



VOCAL₂₀₁₀

PROGRAM and ABSTRACTS

VOCAL 2010
Program and Abstracts

Sponsors



Faculty of Information Technology, University of Pannonia,
Veszprém, Hungary



Regional Centre of the Hungarian Academy of Sciences,
Veszprém, Hungary

Organizers

Faculty of Information Technology, University of Pannonia
Regional Centre of the Hungarian Academy of Sciences, Veszprém

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VOCAL 2010

The Veszprém Optimization Conference: Advanced Algorithms is held at the Regional Centre of the Hungarian Academy of Sciences in Veszprém (VEAB), Hungary, December 13-15, 2010. The conference is hosted by University of Pannonia.

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 Ch. Pflug

Department of Statistics and Decision Support Systems, University
of Vienna



On stochastic bilevel programs

We consider stochastic bilevel programs, where typically the upper level problem is to determine the price (e.g. in electricity) for a contract asked by a producer and the lower level problem is to determine the demand pattern for the exercising the contract by the consumer.

It is well known that in the deterministic case, even if the lower level problem behaves nice, the upper level problem is difficult.

In the stochastic case, the difficulty is even larger. However, we restrict ourselves to a one-dimensional upper problem and a linear stochastic lower level problem, where – using results from parametric optimization – estimates for the dependency of the solution on the upper level decision can be found. This allows to reduce the upper problem to an interval search.

As application, we demonstrate that electricity swing option pricing leads to exactly the problem described above. Moreover, due to its special structure, the upper level problem can be formulated as a fix-point problem and effectively solved.

Stratos Pistikopoulos

Department of Chemical Engineering, Imperial College, London



Multi-Parametric Programming & Model Predictive Control

Multi-Parametric programming provides a complete map of solutions of an optimization problem as a function of, unknown but bounded, parameters in the model, in a computationally efficient manner, without exhaustively enumerating the entire parameter space. In a Model-based Predictive Control (MPC) framework, multi-parametric programming can be used to obtain the governing control laws - the optimal control variables as an explicit function of the state variables. The main advantage of this approach is that it reduces repetitive on-line control and optimization to simple function evaluations, which can be implemented on simple computational hardware, such as a microchip, thereby opening avenues for many applications in chemical, energy, automotive, and biomedical equipment, devices and systems.

In this presentation, we will first provide a historical overview of the key developments in multi-parametric programming and control. We will then describe a number of key application areas, where this technology shows a lot of potential and discuss key challenges and directions for future research. We will critically address the question of the suitability of multi-parametric control as part of the advanced model-based control technology portfolio of the future.

Michael Ulbrich

Chair of Mathematical Optimization, Technische Universität München



Semismooth Newton methods with multi-dimensional filter globalization for l_1 optimization

For many applications, it is important to include the requirement of sparse solutions efficiently into the formulation of optimization problems. The observation that l_1 -regularization promotes sparsity (i.e. few nonzeros) has resulted in significant recent research with important applications ranging from image inpainting to actuator placement in optimal control.

We start with a discussion of important properties of l_1 -regularized (and thus nonsmooth) optimization problems and sketch selected approaches for their numerical solution. Then, we focus on methods for l_1 -regularized optimization problems that combine semismooth Newton algorithms with globally convergent descent methods in a flexible way. The acceptance of semismooth Newton steps is controlled efficiently by a multi-dimensional filter globalization. The filter approach is especially beneficial here since sufficient decrease conditions are difficult to implement for semismooth Newton steps. Suitable descent methods can, e.g., be obtained via shrinkage steps. We discuss the global convergence of this algorithm and show that under suitable assumptions the method eventually turns into a

semismooth Newton method that converges locally q -superlinearly. Extensions of this approach to l_1 -regularized optimization problems in function space will also be addressed.

The talk concludes with numerical illustrations, including applications to image reconstruction and optimal control problems.

Rolf H. Möhring

Institute of Mathematics, Technische Universität Berlin



Routing in Graphs with Applications to Logistics and Transport

Traffic management and routing in logistic systems are optimization problem by nature. We want to utilize the available street or logistic network in such a way that the total network „load” is minimized or the „throughput” is maximized. This lecture deals with the mathematical aspects of these optimization problems from the viewpoint of network flow theory and scheduling. It leads to flow models in which – in contrast to static flows – the aspects of „time” and „congestion” play a crucial role.

We illustrate these aspects on several applications:

- (1) Traffic guidance in rush hour traffic (cooperation with pty).
- (2) Routing automated guided vehicles in container terminals (cooperation with HHLA).
- (3) Ship Traffic Optimization for the Kiel Canal (cooperation with the German Federal Water- ways and Shipping Administration).

All these applications benefit from new insights into routing in graphs. In (1), it is a routing scheme that achieves traffic patterns that are close to the system optimum but still respect certain fairness conditions, while in (2) it is a very fast real-time algorithm that avoids collisions, deadlocks, and other conflicts already at route

computation. Finally, (4) combines techniques from (2) with special purpose scheduling algorithms.

Technical Program

December 12, 2010 (Sunday)

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

December 13, 2010 (Monday)

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

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

- Welcome note
- Johann Sebastian Bach (1685-1750) : Goldberg Variations BWV 988, pianist Péter Rozsnyói

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

Multi-Parametric Programming & Model Predictive Control

Stratos Pistikopoulos

10:30 am – 11:00 am **Coffee break**

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

An empirical study of different methods in the decomposition approach to two-stage linear SP problems

Eldon Ellison, Csaba Fábián, Gautam Mitra, Viktor Zviarovich

Stochastic Programming DEA Model and Financial Applications

Chanaka Edirisinghe

A computational study on the utility of scenario generation methods in portfolio optimisation

Csaba Fábián, Tibor Vajnai, Gautam Mitra, Diana Roman, Olga Papp, Edit Csizmas

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

A method for approximating general pairwise comparison matrices by consistent matrices

János Fülöp

Nonlinear Transformations for the Simplification of Unconstrained Nonlinear Optimization Problems

Elvira Antal, Tibor Csendes, János Virágh

Computational results of an $O^*(n^4)$ volume algorithm

László Lovász, István Deák

12:30 pm – 2:00 pm **Lunch**

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

On sparse matrix ordering algorithms in interior point methods

Csaba Mészáros

More Colourful Simplices

Antoine Deza, Tamon Stephen, Feng Xie

The similarities and differences of inconsistency indices

Attila Poesz, Sándor Bozóki, János Fülöp

Krein Space Linear Estimation to Fine Alignment on the Moving Base for SINS

Jin Feng, Fei Yu, Wei Gao, Xin Zhang

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

Formulation of Workforce Skill Constraints in Assembly Line Balancing Models

Tamás Koltai, Viola Tatay

Exact Solution for a Bandwidth Packing Problem with Queueing Delay Guarantees

Jinil Han, Kyungsik Lee, Chungmok Lee, Sungsoo Park

Optimizing intermodal transportation planning with an integrated software solution

Ferenc Brachmann, Gergely Nitsch

Modelling career aggregate ALGRAN Adhrar Oufella of Bejaia using the activity cycle diagram

