment Problem in Freight Transportation

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There are many optimization problems in connection with railway operation and they are sufficiently complex and almost exclusively large tasks. The larger railway companies nowadays employ matematical researchers so as to be cost-effective.

In the presentation we discuss a particular task of the railway optimization problem, the well-known locomotive assignment problem. The problem is the following: for a fix period (for example a day or a week) a region's timetable is known and the goal is to assign minimum number of locomotives to the trains. Solving this particular problem can take up to several days for the transportation engineers.

The topic is very timely because we work together with the MÁV-Trakció company to create the matematical background of a computer-based decision-support system in order to help the dispatcher's work. The company give engine-drivers and/or locomotives to the incoming requests for freight trains. In this project the most of our existing results we can use, but the models have to take notice of some other conditions. There are a lot of requests and the company doesn't have enough locomotives, so there is a need for light travel locomotives and we have to deal with the services of the locomotives. The procurer companies often decline their request and sometimes they ask resources (engine-driver and/or locomotive) for several different time for the same freight train, because the cost

of renouncement is very low. Further problem is the large delays of the freight trains. It is true especially for international freight trains. We create such models which deal with this information too and we tested them on real data.

An Algorithm for Automatic Drawing of Connections in BPMN Diagrams

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The problem of drawing pleasing looking diagrams of business processes is important in business process management. Simple and pleasant looking diagrams are easier to understand. In these diagrams a set of shapes are connected together in a rectangular lattice by connections consisting of straight line segments. We have established three criteria for aesthetical attractiveness based on intuition and on a small study done with university students. These criteria are - the length of the path (shorter is better), number of bends in the path (straighter is better) and number of intersections between paths (large number of intersections in the diagram makes it harder to understand). The paths are drawn on a rectangular lattice with shapes sitting at the centers of cells. The problem is to find a good set of paths given the shapes to connect together. An algorithm was developed for this problem - a combination of recursive path generation and a genetic algorithm. For each connector, a set of possible paths up to some specified length and number of bends is generated recursively by travelling from starting node to the neighboring nodes until the target node is reached. This is done on a simple graph, with less nodes. Paths are transfered to a more complicated graph and permutations of these paths are calculated. Then a genetic algorithm is used to select a path for each connector so that this combination has the lowest number of intersections, sum length and number of folds.

Optimal Design of Process Networks Involving Subsystems with Variable Composition Streams

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Variable composition streams often arise in chemical and allied industries and optimizing their treatment has major impact on the overall performance of the chemical plants. Optimization of process systems with variable composition streams yields in nonlinear mathematical programming problems and thus difficult to solve in large scale. Meanwhile, conceptual process design requires to consider a wide range of design alternatives modeled by numerous variables representing candidate process elements and their potential interconnections, i.e., streams. As a result, conceptual design and the optimization of the variable composition subsystems either performed as two consecutive steps or formulated and solved as a large scale mixed integer nonlinear mathematical programming problem. Practically none of the above approaches can guarantee globally optimal solution.

The present paper introduces a synergistic method for optimal design of process networks involving subsystems with variable composition streams. The proposed method provides a synergy between two branch-and-bound methods. The one responsible for determining the optimal values for the decision variable of the conceptual design and the other solving the nonlinear part of the model representing the variable composition streams. The method integrated herein guaranties the globally optimal solution with a custom level of accuracy. The effectiveness of the method is demonstrated by applying it to a real life problem from the chemical industry, the synthesis of the optimal process for producing vinyl chloride (C_2H_3Cl).

Modeling, Simulation and Optimization of Robotic Arm Motion Using RRTs Algorithm

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This paper presents the implementation of the RRT algorithm and its modifications to plan motion for a planar four-link robot arm. Modeling and simulation are performed for several defined environments. A workspace goal for the end effector of the robot is given, along with a starting configuration of the arm. The robot arm starts motion from this given configuration and then should execute some trajectory to reach the goal. Every environment includes different number of static obstacles of different size which the robot should avoid as it is moving. Obviously the robot should also avoid colliding with itself. The problem is simulated using MATLAB. Simulation includes the RRT algorithm implementation, necessary collision checking, inverse kinematics, forward kinematics and visualization functions.