Latifa Baghdali-Ourbih, Megdouda Ourbih-Tari, Abdelnasser Dahmani

4:00 pm – 4:30 pm **Coffee break**

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

Mixed-integer Nonlinear Process Synthesizer MIPSYN
Zdravko Kravanja

An Algorithm for Determination of Time Slices with
Constant Load for Integration of Renewable Sources of
Energy

Andreja Nemet, Petar Sabev Varbanov, Jiří Jaromír Klemesš

Solution of LMIs in the Problem of Robust Stabilization
of Chemical Reactors

Monika Bakosova, Juraj Oravec

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

Calculus of the matrix determinant in ABS
Zsolt Benczúr

Numerical analysis of integer ABS methods
Szabina Fodor, József Abaffy

Developing of a random number generator using Refined
Descriptive Sampling

Megdouda Ourbih-Tari, Abdelouhab Aloui, Amine Alioui

19:00 pm – 20:00 pm **Organ concert in the St. Michael's Cathedral**

December 14, 2010 (Tuesday)

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

8:30 am – 9:30 am **Plenary Session 2**

Semismooth Newton methods with multi-dimensional filter
globalization for l_1 optimization

Michael Ulbrich, Andre Milzarek

9:30 am – 10:30 am **Plenary Session 3**

Routing in Graphs with Applications to Logistics and

Transport

Rolf H. Möhring

10:30 am – 11:00 am **Coffee break**

11:00 am – 12:30 pm **Parallel Session 4A**

Discovering a junction tree behind a Markov network by a greedy algorithm

Edith Kovacs, Tamas Szantai

Obtaining location equilibria of an uncapacitated continuous competitive facility location problem under delivered pricing

Boglárka G.-Tóth, José Fernández, Said Salhi

A Guided Reactive GRASP for the Capacitated Multi-Source Weber Problem

Martino Luis, Said Salhi, Gábor Nagy

11:00 am – 12:30 pm **Parallel Session 4B**

Optimization-Based Derivation of Hybrid Approximations

Michal Kvasnica, Alexander Szucs, Miroslav Fikar

Cell-based dynamic heat exchanger models - direct determination of the cell number and size

Petar Varbanov, Jiří Klemeš, Ferenc Friedler

Advances Biomass Networks Synthesis Methods: P-graph and Mathematical Programming

Hon Loong Lam, Lidija Cuček, Petar Varbanov, Jiří Klemeš, Zdravko Kravanja

12:30 pm – 2:00 pm **Lunch**

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

A Stochastic Programming Approach for QoS-aware Service Composition

Ronald Hochreiter

Optimization under Model Ambiguity: Maximum-Loss, Minimum-Win and the Esscher Pricing Principle

Raimund Kovacevic

Algorithmic framework for approximate stochastic design of flexible process flow sheets

Mihail Kasas, Zdravko Kravanja, Zorka Novak Pintaric

Economic oriented stochastic optimization of model predictive controlled processes

Laszlo Dobos, Andras Kiraly, Janos Abonyi

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

New Lower Bound for Online Bin Packing Algorithms

János Balogh, József Békési, Gábor Galambos

Bin covering games

Attila Benko, Gyorgy Dosa, Zsolt Tuza

Online 2-dimensional clustering problems

Gabriella Divéki, Csanád Imreh

S-graph as an integrated modelling and optimization tool for the scheduling of industrial batch processes

Tibor Holczinger, Mate Hegyhati, Ferenc Friedler

4:00 pm – 4:30 pm **Coffee break**

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

Hybrid systems: discrete and continuous dynamics

István Györi

Computation of Consistent Equilibrium in Mixed Oligopoly Markets

Nataliya Kalashnykova, Vladimir Bulavsky, Vyacheslav Kalashnikov

Computing Minimum- norm Solution of a Specific Constrained Convex Problem

Saeed Ketabchi, Hossein Moosaei

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

Using P-Graph for Optimising Regional Sustainable Energy Systems

Laszlo Halasz, Michael Eder, Nora Sandor, Nora Niemetz, Karl-Heinz Kettl, Michael Narodslawsky

Algorithmic Synthesis of Process Networks with Time Constraints by the P-graph Framework

Botond Bertók, Károly Kalauz, Zoltán Süle, L.T. Fan, Ferenc Friedler

Generation of Redundant Structures to Guarantee Pre-defined Level of Reliability in Business Processes

Károly Kalauz, Zoltán Süle, Botond Bertók, Ferenc Friedler, L.T. Fan

7:00 pm – 10:00 pm **Banquett in Villa Medici**

December 15, 2010 (Wednesday)

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

9:00 am – 10:00 am **Plenary Session 4**

On stochastic bilevel programs

Georg Ch. Pflug

10:00 am – 10:30 am **Coffee break**

10:30 pm – 12:30 pm **Parallel Session 7A**

Manifold Learning by Semidefinite Facial Reduction

Babak Alipanahi, Nathan Krislock, Ali Ghodsi

Computation of Huber's M -estimator using a primal-dual active-set method with a long step rule

Tanja Binder, Ekaterina Kostina

Newton's method in eigenvalue optimization for incomplete pairwise comparison matrices

Kristóf Abele-Nagy, Sándor Bozóki

A Multiobjective Dynamic Nonlinear Robot Assignment Problem

István Maros, Sampo Ruuth, Kimmo Nieminen

10:30 pm – 12:30 pm **Parallel Session 7B**

Computational performance of simplex and MBU-simplex algorithms using different anti-cycling pivot rules

Tibor Illés, Adrienn Nagy

Simplex based solution of convex quadratic programming problems

Zsolt Csizmadia

General linear complementarity problems: algorithms and models

Zsolt Csizmadia, Tibor Illés, Adrienn Nagy, Marianna Nagy

Some combinatorial optimisation problems in multimedia systems

Tibor Szkaliczki

12:30 pm – 2:00 pm **Lunch**

2:00 pm – 4:00 pm **Parallel Session 8A**

On the handicap of a sufficient matrix

Marianna Nagy, Etienne de Klerk

Positive Edge: A new rule to identify non-degenerate simplex pivots

Vincent Raymond, François Soumis, Abdelmoutalib Metrane, Jacques Desrosiers

Implementing the simplex method as a cutting-plane method

Csaba Fábián, Olga Papp, Krisztián Eretnék

NCP functions

Aurél Galántai

2:00 pm – 4:00 pm **Parallel Session 8B**

Time-Optimal Diafiltration Process: Dynamic Optimization Approach

Radoslav Paulen, Miroslav Fikar, Greg Foley, Zoltán Kovács, Peter Czermak

Measurement-based Optimisation of Batch Process by Integrated Two-Time-Scale Scheme

Marian Podmajersky, Benoit Chachuat, Miroslav Fikar

Using greedy-type graph colorings for relatively useful bounds in operations research

M. Hujter

Combinatorial optimization and Cross Entropy Method

Afet Oneren, Arif Akkeles, Filiz Bilen

4:00 pm – 4:30 pm **Coffee break**4:30 pm – 6:00 pm **Parallel Session 9A**

Parallel greedy algorithms for the permutation flow shop problems

Zoltán Horváth, Pál Pusztai

Parallel Gene Transfer Operators of Bacterial Evolutionary Algorithm

András Horváth, Miklós Hatwágner

Gaussian Transductive Regression

Gábor Takács

4:30 pm – 6:00 pm **Parallel Session 9B**

Reliability of Process-Networks

Zoltan Kovacs, Botond Bertók, Ferenc Friedler, L.T. Fan

P-graph Representation and Structural Analysis of Business Process Models

Tünde Tarczali, Helga Kadanoczki, Edina Osz, Gergely Zachár, Károly Kalauz, Zoltán Süle

Scheduling of Bus Maintenance by the P-graph Methodology

Róbert Adonyi, István Heckl, Ferenc Olti, Ferenc Friedler

6:00 pm – 6:30 pm **Closing**

Abstracts

An empirical study of different methods in the decomposition approach to two-stage linear SP problems.

Eldon Ellison

Brunel University, UK

Csaba Fábíán

Eotvos Lorand University, Hungary

Gautam Mitra

Brunel University, UK

Viktar Zviarovich

Brunel University, UK

Benders Decomposition, with its developments, becomes the method of choice for obtaining exact solutions to linear SP problems once the simple Deterministic Equivalent LP becomes too large to solve efficiently. Regularisation is necessary to dampen the zig-zagging that arises and improve convergence. There are three principle methods that we concentrate on here, and two general structures for the algorithm: that is with separate cuts for each scenario, or with cuts aggregated. We show here that aggregation becomes the best choice for larger scenario-counts in any series of similar models with increasing scenario-size. Best choice is dependent on the computing environment and on the efficiency with which the LP and QP solvers can be integrated. Certain inferences can be drawn for sampling methods.

Stochastic Programming DEA Model and Financial Applications

Chanaka Edirisinghe

University of Tennessee, U.S.A.

A stochastic programming extension to the traditional Data Envelopment Analysis (DEA) model is developed when input/output data are random. The resulting optimization model yields robust performance metrics for underlying firms by controlling for outlier data and randomness in data. The traditional DEA model is shown to over-estimate the actual firm efficiencies. The stochastic model is used to develop lower and upper estimates on performance. These results are applied within portfolio optimization via fundamental analysis of public firms. Computational results are presented for validation of the proposed methodology.

A computational study on the utility of scenario generation methods in portfolio optimisation

Csaba Fábián

Kecskemet College, Hungary

Tibor Vajnai

Kecskemet College, Hungary

Gautam Mitra

Brunel University, UK

Diana Roman

Brunel University, UK

Olga Papp

Kecskemet College, Hungary

Edit Csizmas

Kecskemet College, Hungary

The main aim of this study is to test whether the performance of portfolio choice models is improved by using scenario generators for the future returns of the assets involved. We use two portfolio choice models, both based on Second-order Stochastic Dominance. One is the multi-objective model of Roman, Darby-Dowman and Mitra (2006) that we call unscaled model. The other is the scaled model of and Fábián, Mitra, Roman and Zverovich (2010). We construct optimal portfolios using representations of the future asset returns given by (a) historical data, (b) scenarios generated by Geometric Brownian Motion, and (c) scenarios generated using Copulas. The properties of copula provide a way to create a model distribution and its calibration and simulation. In this article we apply the Gaussian copula and the two types of marginal (log-normal and empirical) distributions to generate different scenarios.

Our test data consist of weekly returns of 68 stocks from the FTSE 100 basket, together with the weekly returns of the FTSE 100 index. We consider the period 1993-2009. The above mentioned real market data was used to calibrate the copula and marginal distributions. Part of the data are reserved for out-of-sample tests. In

both portfolio choice models, the objective is to construct a portfolio that dominates the stock to the largest possible extent. We compare the return distributions of the respective optimal portfolios of the models.

A method for approximating general pairwise comparison matrices by consistent matrices

János Fülöp

Computer and Automation Research Institute, Hungarian Academy of Sciences, Hungary

In multiattribute decision making, pairwise comparison (PC) matrices are applied to derive implicit weights for a given set of decision alternatives. A class of the approaches is based on the approximation of the PC matrix by a consistent matrix. We consider PC matrices without the reciprocity condition, and approximate them by consistent matrices in the least-squares sense. We transform the problem into the form of separable programming, and give sufficient conditions of the convexity of the objective function over the feasible set. For the general case, we propose a branch-and-bound method.

Nonlinear Transformations for the Simplification of Unconstrained Nonlinear Optimization Problems

Elvira Antal

University of Szeged, Hungary

Tibor Csendes

University of Szeged, Hungary

János Virág

University of Szeged, Hungary

The form of an optimization problem could significantly influence the complexity of the solution and so the efficiency of the applied solver method.

As it was pointed out by Csendes and Rapcsák[1, 2], in some cases it is possible to simplify the unconstrained nonlinear objective function by nonlinear coordinate transformations. That means mostly symbolic replacement of redundant subexpressions with the expectation to relax the necessary effort of the solver, while the simplified task still remain equivalent to the original.

We present a proper implementation of the referred theoretical algorithm in a modern symbolic computation environment, and provide some solved examples both from the original publications and from the set of standard global optimization test problems.

[1] T. Csendes and T. Rapcsák: Nonlinear Coordinate Transformations for Unconstrained Optimization. I. Basic Transformations. J. of Global Optimization 3(1993) 213-221

[2] T. Rapcsák and T. Csendes: Nonlinear Coordinate Transformations for Unconstrained Optimization. II. Theoretical Background., J. of Global Optimization 3(1993) 359-375

Computational results of an $O^*(n^4)$ volume algorithm

Laszlo Lovasz

ELTE, Hungary

Istvan Deak

Corvinus University of Budapest, Hungary

Recently an $O^*(n^4)$ randomized volume algorithm has been presented for convex bodies by Lovász and Vempala. This algorithm is the product of more than ten years of development, and presently it seems to be the best procedure for computing volume of convex bodies, given by an oracle. Essentially the algorithm is a series of Monte Carlo integrations. In this paper we describe a computer implementation of the volume algorithm, and present some computational results for convex bodies in dimensions ranging from 2 to 10, bounded by hyperplanes.

On sparse matrix ordering algorithms in interior point methods

Csaba Mészáros

MTA SZTAKI, Hungary

The major computational task of most interior point implementations is solving systems of equations with symmetric coefficient matrix by direct factorization methods, therefore, the performance of Cholesky-like factorizations is a critical issue. In case of sparse and large problems the efficiency of the factorizations is closely related to the exploitation of the nonzero structure of the problem. A number of techniques were developed for fill-reducing sparse matrix orderings which make Cholesky factorizations more efficient by reducing the necessary floating point computations. We present a variant of the nested dissection algorithm incorporating special techniques that are beneficial for graph partitioning problems arising in the ordering step of interior point implementations. We illustrate the behavior of our algorithm and provide numerical results and comparisons with other sparse matrix ordering methods.