RRT is a popular probabilistically complete search algorithm for a variety of motion planning problems to search a trajectory from the starting configuration to the goal configuration in configuration spaces of different complexity. Since RRT is probabilistically complete, time parameter is used for the algorithm execution to limit its performance. In result, the whole search tree and a trajectory in terms of joint angles that achieve the goal have been calculated. Algorithms is tested with different parameters. Some statistical data was calculated and analyzed, and their effects on the algorithm performance, time, and resulting trajectory are discussed. Since the RRTs algorithm is based on random sampling, there are many unnecessary motions of the arm during the algorithm execution. Therefore some smoothing optimizations are also suggested.

Combinatorial Tool for Cyclic Scheduling of Batch Processes: S-graph Approach

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In terms of the length of the time horizon, batch process scheduling is considered as short-, mid-, and long-term problems. The high number of discrete decisions makes scheduling a complex problem, hence, the published mathematical programming approaches can only be applied to limited size problems. These models, despite being effective in short-term, become intractable when applied for longer time horizon of several months. To make these problems solvable in reasonable time, additional restrictions can be applied. One of the most commonly considered assumption for long-term scheduling is constructing a sequence of periodically repeating short-term schedules, called cyclic schedules. Even though the solution of this problem is not necessarily optimal, it may have advantages in practice.

Several papers have reported MINLP formulations for cyclic scheduling of long-term scheduling problems. These approaches either consider a non-linear objective function or need a repetitive solution of MILP models with fixed cycle time. In the present work, an S-graph based algorithm is presented to generate cyclic schedules for long-term throughput maximization problems. This approach enumerates the possible number of batches for each product, where in each instance, the cycle time is minimized. Accelerations were developed to enhance the enumeration, tighten the bounds of subproblems, and to decrease the overall search space by excluding suboptimal cases. The efficacy of these techniques was investigated by solving examples.

Models for the Optimal Management of Medium-voltage AC Network with Distributed Thermal and RES Generation and Storage Devices

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A medium-voltage AC network with distributed generation and storage devices is considered for which set points are assigned in each time period of a given time horizon. A set point in a time period is defined by modules and phases of voltages in all nodes, active and reactive powers, on load tap changer and variable loads. When some parameters vary, in order to restore feasibility new set points need to be determined so as to minimize the variations with respect to the initial ones. This can be done by minimizing distributor's redispatching costs, which are modelled by means of binary variables, while satisfying service security requirements and ensuring service quality, which are represented by nonlinear constraints, such as the nodal balance of active and reactive power and the current transits on lines and transformers for security. Storage devices are modeled by means of constraints that relate adjacent time periods. A two-step solution procedure is proposed, which is based on decoupling active and reactive variables: in the first step a MILP model determines the active power production and the use of storage devices that minimize redispatching costs over all time periods in the time horizon; in the second step, given the optimal active power production computed in the first step, reactive variables in each time period are computed by solving a nonlinear programming model.

Dynamic Sequencing and Cut Consolidation for the Parallel Hybridcut Nested L-shaped Method

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The Nested L-shaped method is used to solve two- and multistage linear stochastic programs with recourse, which can have integer variables on the first stage. In this paper we present and evaluate a cut consolidation technique and a dynamic sequencing protocol to accelerate the solution process. Furthermore, we present a parallelized implementation of the algorithm, which is developed within the COIN-OR framework. We show on a test set of 48 two-stage and 42 multi-stage problems, that both of the developed techniques lead to significant speed ups in computation time.

Computational Aspects of Risk-averse Optimization

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We deal with solution methods for two-stage stochastic linear programming problems, with an emphasis on variants that include convex risk measures. We consider cutting-plane and bundle-type methods. The aim is to specialize general linear programming computing techniques to these stochastic problems; and on the other hand, to work out LP computational techniques based on ideas originally developed for the handling of risk measures.

Stochastic Quadratic Assignment Problem

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Some parameters of a quadratic assignment problem (QAP) can be random in practice. Therefore, it may be very important to include randomness into a mathematical model to correctly describe the real-world behaviour. For this reason, the stochastic quadratic assignment problem will be formulated using stochastic programming approach. Uncertainty will be included through a random flow matrix. Two commonly known deterministic equivalents will be used - EO (expected objective) reformulation and EV (expected value) reformulation. Both models lead to unconstrained deterministic quadratic problems. The model corresponding to the EO reformulation is more computationally intensive than the EV reformulated model but it should provide more reliable results. The usefulness of including randomness into a model in the form of EO reformulation will be quantified using the value of stochastic solution. The paper describes stochastic QAP and to display the proper solutions of given tasks.