More Colourful Simplices

Antoine Deza

C&O, Paris VI, France and McMaster University, Canada

Tamon Stephen

Simon Fraser University, Canada

Feng Xie

McMaster University, Canada

A point $p \in R^d$ has *simplicial depth* q relative to a set S if it is contained in q closed simplices generated by $(d+1)$ sets of S . This was introduced by Liu (1990) as a statistical measure of how representative p is of S . More generally, we consider *colourful simplicial depth*, where the single set S is replaced by $(d+1)$ sets, or colours, $\mathbf{S}_1, \dots, \mathbf{S}_{d+1}$, and the *colourful* simplices containing p are generated by taking one point from each set. Assuming that the convex hulls of the $\mathbf{S}_i$'s contain p in their interior, Bárány's colourful Carathéodory Theorem (1982) shows that p must be contained in some colourful simplex. We are interested in determining the minimum number of colourful simplices that can contain p for sets satisfying these conditions. That is, we would like to determine $\mu(d)$, the minimum number of colourful simplices drawn from $\mathbf{S}_1, \dots, \mathbf{S}_{d+1}$ that contain $p \in R^d$ given that $p \in \text{int}(\text{conv}(\mathbf{S}_i))$ for each i . Without loss of generality, we assume that the points in $\bigcup_i \mathbf{S}_i \cup \{p\}$ are in general position. The quantity $\mu(d)$ was investigated in Deza, Huang, Stephen, and Terlaky (2006), where it is shown that $2d \leq \mu(d) \leq d^2 + 1$, that $\mu(d)$ is even for odd d , and that $\mu(2) = 5$. This paper also conjectures that $\mu(d) = d^2 + 1$ for all $d \geq 1$. Subsequently, Bárány and Matoušek (2007) verified the conjecture for $d = 3$ and provided a lower bound of $\mu(d) \geq \max(3d, \lceil \frac{d(d+1)}{5} \rceil)$ for $d \geq 3$, while Stephen and Thomas (2008) independently provided a lower bound of $\mu(d) \geq \left\lfloor \frac{(d+2)^2}{4} \right\rfloor$. We show that for $d \geq 1$, we have $\mu(d) \geq \lceil \frac{(d+1)^2}{2} \rceil$. This strengthens the previously known lower bounds for all $d \geq 4$.

The similarities and differences of inconsistency indices

Attila Poesz

Department of Operations Research, Corvinus University of Budapest,
Hungary

Sándor Bozóki

Department of Operations Research, Corvinus University of Budapest,
Hungary

János Fülöp

Computer and Automation Research Institute, Hungarian Academy of
Sciences, Hungary

Pairwise comparison matrices are often used in Multi-attribute Decision Making for determining relative importance of the attributes or evaluation of the alternatives. The decision makers can rarely establish consistent pairwise comparison matrices but it is crucial to measure and detect high inconsistency. The index of inconsistency can be defined in several ways, a few of them are discussed in the talk. We present a convex mixed integer optimization problem (MIP or MINLP) for all indices to find a matrix element or elements by the modification of which we can minimize the corresponding consistency index. In order to see the similarities and differences of the optimal elements resulted by indices tests on a database of empirical pairwise comparison matrices (EPCM) originated from real decision problems were run.

Krein Space Linear Estimation to Fine Alignment on the Moving Base for SINS

Jin Feng

Harbin Engineering University, China

Fei Yu

Harbin Engineering University, China

Wei Gao

Harbin Engineering University, China

Xin Zhang

Harbin Engineering University, China

In this paper, Krein space linear estimation to fine alignment on the moving base for Strapdown Inertial Navigation System (SINS) is proposed.

The error of attitude is identified by the difference between positions of SINS and Global Positioning System (GPS). And the speed is provided by SINS. However, the speed is inaccurate before the accomplishment of fine alignment. Simultaneously, Lever-arm Effect exists. Thus parameter uncertainty exists in the state transition matrix as well as the observe matrix. Moreover, the bias is time-varying and accumulated in SINS.

The deterministic Sum Quadratic Constraint (SQC) is an economic ellipsoidal constraint to initial conditions and system uncertainties. It leads to an ellipsoidal set-valued estimation problem. Then the objective deterministic quadratic form is obtained from the SQC. The optimum of the quadratic form is the result that fine alignment wants.

The corresponding formal stochastic system in Krein space is established from the quadratic form. After verifying the inertia condition to the minimizing point of the quadratic form, the priori and the posteriori estimation recursions of Krein space linear estimation to fine alignment are proposed. In addition to the priori and the posteriori gain, the cross-correlation gain is also needed.

Finally, the simulation to fine alignment for SINS with time-varying bias is given. Compared to standard Kalman estimation, the proposed Krein space estimation shows robustness.

Formulation of Workforce Skill Constraints in Assembly Line Balancing Models

Tamás Koltai

Budapest Univesrity of Technology and Economics/Dept of
Management and Corporate Economics, Hungary

Viola Tatay

Budapest Univesrity of Technology and Economics/Dept of
Management and Corporate Economics, Hungary

The objective of assembly line balancing (ALB) is to minimize the number of workstations organized to perform tasks with precedence constraints. An important element of proper assignment of tasks to workstation is the consideration of skill requirement of tasks, and skill level of workers. Some tasks may require special skills, some workers might not be able to perform complicated tasks, and some workers might be specialized for specific tasks. This paper provides a general framework to model skill requirements and skill conditions for assembly line balancing models. Three types of skill constraints are defined. Low skill constraints determine workstations for workers who are able to perform only some simple tasks. High skill constraints consider tasks which require higher than average skills of workers. Finally, exclusive skill constraints consider situations where different groups of workers are specialized for different subsets of tasks. The paper summarizes the mathematical description of the different skill constraints, and shows how simple assembly line balancing models can be completed with skill considerations. The mathematical characteristics of the resulting models are discussed, and some sample problems are solved to illustrate the results of each specific skill situation.

Exact Solution for a Bandwidth Packing Problem with Queueing Delay Guarantees

Jinil Han

KAIST, South Korea

Kyungsik Lee

Hankuk University of Foreign Studies, South Korea

Chungmok Lee

KAIST, South Korea

Sungsoo Park

KAIST, South Korea

The bandwidth packing problem concerns the selection of calls from a given set and the assignment of one path to each selected call. We want to maximize profit while the routings of the selected calls observe the capacity constraints of the links. Here, we additionally consider queueing delays in the network, which possibly deteriorate quality of service to users if they exceed the acceptable limits. The integer programming formulation for the bandwidth packing problem assuring queueing delay restriction contains nonlinear constraints intrinsically. We reformulate the problem as a linearly constrained one by applying the Danzig-Wolfe decomposition to the original formulation. Since it has exponentially many variables, branch-and-price procedure is proposed to solve it. Then the nonlinearity in the original formulation is transferred to the knapsack subproblem and we can efficiently solve this nonlinear knapsack problem by modifying the dynamic programming algorithm for the ordinary knapsack problem slightly. We report computational results on some realistic telecommunication networks which show that the exact solutions can be obtained in a reasonable time.

Optimizing intermodal transportation planning with an integrated software solution

Ferenc Brachmann

University of Pécs - Faculty of Sciences, Hungary

Gergely Nitsch

KÖZLEKEDÉS Consulting and Planning Engineers Ltd., Hungary

The subject of intermodal local and regional transportation planning is a hot topic in the field of transportation sciences. Multimodal optimizations have significant possibilities for decreasing costs and increasing customer satisfaction.

Our concept covers aspects of public transportation planning and operation, from strategic planning to controlling and accounting stages. Key elements are data integration from multiple sources, change management, scenario analysis, multilingual environment, standardized architecture and CEN-standard interfaces.

The proposed software optimization solution will be able to offer the following functionality: - Cadenced, national-level intermodal transportation planning (based on available data) for passengers - Support for route planning and re-planning with support for precise connection planning and handling of emergency or temporary situations - Offer support for high-level professionals in the transportation operation sector

Solution architecture is based on CEN reference data model 'Transmodel', while interaction is planned to be based on the NeTEx network and timetable exchange standard which is in preparation phase at the moment. Applied technologies include widespread GIS Engine and RDBMS solutions.

Keywords: intermodal public transport, optimization, efficiency, intelligent services

Modelling career aggregate ALGRAN Adhrar Oufella of Bejaia using the activity cycle diagram

Latifa Baghdali-Ourbih

Higher National School of Public Works (ENSTP), Algeria

Megdouda Ourbih-Tari

University A. Mira of Bejaia, Algeria

Abdelnasser Dahmani

University A. Mira of Bejaia, Algeria

Generally the functionality of a career are: drilling, testing and blasting holes, shooting, inspection of premises to remove the guard, loading and transporting the rock to the crushing zone and finally the primary and secondary crushing of the rock. All these operations are complex and this complexity is related to conditions of startup and shutdown of such complex activities. This superimposition of factors requires the representation of the system as a model in which all its components interact. This paper proposes a modelling career aggregate ALGRAN adhrar Oufella of Bejaia using the activity cycle diagram of which expresses the logic of complex simulation models effectively. This model is based on expanded activity cycle diagram. It aims to measure the performance of the career by optimizing the number of trucks needed (Given the frequent breakdowns of dumpers) and completion time of the desired aggregate, taking into account the costs of different operations.

Mixed-integer Nonlinear Process Synthesizer MIPSYN

Zdravko Kravanja

Faculty of Chemistry and Chemical Engineering, University of Maribor,
Slovenia

Although several efficient mixed-integer nonlinear programming (MINLP) solvers have been developed in the last two decades, hardly any academic or professional MINLP synthesizer for solving non-trivial process synthesis problems has been developed so far. The present contribution wishes to shed light on some important issues relating to different challenges that had to and still have to be mastered as well as various capabilities which in turn were rewarded by mastering some of the challenges during the development of the advanced systems synthesizer MIPSYN (Kravanja, 2010), the successor of the process synthesizer PROSYN (Kravanja and Grossmann, 1990, 1994). Capabilities that have been implemented in the synthesizer like automated vs. interactive mode of operation, initialization of NLP subproblems, calling different NLP and MILP solvers in a sequence with different option files, efficient modeling formulations (hybrid models, convex-hull and alternative convex-hull formulations), different strategies, e.g. modeling and decomposition strategy, multi-level MINLP, a possibility of solving feasibility problems with augmented penalty objective functions, multi-objective optimization, integer-infeasible path optimization, multi-period optimization, and flexible synthesis in cases of uncertain parameters will be briefly discussed in the presentation.

An Algorithm for Determination of Time Slices with Constant Load for Integration of Renewable Sources of Energy

Andreja Nemet

University of Pannonia, FIT, Research Institute of Chemical Technology
and Process Engineering, CPI2, Hungary

Petar Sabev Varbanov

University of Pannonia, FIT, Research Institute of Chemical Technology
and Process Engineering, CPI2, Hungary

Jiří Jaromir Klemes

University of Pannonia, FIT, Research Institute of Chemical Technology
and Process Engineering, CPI2, Hungary

An important problem of renewable energy supply is their varying availability and the variation of process energy demands. For handling this problem a new algorithm is developed. The goal is to determine a set of Time Slices with piecewise-constant heat loads, minimising the integral imprecision between the measured and approximating load profile while also minimising the number of Time Slices. Two main approaches are investigated. One is to determine the load threshold within which the fluctuation can be neglected. If the difference between heat loads of the neighbouring measurement is larger from threshold, a new Time Slice is created. The optimal threshold value is selected from the trade-off between the overall imprecision and number of time slices. The other approach is to partition the measured heat load curve into a large number of time intervals and represent it by an equivalent piecewise-constant profile with high precision. The latter is supplied to a MILP formulation to screen the candidate time boundaries using binary variables of acceptance-rejection. The time slice definitions are completed by the corresponding approximating heat loads. The objective is to minimise the overall integral imprecision between the time integrals of the input load profile and the approximation profile. To determine which algorithm is better, their solutions are compared using several criteria, the imprecision, the number of Time Slices, and the speed of obtaining the solution.

Solution of LMIs in the Problem of Robust Stabilization of Chemical Reactors

Monika Bakosova

Slovak University of Technology in Bratislava, Faculty of Chemical and Food Technology, Slovakia

Juraj Oravec

Slovak University of Technology in Bratislava, Faculty of Chemical and Food Technology, Slovakia

Chemical reactors are ones of the most important plants in chemical industry. However, their operation is corrupted with different uncertainties that can even instability of a closed-loop control system. Chemical reactors are ones of the most important plants in chemical industry. However, their operation is corrupted with different uncertainties that can even instability of a closed-loop control system. Application of robust static output feedback control can be one of ways to overcome this problem. The necessary and sufficient conditions for robust stabilization can be formulated in the form of linear matrix inequalities (LMIs). The solution of LMIs represents in fact the problem of convex optimization. The second aspect of the robust stabilization problem is related to finding a procedure for obtaining robustly stabilizing control law, because it is necessary to solve several sets of LMIs. The procedure can be either iterative or non-iterative one. In this paper, necessary and sufficient conditions for robust stabilization of uncertain linear continuous-time systems via static output feedback are presented at first. Then, these conditions are transformed into two sets of LMIs and a computationally simple non-iterative algorithm is used for the design of robust static output feedback controller. The main aim of this paper is to compare and analyze two possibilities of LMIs solution in the MATLAB programming environment. The first approach uses Robust Control Toolbox and the second uses YALMIP toolbox and solver SeDuMi. CPU time and control performance reached by the designed robust controller are used for comparison of these two approaches.

Calculus of the matrix determinant in ABS

Zsolt Benczúr

Corvinus University of Budapest, Hungary

Linear systems of equations have a great importance both in academic research and in managerial applications. ABS is very efficient in the calculation of linear systems of equations. In my study I am focusing on the potential ways of improvement of the linear algebra calculus in ABS class, especially on the calculus of the matrix determinant by decreasing the number of operations while increasing the speed of the calculus. The minimal number of operations is theoretically $n^3/6$, but it has never been reached yet. It is an exciting research question if it is possible to take a step forward to this theoretical limit and if so, how, with which optimisation method. The methodology of the research is based on the comparative analysis of my results in the matrix determinant calculus in the ABS class (according to Abaffy's H-matrix) and in the MATLAB program package, laying emphasis on the aggregated calculus of the determinants of those matrixes belonging to the principal minors, starting from the upper-left part of the matrix. To support comparability I am implementing the ABS method for matrix determinant calculus to the MATLAB program package.