Adaptive Multilevel SQP Method for State Constrained Optimization with PDEs

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We consider optimal control problems with state constraints and semilinear elliptic PDEs. In order to overcome the low regularity of the Lagrange multiplier associated with the state we apply the Moreau Yosida regularization. The regularized nonlinear subproblems are solved with the adaptive multilevel trust-region SQP method [1], [2]. More precisely, we introduce a combined Moreau Yosida SQP algorithm where the refinement conditions and the Penalty parameter update are modified specifically. Then we ensure that the regularized subproblems satisfy the assumptions of the adaptive SQP method and that the combined algorithm is well-posed, i.e., the sequence of generated Penalty parameters is unbounded. Based on the convergence theory of Moreau Yosida of Meyer and Yousept and the SQP method of Ziems and Ulbrich, we deliver a new first-order necessary optimality result for the output of the combined algorithm. Finally, we present some numerical results with the example superconductivity.

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Preprocessing Nonlinear Optimization Problems by Symbolic Computation Techniques

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An emerging field of mathematical programming is the possible applications of symbolic techniques for preprocessing or solving optimization problems. Symbolic preprocessing of LP problems [5] is the most classic example. This kind of transformations are implemented in the AMPL processor for several years as an automatic "presolving" mechanism [3]. A more recent topic is the assistance for IP/MINLP solving, what is the aim of The Reformulation-Optimization Software Engine of Liberti et al. [4], for example. On this special field, relaxation of some constraints or increasing of the dimension of the problem could be reasonable.

However, as the work of Csendes and Rapcsák [2] shows, it is also possible to produce equivalent forms of unconstrained nonlinear optimization problems by symbolic transformation in the sense, that a transformation between the optima of the problem forms is possible. This method is capable to eliminate redundant variables or simplify the problems in other ways.

We present an improved version of this algorithm with promising test results on the set of standard global optimization problems and further test problems, and a short introduction to related development issues in Maple and Mathematica.

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A New Interpretation of the Logarithmic Least Squares Method (LLSM)

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Pairwise comparison matrices are widely used in decision making methodology, since it is more simpler to compare two opportunities than to provide all weights explicitly. Finding the optimal positive weight vector is not trivial in the case of inconsistent pairwise comparison matrices. One of the most common distance-based techniques is the Logarithmic Least Squares Method (LLSM), when optimal weights are the geometric means of row elements.

In certain cases some of the pairwise comparisons are not given, causing further difficulties in calculating optimal weights. Bozóki, Fülöp and Rónyai (2010) has extended LLSM to incomplete matrices. It has multiple links to graph theory: it is proven that the uniqueness of the solution is equivalent to the connectedness of the graph representing the structure of known matrix elements. The calculation of optimal weights is based on a system of linear equations.

In the presentation we give a new method to solve this problem by regarding the generalized inverse of the Laplacian matrix as a sum by using its Neumann series. It has an interpretation for the graph representation and can contribute to the definition of new methods. Finally, we reveal some interesting properties of incomplete LLSM based on the calculation process, which makes possible to apply it as a ranking method in sport tournaments.

An On-line Robust MPC Based on Nominal Optimization and Parameter-depended Lyapunov Functions

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The approach address the problem of on-line robust constrained model predictive control (MPC) design for uncertain systems, see Kothare et al. (1996), Cuzzola et al. (2002), Ding et al. (2004), Ding et al. (2007), Zheng and Wu (2008), Bumroongsri and Kheawhom (2012) and references therein. The presented robust MPC strategy combines two existing approaches with intentions to adopt their benefit facets into single improved control scenario. The first algorithm (Cuzzola et al., 2002) is based on the minimization of the parameter depended Lyapunov functions (PDLFs) and the second strategy (Ding et al., 2007) afford an idea of optimization of the nominal performance cost. It is supposed the controlled process can be described by the discrete-time state-space system with polytopic uncertainties and corresponds to the convex set. System vertices are generated as a vertices of the convex hull of the uncertain system set. Each uncertain system can be formulated as a convex combination of its vertices. Therefore the problem of robust stabilization can be reduced to stabilization of the vertex systems. Using proper sampling time, the robust MPC generates in each control step a gain matrix of the closed-loop control law. The state feedback controller design is based on minimization of the upper bound represented by the quadratic Lyapunov function. To improve the control performance and extend the feasible set of initial conditions the parameter depended Lyapunov functions (PDLFs) are defined. This strategy reduces the conservativeness of the designed controller (Cuzzola et al., 2002). The optimization problem is transformed via linear matrix inequalities (LMIs) to obtain the semidefinite programming problems (SDPs). This more tractable form of SDPs enables to design robust MPC in effective way. Moreover, the optimization problem can be extended to include symmetric constraints on control inputs and outputs formulated via LMIs. These