Numerical analysis of integer ABS methods

Szabina Fodor

Corvinus University of Budapest, Hungary

József Abaffy

Corvinus University of Budapest, Hungary

Solving Diophantine systems of equations is a challenging task due to the large magnitude of intermediate computational values. We have previously developed a novel group of algorithms (called integer ABS or iABS) to solve full rank and rank-deficient linear Diophantine systems of equations based on the Abaffy-Broyden-Spedicato (ABS) class of methods. We also suggested several approaches to keep the intermediate values and number of computation steps at the minimum possible by using different iABS variants designated scaled iABS (siABS), scaled symmetric iABS (ssiABS) and scaled non-symmetric iABS (snsiABS). Here we provide the first numerical analysis of those iABS algorithms. The different iABS variants were implemented using a new Java numerical package (JABS) and their performance in terms of speed and the magnitude of the intermediate values were tested. All implemented algorithms were able to solve pre-defined and randomly generated linear Diophantine systems of equations. Analysis of a large set of randomly generated systems of equations identified one sub-variant of the snsiABS algorithm which was able to solve the largest systems of equations at a given allocation of computer memory and it was also the fastest of all algorithms tested. Direct comparison with the linsolve algorithm of the commercially available Maple software indicated that the most effective sub-variant of our iABS algorithm has significantly outperformed the Maple software.

Developing of a random number generator using Refined Descriptive Sampling

Megdouda Ourbih-Tari

University of Bejaia, Algeria

Abdelouhab Aloui

University of Bejaia, Algeria

Amine Alioui

University of Bejaia, Algeria

Because some form of random sampling (RS) 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 for efficiently implementing a high-quality RDS 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 improve performance in at least M/M/1 queuing system compared with the random number generator built in C programming language under Linux.

Discovering a junction tree behind a Markov network by a greedy algorithm

Edith Kovacs

Budapest College of Management, Department of Mathematics,
Hungary

Tamas Szantai

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

In our paper [1] we introduced a special kind of k -width junction tree, called k -th order t -cherry junction tree in order to approximate a joint probability distribution. The approximation is the best if the Kullback-Leibler divergence between the true joint probability distribution and the approximating one is minimal. Finding the best approximating k -width junction tree is NP-complete if $k \geq 2$ (see in [2]). In [1] we also proved that the best approximating k -width junction tree can be found between the k -th order t -cherry junction trees and developed a greedy algorithm resulting very good approximations in reasonable computing time.

In this paper we prove that if the Markov network underlying the random variables corresponds to a chordal graph or can be transformed into it, our greedy algorithm is able to find the true probability distribution. We emphasize that in opposite to other approaches ([3] and [4]) our algorithm does not need any knowledge about the underlying Markov network. Our algorithm uses just the k -th order marginal probability distributions.

Keywords: conditional independence, Markov network, chordal graph, t -cherry junction tree.

[1] T. Szántai and E. Kovács, Hypergraphs as a mean of discovering the dependence structure of a discrete multivariate probability distribution, Proc. Conference APplied mathematical programming and MODelling (APMOD), 2008, Bratislava, 27-31 May 2008, Annals of Operations Research, to appear. [2] D. Karger, N. Srebro, Learning Markov Networks: Maximum Bounded Tree-Width Graphs, in: Proceedings of the 12th ACM-SIAM Symposium on Discrete Algorithms, 2001, pp. 392-401. [3] S.L. Lauritzen, D.J. Spiegelhalter, Local computations with probabilities on graphical structures and their application to expert systems, Journal of the

Royal Statistical Society, Ser. B 50 (1988) No. 2, pp. 157-224.
[4] J. Pearl, Probabilistic Reasoning in Intelligent Systems, Morgan Kaufmann Publishers, Revised second printing edition, 1997.

Obtaining location equilibria of an uncapacitated continuous competitive facility location problem under delivered pricing

Boglárka G.-Tóth

Budapest University of Technology and Economics, Hungary

José Fernández

University of Murcia, Spain

Said Salhi

University of Kent, United Kingdom

The problem of finding location equilibria of a location-price game where firms first select their locations and then set delivery prices in order to maximize their profits is investigated. Assuming that firms set the equilibrium prices in the second stage, the game is reduced to a location game for which a global minimizer of the social cost is a location equilibrium (provided that demand is completely inelastic and marginal production cost is constant). When the set of feasible locations is a region of the plane the minimization of the social cost is a hard-to-solve global optimization problem. We propose both an exact interval branch-and-bound algorithm and a Weiszfeld-like heuristic to solve the problem. Computational studies are reported.

A Guided Reactive GRASP for the Capacitated Multi-Source Weber Problem

Martino Luis

Institut Teknologi Nasional, Indonesia

Said Salhi

University of Kent, United Kingdom

Gábor Nagy

University of Kent, United Kingdom

The capacitated multi-source Weber problem entails finding both the locations of capacitated facilities on a plane and their customer allocations. A framework that uses adaptive learning and functional representation to construct the restricted candidate list (RCL) within a greedy randomized adaptive search procedure (GRASP) is put forward. An implementation of restricted regions that forbids new facilities to be located too close to the previously found facilities is also embedded into the search to build up the RCL more efficiently. The performance of this GRASP based approach is tested on three classes of instances with constant and variable capacities. Very competitive results are obtained when compared to the best known results from the literature.

Optimization-Based Derivation of Hybrid Approximations

Michal Kvasnica

Slovak University of Technology in Bratislava, Slovakia

Alexander Szucs

Slovak University of Technology in Bratislava, Slovakia

Miroslav Fikar

Slovak University of Technology in Bratislava, Slovakia

Mathematical models of real plants play a vital role in many areas, such as in rigorous simulations or control synthesis. Here, high model accuracy is usually desired while keeping the model complexity on an acceptable level. Recently, the concept of hybrid models was introduced as a good compromise between accuracy and complexity. Hybrid models feature a collection of local linear models accompanied with logic conditions which enforce switching of the local dynamics. The problem which we address in this paper is the following: given a nonlinear dynamical model and a fixed complexity of its hybrid approximation, how should one design the hybrid model of maximal accuracy? The answer is first provided in terms of optimally approximating nonlinear functions in one variable. The best approximation is found by solving a nonlinear optimization problem where good initial guesses are found by a tailored heuristic procedure. Subsequently, the procedure is extended to approximation of functions in n variables and we show that this problem boils down to solving n problems of the former kind. Finally, a case study with a highly nonlinear chemical reactor is presented to illustrate benefits of the optimization-based approach over other possibilities. Numerical results are provided to show that the procedure is computationally efficient and tractable.

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Cell-based dynamic heat exchanger models - direct determination of the cell number and size

Petar Varbanov

University of Pannonia, Hungary

Jiří Kleměš

University of Pannonia, Hungary

Ferenc Friedler

University of Pannonia, Hungary

Large amounts of thermal energy are transferred to for heating or cooling in the industry as well as in the other sectors. Typical examples are crude oil preheating, ethylene plants, exothermic and endothermic reactions and many others. Heat exchangers frequently operate under varying conditions. Their appropriate use in flexible heat exchanger networks as well as maintenance/reliability related calculations require adequate models for estimating their dynamic behaviour. Cell-based dynamic models are very often used to represent heat exchangers with varying arrangements. This paper describes a direct method and a visualisation technique for determining the number of the modelling cells and their size. It is based on the evaluation of the temperature differences inside the modelling cells and equivalent recalculation of the heat transfer coefficients. Although the procedure is illustrated on shell-and-tube heat exchangers, it can be readily extended further to the other kinds of heat exchangers.