properties highly determines the quality of closed-loop control. The final complexity of solved convex optimization problem is strongly depended on the size of the uncertain polytopic set. Due to this fact, the control performance is optimized according to the nominal system to reduce the computational effort, whereas the constraints are optimized subject to the all vertex systems (Ding et al., 2007). Nominal system is proposed as a controlled system with mean values of uncertain parameters. The impact of the described on-line robust constrained MPC approach was investigated on the illustrative example of uncertain benchmark represented by the continuous-stirred tank reactor (CSTR). The optimization has been realized in MATLAB-Simulink environment using YALMIP toolbox (Löfberg, 2004) and solver SeDuMi (Polik, 2010). The quadratic cost function values and computational effort were evaluated for each vertex system. The case study confirm the improvement of control performance ensured by an algorithm combined of two strategies (Cuzzola et al., 2002; Ding et al. 2007; Ding et al., 2004; Zheng and Wu, 2008; Bumroongsri and Kheawhom, 2012).

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New 0-1 Reformulations for the Maximum Clique Problem

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Many combinatorial optimization problems can be expressed in terms of 0-1 linear programs. For the maximum clique problem the so-called edge reformulation is applied most commonly. Two less frequently used LP equivalents are the independent set and edge covering set reformulations. The number of the constraints (as a function of the number of vertices of the ground graph) is asymptotically quadratic in the edge and the edge covering set LP reformulations and it is exponential in the independent set reformulation, respectively. We propose two new approaches in which the numbers of constraints are linear.

The work horses in the majority of the real life clique search computations are the Carraghan-Pardalos and the Östergård algorithms. In their simplest forms these are nothing more than implicit enumeration schemes. Equipped with pruning methods coming from elementary combinatorial considerations such as coloring and matching, well tuned implementations of the algorithms are capable of handling highly non-trivial instances. Our main motivation of studying the 0-1 LP equivalents of the maximum clique problem is to see if the upper estimates provided by the LP machinery can be exploited to improve the performance of the clique search procedures.

The Shapley Value for Irrigation Games

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In our presentation we are going to discuss cost sharing problems. We focus on problems on a rooted tree, we call these problems cost-tree problems, and on the induced transferable utility cooperative games, we call these games irrigation games. A formal notion of irrigation games is introduced, and the characterization of the class of these games is provided. The well-known class of airport games [1] is a subclass of irrigation games. The Shapley value [2] is probably the most popular solution concept for transferable utility cooperative games. [3] and [4] show respectively, that Shapley's [2] and Young's [5] axiomatizations of the Shapley value are valid on the class of airport games.

We extend Dubey's [3] and Moulin's [4] results to the class of irrigation games, that is, we provide two characterizations of the Shapley value for cost sharing problems given on a rooted tree. In our characterization results we relate the *TU* games terminologies to the cost sharing terminologies, so we bridge between the two fields.

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Promising GAHC and HC12 Algorithms in Quadratic Assignment Problem Tasks

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The paper describes new and very efficient implementation of HC12 and GAHC solvers for a quadratic assignment problem (QAP) which is one of the hardness optimization problem in the combinatorial domain. The original HC12 and GAHC metaheuristic methods was used [(2000) Brno University of Technology, (2007) University of California, Berkeley, (2008) Vocal 2008]. The paper also describes special QAP problem reformulation suitable for CUDA GPU implementation which was used. The result is, that the designed solvers are in many cases the best in the world at present. The statement is supported by examples of QAPLIB and by results which are computed by another metaheuristic and Matlab/GUROBI solver.

Different Coloring Methods in Maximum Clique Search

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Edge free coloring proved to be most useful in practical NP-hard solving of maximum clique finding. The canonical edge free coloring is an NP-hard problem by itself, so in the maximum clique finding methods we are interested in approximate colorings and use greedy coloring schemes. While we are clearly not interested in the mathematical properties of coloring itself in this aspect, we use the information from the coloring for setting up preconditions and pruning conditions.

This limited usage opens up the possibility to seek for alternative approach instead of canonical coloring, which would serve the same purpose of preconditions and pruning.

We introduced alternative coloring schemes in couple papers published and under publishing. To name some but not all: s-clique free coloring, different edge colorings, aggressive colorings. Also we introduced alternative coloring methods for tournament and directed graph colorings for the problem of maximum transitive subtournament finding problem.

In our presentation we would like to introduce these coloring schemes, show some examples and explain their usage in preconditioning and pruning. Also we would like to present some measurements which would show us the usefulness of the introduced colorings.

A Comparison of Refined Descriptive Sampling and Simple Random Sampling and Their Application on a Vibrating String Model

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Refined descriptive sampling (RDS) [3] derived from Descriptive Sampling (DS) [1] is a method of sampling that can be used to produce input values for estimation of expectation of functions of output variables. The estimator of RDS is shown to be unbiased and a comparison of variances estimators of RDS and simple random sampling [2] is also proposed showing the efficiency of RDS.

In this paper, we study also a comparison between these both sampling methods through a vibrating string model to estimate the solution to the model of d'Alembert, and we obtain an estimator of its mean and its variance. From the results obtained through simulation, the RDS method is proved to be better than simple random sampling method. It is therefore more accurate.

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Implementing Refined Descriptive Sampling into Three Phase Discrete-Event Simulation Systems

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The Bejaia aggregates career in Algeria suffers from low productivity and their related cost. This work investigates how a three discrete-event simulation system PSim: Turbo Pascal Three Phase Simulation Routines and its libraries using Refined Descriptive Sampling (RDS) [1] and Random Sampling (RS) [2], can be used in planning of aggregates production at a minimum cost. Then, this paper examines the behavior of RDS method on a Civil Engineering problem through that career. A model is developed using the activity cycle diagram and the performance measures of the system are evaluated using the developed software "career Simulator". Inefficiencies of the studied problem are identified and improvement is proposed for the career managers by determining the optimal strategy. Furthermore, this paper focuses on the statistical comparison of both sampling methods and the obtained results prove once more the efficiency of RDS over RS. To do so, a random number generator called "RDSRnd" is developed under windows environment in Turbo Pascal programming language and installation in the simulation system PSim is proposed.

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Empirical Analysis of Methods and Software Tools for Batch Process Scheduling

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Batch processes are present in many fields of industry, especially in the production of high valued specific products. Finding the optimal schedule of tasks is a common goal. Due to the complexity of the problem, a huge attention has been paid to developing methods which solve scheduling with an acceptable computational effort. Though the majority of the approaches relies on Mixed-Integer Linear Programming (MILP) formulations, combinatorial approaches have been presented as well.

In the present work, a detailed analysis and comparison is provided among the state-of-the-art approaches via an empirical analysis. Time-based, slot-based and precedence-based MILP models and the S-graph framework were considered. For the MILP-based approaches, commercial and open-source optimization tools such as Gurobi, CPLEX, CBC, and GLPK were used, while the S-graph framework was applied by using a specific combinatorial solver.

The results of the comparison provide valuable information about the efficiency of the different mathematical programming approaches and the developed optimization tools, highlighting advantages and disadvantages at different types of problems.

Global Branching Tree for Throughput Maximization with the S-graph Framework

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Large number of papers has been published for scheduling of industrial batch processes, however, it is still a challenging field in operations research to find the optimal schedule for industrial scale problems. One of the most comprehensive combinatorial tool for batch process scheduling is the S-graph framework, including the S-graph model and the corresponding algorithms.

Majozi and Friedler (2006) developed the first systematic approach for throughput maximization. It examines a sequence of subproblems, especially the instances of the scheduling problem with different number of batches. Although, their S-graph-based approach was extended with acceleration techniques (Holczinger et al. 2007), there is still room for further improvement. In Holczinger et al's approach, a branching tree is generated for each subproblem, even though these branching trees may have common parts. In the present approach, only one branching tree, called global branching tree, is to be built, reducing the redundant computations during the search. With the global branching tree, the examination of different number of batches are able to exploit the previously computed results of other subproblems, resulting in a reduction of the computation time. The effectiveness of the proposed method was tested and proved on different test examples with various time horizons.