Advances Biomass Networks Synthesis Methods: P-graph and Mathematical Programming

Hon Loong Lam

University of Pannonia, Hungary

Lidija Cuček

University of Maribor, Slovenia

Petar Varbanov

University of Pannonia, Hungary

Jiří Klemeš

University of Pannonia, Hungary

Zdravko Kravanja

University of Maribor, Slovenia

This contribution presents two advanced approaches for biomass and biofuel production networks synthesis. Both of them have the optimisation criterion the maximization of the profit, whilst considering the environmental issues. The first approach is P-graph (Process Graph). The P-graph framework has been introduced by Friedler et al. (1992) and consequently further developed for systematic optimal design, i.e., synthesis, of industrial processes and also supply networks for multiple products in the process industry. The networks synthesis can be also carried out by a generic optimisation model of production and supply networks of biomass. The superstructure approach is based on the flexible number of network layers: plantation, collection and pre-treatment, process, and consumption. The constraints, process specifications, mass and energy balances for each layer are represented by Mixed Integer Linear Programming (MILP). The optimal solution to different distances and sizes of zones and region, transportation costs and pre-processing alternatives from these two methods are analysed and compared.

A Stochastic Programming Approach for QoS-aware Service Composition

Ronald Hochreiter

WU Vienna University of Economics and Business, Austria

We formulate the service composition problem as a multi-objective stochastic program which simultaneously optimizes the following quality of service (QoS) parameters: workflow duration, service invocation costs, availability, and reliability. All of these quality measures are modelled as decision-dependent random variables. Our model minimizes the average value-at-risk (AVaR) of the workflow duration and costs while imposing constraints on the workflow availability and reliability. By replacing the random durations and costs with their expected values, our risk-aware model reduces to the nominal problem formulation prevalent in literature. We argue that this nominal model can lead to overly risky decisions. Scalability properties of the model are presented and aspects of scenario generation for this specific problem are discussed. (Joint work with W. Wiesemann and D. Kuhn, Imperial College of Science, London)

Optimization under Model Ambiguity: Maximum-Loss, Minimum-Win and the Esscher Pricing Principle

Raimund Kovacevic

University of Vienna, Austria

Maximum-Loss was recently introduced as a valuation functional by T. Breuer and I. Csiszár in the context of systematic stress testing. The basic idea is, to value a (financial) random variable by its worst case expectation, where the most unfavourable probability measure - the worst case distribution - lies within a given Kullback-Leibler radius around a previously estimated distribution. The article gives an overview of the properties of this measure and analyzes the relations to other well known risk- and acceptability measures and to the well known Esscher pricing principle, used in insurance mathematics and option pricing. The main part of the article focuses on optimal decision making - in particular related to portfolio optimization - with Maximum-Loss as the objective function, to be minimized. A simple algorithm for dealing with the resulting saddle point problem is introduced and analyzed.

Algorithmic framework for approximate stochastic design of flexible process flow sheets

Mihael Kasas

University of Maribor, Faculty of Chemistry and Chemical Engineering,
Slovenia

Zdravko Kravanja

University of Maribor, Faculty of Chemistry and Chemical Engineering,
Slovenia

Zorka Novak Pintaric

University of Maribor, Faculty of Chemistry and Chemical Engineering,
Slovenia

Chemical processes are usually designed to operate over several decades. Due to the long-term operational horizon, uncertainty must be taken into account at the design phase in order to generate flexible process solutions. Numerous design parameters are subject to significant uncertainty. They can be divided into: a) model parameters, e.g. kinetic constants, transfer coefficients, b) process parameters, e.g. flow rates, temperatures, and c) external uncertainties, e.g. demand, prices, etc. Designing large process flow sheet models with significant number of uncertain parameters (several tens or up to a hundred) is still a challenging task, irrespective of which approach is used, as e.g. scenario-trees or two-stage stochastic methods. All approaches suffer from enormous increase in problem size with the number of uncertain parameters. The objective of this contribution is thus to present an algorithmic framework for solving flexible process flow sheet models with large number of uncertain parameters. The strategy relies on standard two-stage stochastic formulation for fixed degree of flexibility. It combines several solution techniques whose main objectives are to: - reduce the number of discretized points, - decompose large problem into several smaller problems, - approximate the rigorous stochastic solution. Reduction/decomposition/approximation techniques are merged into a strategy for designing process flow sheets which are flexible to operate under changeable internal and external conditions. The proposed strategy will be illustrated by a synthesis of flexible chemical process flow sheet.

Economic oriented stochastic optimization of model predictive controlled processes

Laszlo Dobos

University of Pannonia / Department of Process Engineering, Hungary

Andras Kiraly

University of Pannonia / Department of Process Engineering, Hungary

Janos Abonyi

University of Pannonia / Department of Process Engineering, Hungary

The optimization of the chemical processes is a key-component of staying competitive in the market. In case of operating processes this goal could be considered as a multilevel optimization problem. In the industrial practice Advanced Process Control (APC) systems are applied for supporting the increase economic performance which is the final result of the multilayer optimization problem. APC systems use model predictive controllers (MPCs) to improve the efficiency, which could be considered as the lower level. These controllers have doubled goal: the first is to reduce the time consumption of transients between the different operation points. As a second goal they have to assure the efficient steady state operation in spite of the disturbances and the variance of the closed loop. Because of the process variance the safest operation point should be in the middle specification range, but it is economically optimal in the rarest cases. That is why necessary to shift the operation set points closer to the specification and process limits as possible to approach the economic optimum. In this work a novel framework is introduced to support APC systems to find optimal steady state operation point. Monte Carlo approach is applied to be able to consider the variance of the process and the controllers. A cornerstone of the framework is the capability of handling non-linear constraints. This way it is possible to assure that the probability of crossing the specification limits is lower than a safety boundary. To find the optimal operation set point quadratic programming and the NOMAD direct search optimization algorithms are applied. The efficiency of the different methods is compared throughout a case study of a MPC controlled polymerization process.