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Applying Mathematical Models and Methods to Some Planning Problems of TESCO

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In this talk we present the basic questions and problems of a joint research project between the TESCO Hungary Ltd. and the colleagues of the Institute of Mathematics, Budapest University of Technology and Economics. The main topic of this research is to develop appropriate mathematical models and tools for the planning problems of the TESCO experts in promotion sales.

The first step of this project consist of the following parts: developing appropriate data mining and statistical methods in order to analyze the TESCO database, forecasting the total amount of consumptions in a promotion period, setting up a convenient operations research methodology required by the plan of store-level distribution in TESCO store-network and the dynamic control of goods in promotion sales. Parallel to this problem we also test all of these models on historical data.

In this talk we summarize the applied mathematical models and data mining tools appli ed for the solution of the problems of this project, and we present some useful statistical tools of the data mining procedure and the first results of the solution of the forecast of the total sales of promotions using multivariable stochastic processes.

Minimum Conditional Entropy Based Inventory Control and its Application

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Edith Kovács
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A. Prékopa and T. Szántai published a paper about the dynamic control of the water level of Lake Balaton in 1979. Recently this model has been modified by the authors and A. Egri for controlling the stock level in bargain sale of a department store. The main problem of the new model was that the multivariate normal probability distribution usually cannot be properly fitted to sales data. In our talk we present an information theoretical approach, for finding the so called "informative" variables which give us maximum information on the variable we are interested in. Using the informative variables we forecast the sales data of the forthcoming day and will use the forecasted values for controlling the stock level in bargain sale of a department store. Numerical test results will be presented for both models and the results will be compared.

A Class of Distributed Optimization Methods with Event-triggered and Local Communication

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We present a class of methods for distributed optimization with event-triggered and local communication. To this end, we extend Nesterov's first order scheme to use event-triggered communication in a networked environment. We then apply this approach to generalize the Proximal Center Algorithm (PCA) for separable convex programs by Necoara and Suykens. Our method uses dual decomposition and applies the developed event-triggered version of Nesterov's scheme to update the dual multipliers. The approach is shown to be well suited for solving the active optimal power flow (DC-OPF) problem in parallel with event-triggered and local communication. Numerical results for the IEEE 57 bus and IEEE 118 bus test cases confirm that approximate solutions can be obtained with significantly less communication while satisfying the same accuracy estimates as solutions computed without event-triggered communication.

NLP-based Derivation of Bounded Convex PWA Functions: Application to Complexity Reduction in Explicit MPC

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Explicit Model Predictive Control (MPC) is widely adopted when one aims at a fast, predictable, and certifiable implementation of MPC on hardware platforms which have limited storage and computational capabilities. Despite its simple structure, explicit MPC controllers often suffer from their complexity, expressed in terms of number of regions over which they are defined. Therefore it is of imminent practical importance to keep complexity of the controller low, even at the expense of obtaining a suboptimal performance. The amount of suboptimality, however, must be limited for the controller to remain closed-loop stabilizing. As shown in [1], closed-loop stability is preserved for any controller whose value function is bounded from below and from above by suitable functions. Therefore we can trade optimality for complexity by searching for a simpler representation of the value function, provided it stays bounded. In this paper we show how to find a bounded piecewise affine convex value function of specified complexity by solving a nonlinear optimization problem. The suboptimal, stabilizing feedback law is then recovered by triangulation and interpolation.

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Adaptronic Systems

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In the first part of this talk we investigate the optimal actuator placement for a two dimensional flexible clamped plate. The flexible, clamped plate is described as a finite dimensional, controllable and observable state-space model. The concept of controllability by Kálmán forms the basis for the definition of controllability measures. In this context, the controllability Gramian matrix plays an important role. This matrix can be calculated as the solution of a Lyapunov equation and is the basis for defining the controllability measure. The actuators are placed in such a way that the selected controllability measure becomes maximal. This leads to a nonlinear, convex optimization problem with binary and continuous variables and linear constraints.
In the second part of the talk we deal with the reduction of undesirable vibrations on truss structures using absorbers. We present a method for determining the absorber parameter mass, damping and stiffness, which allows us to optimize the interaction of several absorbers on a complex structure. Also the targeted attenuation of certain frequency regions can be involved in the optimization problem. We use the H_∞-norm as a quality criterion for a generalized disturbance transfer function. The numerical results show that the first bending shapes of the truss structure can be damped well by the optimized absorber parameter setting.

Consistent Conjectural Variations Equilibrium in a Mixed Oligopoly Electricity Market

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In this paper, we consider a mixed oligopoly model of electricity market with conjectures concerning the price variations depending upon the agents' production fluctuations. By introducing the notion of an exterior equilibrium state and making use of a special type of the producers' cost functions, we establish the existence and uniqueness of the exterior (conjectural) equilibrium. Then we propose a criterion of consistency of the agents' conjectures and define the concept of an interior (consistent, or stable) equilibrium state. The interior equilibrium existence is established under quite mild assumptions. This concept allows us to analyze the behavior of groups of consumers with different consumption abilities. The proposed techniques permit us to make a qualitative description of the dependence of the market price upon the active demand component.

Determining the Optimal Number of Cycles in Electronic Repair Processes

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Electronic repair processes (ERP) are business-like, industrialized activities with the purpose to provide electronic repair services to the customers of a service provider enterprise. These processes are typically complex with high number of process states and possible paths from the start state to the absorbing end states. Electronic repair processes are inherently cyclical. After repairing a failure, new problems can appear which causes a circle in the process. Having a circle in an ERP is not necessarily due to its inefficiency as in some cases stepwise and successive debug and repair activities are needed to discover and eliminate all the product defects. However, the number of economically justifiable cycles is relatively small. To study electronic repair processes with finite circulations, we developed an acyclic absorbing Markov chain model. With this model, the likelihood and the time of each possible path in the repair process were calculated. Based on these results, the costs of repeats were modelled and the optimal cycle limit was determined. To complete our studies, we performed sensitivity analyses and considered the effects of possible cost decreases and process changes (relating to process times and path likelihoods). These results can support decisions about process development and can form the basis of a pricing method as well for ERPs and other similar processes.

Optimisation of the HEN Design over Full Life-span with a Simultaneous Risk Assessment

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The extent of heat recovery is naturally constrained by the economy: when the utility prices increase, the limit of recuperation also increases. The optimisation of Heat Exchanger Networks (HENs) is a result of a trade-off between the investment and operating cost. To date, the majority of the optimisation models for HEN synthesis have been developed as single-period models with utility prices being fixed over the whole life-span to their current values. However, those models with fixed utility prices do not truly reflect the appropriate trade-off, since the prices fluctuate significantly. The aim of this work is to optimise the HEN design over its full life-span, considering the fluctuation of utility prices. Additionally, since the forecasts of energy prices are uncertain, the optimisation is intended to be performed with a simultaneous risk assessment. A multi-period mixed-integer nonlinear programming (MINLP) model for HEN synthesis with utility cost coefficients forecasted over the whole life-times has been developed, in order to consider future variations of energy prices. Different projections regarding utility prices have been derived, based on the past utility prices, due to the uncertainty of forecasting. A stochastic approach was applied, where all possible utility price scenarios with its varying probabilities were considered. The maximisation of Expected Incremental Net Present Value (Expected INPV) was selected as an optimisation criterion in order to consider utility prices fluctuations over the whole life-time. In order to asses risk related to the uncertainty of the energy prices, the Certainty Equivalent of INPV was maximised rather than the Expected INPV. The solutions obtained by

the proposed optimisation express more robustness compared to the conventional optimisation techniques, with a higher probability to meet the optimal solution through the whole life-span.

Safety Considerations for Process Network Synthesis Problems

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A manufacturing system consists of operating units which convert their input materials into their output materials. In the problem of designing a process network, we have to find a suitable network of operating units which produces the desired products from the given raw materials. If we consider this process network design problem from a structural point of view, then minimizing the cost of the network leads to an NP-hard combinatorial optimization problem called the Process Network Synthesis or (PNS) problem. Now we define an extension of the PNS problem, where probability of failure is assigned to the operating units, and we need to determine a sufficiently safe solultion with minimal cost. Furthermore, assuming that we have found the desired solution, we have to give possible solutions for the case of failure of some operating units. In this talk we define the extended model, the main problems, solution algorithms, and some special cases, when these algorithms can be more efficient.

Symmetry Reduction of Semidefinite Relaxation with RLT Cuts

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The reformulation-linearization technique (RLT), introduced in [W. P. Adams, H. D. Sherali, A tight linearization and an algorithm for zero-one quadratic programming problems, Management Science, 32(10):1274-1290, 1986], provides a way to build a linear programming approximation hierarchy for NP-hard combinatorial optimization problems. This is a lift-and project type strategy: the 'lifting' refers to the addition of new variables, and the 'projection' to projecting the optimal values of the new variables to a feasible point of the original problem. We study the RLT technique for two specific problems, namely the standard quadratic program and the quadratic assignment problem. The difficulty is that the size of the relaxations is rapidly increasing. We show how one may solve the second level RLT relaxation with additional semidefinite programming constraints in the case of suitable algebraic symmetry in the problem data. Using this technique we are able to compute the best known bounds for certain graph partitioning problems involving strongly regular graphs.

The Practical Behavior of the Homogeneous Self–Dual Formulations in Interior Point Methods

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Interior point methods are well known for their efficiency and numerical robustness when solving large–scale optimization problems fulfilling some regularity conditions, but they often face difficulties when solving primal or dual infeasible problems. As a remedy, various self–dual embedding formulations were proposed which overcome this bottleneck at the expense of additional operations. In our computational study we overview and compare the implementation of the homogeneous self–dual interior point algorithm with the more traditional infeasible–start primal–dual log barrier method. We discuss the differences on a variety of optimization problems and demonstrate our findings by numerical examples.

Efficient Product Form of the Inverse for the Simplex Method

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István Maros
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A new optimizaton system (Pannon Optimizer [PanOpt]) is being developed at the University of Pannonia, Veszprém, Hungary. In the first version we included the Product Form of the Inverse (PFI) for the sake of speedy system development. The implementation of the PFI contains some novel elements and is performing far better than expected. While the literature suggests that no more than 30-50 simplex iterations can be made with PFI (as opposed to LU with 120-150 iterations) we are able to make well over 300 (or even more than 1000) iterations without loss of accuracy. We can solve practically the entire `netlib/lpdata` collection. In the talk we present some details of the implementation and give account of the highlights of our computational study.

Automated Failure Detection of Air Conditioners Based on Sensor Signal Classification

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Nowadays due to the general market conditions and the ever increasing competition and rivalry, industrial companies are pushed to optimize their operational costs, and improve the product and service related business processes. In addition to the normal requirements, the service continuity and availability are also expected. Maintaining of a high level quality requires the failure detection of included service elements as soon as possible. Consequently, automating this aspect of support could be essential to minimize the time, personnel and financial costs in a company's everyday operation.

We were asked by an air conditioner service firm to develop a method which is capable to detect some types of machinery failure based on regularly collected signals of motions sensors attached to the device we are monitoring. The technique we developed consist of two major components, a feature extracting and a sample classifier one.

The first part is responsible for creating a descriptor vector or a sample in other words from the raw data sent by the sensors. This is achieved by Fourier analysis of the received signal. Studying the most significant frequencies and the energy distribution in the relevant frequency interval, we managed to determine some robust features which formed a solid basis for the second process of our method.

Secondly, the classification itself is made by a neural net. The classifier trained by back propagation was able to identify not just the presence of a malfunction but the exact type of failure as well. As secondary objective, we also experimented with different sensor sets as source of information to find a minimal sized sensor configuration which is still capable to provide enough data for an acceptable classification success rate.

The system was entirely implemented in MATLAB using its appropriate toolboxes. The data we used during the development was measured on actually working or malfunctioning air conditioners.

New MILP Models for Real Production Line Optimization

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Permutation flow shop problems (PFSPs) with makespan minimization that model production lines working in industry often have some special features: they are typically large-scale and the jobs can be sorted into types such that jobs of the same type have equal processing time values at each machine. In addition to these constraints we investigate finite buffer sizes of machines and upper bound for the total number of jobs on the line at the same time. We construct adequte new mixed integer linear programming (MILP) models for these problems and investigate them numerically.

A General Purpose Module Using Refined Descriptive Sampling for Installation in Simulation Systems

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Because some form of random sampling (RS) [2] is employed in a simulation, then, some, possibly substantial, sampling error is inevitable. As a consequence, a new paradigm emerged: it is not always necessary to resort to randomness. Then, new non-random sampling methods were derived from this paradigm. In this paper, we propose a software component under Linux, for efficiently implementing a high-quality RDS [3] number generator called "getRDS". It was highly tested by statistic properties and some illustrations of the uniformity are also given together with its installation in M/M/1 simulation system. The obtained results demonstrate that "getRDS" software component produces more accurate and efficient point estimates of the true parameters and can significantly improves performance in at least M/M/1 queuing system compared with the Mersenne Twister MT19937 [1] random number generator.

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