New Lower Bound for Online Bin Packing Algorithms

János Balogh

University of Szeged, Hungary

József Békési

University of Szeged, Hungary

Gábor Galambos

University of Szeged, Hungary

One-dimensional bin packing problem can be stated as follows. We are given a list L of n items – where the number of items is the length of the list – with sizes a_i , $i = 1, \dots, n$, satisfying $0 < a_i \leq 1$. We need to pack these items into a minimal number of unit-capacity bins such that the total sum of the sizes in each bin is at most 1. The problem is known to be NP-hard. So, substantial research has been focused on finding good approximation algorithms. One possibility to measure the performance of an algorithm A is to give its asymptotic competitive ratio R_A . If an algorithm belongs to the class of *on-line algorithms* then it packs items immediately when they appear without any knowledge of subsequent items of the list. After an item has been placed in a bin, it must not be moved again. This lack of knowledge is such a severe handicap that no on-line algorithm can have an asymptotic competitive ratio close to 1. On-line algorithms have been extensively studied for the one-dimensional bin packing problem. In this talk we investigate one-dimensional bin packing algorithms, and we give lower bound for their asymptotic worst-case behaviour. For on-line algorithms so far the best lower bound was given by van Vliet in 1992. He proved that there is no on-line bin packing algorithm with better asymptotic competitive ratio (ACR) than $1.54014\dots$. In this talk we give an improvement on this bound to $\frac{248}{161} = 1.54037\dots$ and we investigate the parametric case as well.

Bin covering games

Attila Benko

University of Pannonia, Hungary

Gyorgy Dosa

University of Pannonia, Hungary

Zsolt Tuza

University of Pannonia and Computer and Automation Institute, Hung.
Acad. of Sci., Hungary

We define a new bin covering game. Items come one by one, and two players play in turn, the actual player packs the next item into a bin chosen by him. The player who covers a bin (i.e. the total size of items being packed into a bin becomes to be at least the bin-size): gains the bin. The goal is to gain as many bins as possible.

First we establish some properties of such a game: This is not a constant sum game, and the players must cooperate with each other to cover the bins, and at the same time they also play against each other since only one of them can gain a bin.

We develop several strategies what the players can follow, while each strategy is worked out by an *algorithm*.

We analyze the best strategy what a player can choose against a known strategy of the other player, and we also give a more sophisticated algorithm, what explores the strategy followed by the other player and determines the best answer.

We also treat the offline case where the incoming items are known in advance, and point out some interesting open questions: what will happen if the number of players is bigger than two, and they can, or can not cooperate to each other.

Online 2-dimensional clustering problems

Gabriella Divéki

Institute of Informatics, University of Szeged, Hungary

Csanád Imreh

Institute of Informatics, University of Szeged, Hungary

In online clustering problems, the classification of points into sets (called clusters) is done in an online fashion. Points arrive one by one at arbitrary locations, to be assigned to clusters at the time of arrival. A point can be assigned to an existing cluster, or a new cluster can be opened for it.

In many applications the clusters are balls and we have to cover the requests by them. If the balls have fixed, unit size then the goal is to minimize the number of the used balls, 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. Then the goal is to minimize the sum of costs of the clusters used by the algorithm. We consider the two dimensional clustering problem with variable sized clusters.

We present the first online algorithms for the solution of the problem. We measure the performance of the online algorithms by the competitive analysis. An algorithm is C -competitive if its cost is at most C -times the optimal cost.

S-graph as an integrated modelling and optimization tool for the scheduling of industrial batch processes

Tibor Holczinger

University of Pannonia, Hungary

Mate Hegyhati

University of Pannonia, Hungary

Ferenc Friedler

University of Pannonia, Hungary

Scheduling of industrial batch processes has received considerable attention, however, it is still a challenging field in operations research to find the optimal schedule of equipment units for industrial scale problems. Considering the wide range of process related parameters, e.g., cleaning- and transfer times, variable processing times, heat integration, various storage policies further increases the difficulty of modelling and optimization.

Although, the complexity of this type of problems mainly comes from its combinatorial nature, most of the published techniques are based on mixed-integer linear or non-linear programming formulations that often rely on heuristics, and fail to provide optimal or even feasible solution. The most comprehensive combinatorial tool for batch process scheduling is the S-graph framework, including the S-graph model and the corresponding algorithms. Unlike other methodologies, it considers the scheduling problem as it appears in the industry, therefore it does not need to transform the original form of the problem description to a mathematical model. Furthermore, it is able to directly exploit the structural properties of the problem resulting in improved computational efficiency.

Present work demonstrates the comprehensive applicability of the S-graph framework for the scheduling of multipurpose batch operations, considering various objective functions, storage policies and timing constraints, etc. Moreover, the frameworks ability to integrate diverse industrial aspects and the prospects for computational accelerations are also exhibited.

Hybrid systems: discrete and continuous dynamics

István Gyóri

University of Pannonia, Hungary

Hybrid systems are those that combine both discrete and continuous dynamics. Such kind of systems can be found in applications (e.g., continuous control plant through its interaction with a discrete time controller) or in numerical analysis when the continuous system is only partially discretized. In this lecture we give motivating examples, known results about the oscillation and stability of the solutions, and we also raise up some open questions.

Computation of Consistent Equilibrium in Mixed Oligopoly Markets

Nataliya Kalashnykova

Universidad Aut'ónoma de Nuevo Le'on, Mexico

Vladimir Bulavsky

Central Economics & Mathematics Institute (CEMI), Russian Academy
of Sciences, Russian Federation

Vyacheslav Kalashnikov

ITESM, Campus Monterrey, Mexico

In this paper, we consider a model of mixed oligopoly with conjectured variations equilibrium (CVE). The agents' conjectures concern the price variations depending upon their production output's increase or decrease. We establish existence and uniqueness results for the conjectured variations equilibrium (called an exterior equilibrium) for any set of feasible conjectures. To introduce the notion of an interior equilibrium, we develop a consistency criterion for the conjectures (referred to as influence coefficients) and prove the existence theorem for the interior equilibrium (understood as a CVE with consistent conjectures). A robust mode of computation of the consistent conjectures is proposed. To prepare the base for the extension of our results to the case of non-differentiable demand functions, we also investigate the behavior of the consistent conjectures in dependence upon a parameter representing the demand function's derivative with respect to the market price.

Computing Minimum- norm Solution of a Specific Constrained Convex Problem

Saeed Ketabchi

University of Guilan, Department of Mathmatics, Iran

Hossein Moosaei

University of Guilan, Department of Mathmatics, Iran

In this paper, we study the algorithm that looks for normal solution to a specific convex constrained programming as follows:

$$\begin{aligned} \min_x f(x) &= \frac{1}{2} \|(Qx - d)_+\|^2 \\ \text{subject to} \quad & A_1 x \leq b_1, \\ & A_2 x = b_2, \\ & x \geq 0, \end{aligned} \tag{1}$$

where Q , A_1 and A_2 are $m \times n$, $m_1 \times n$ and $m_2 \times n$ full rank matrices respectively, and $d \in R^m$, $b_1 \in R^{m_1}$ and $b_2 \in R^{m_2}$ are fixed vectors.

Suppose that $X = \{x \in R^n : A_1 x \leq b_1, A_2 x = b_2, x \geq 0\}$ and X^* is the solution set to problem (1).

The characterized of the solution set of convex programs for twice continuously differentiable convex functions explained in [1,2]. This characterization, can be applied to obtain the normal solution of convex optimization problem. We used this theorem for problem (1), then we have:

Lemma 1 Let $X^* \neq \emptyset$ and $x^* \in X^*$, then there exist two submatrices Q_1 , Q_2 of Q and two subvectors d_1 , d_2 of d respectively, such that for each solution point $x \in X^*$, we have

$$\begin{aligned} (Q_1 x - d_1)_+ &= 0, \quad (Q_2 x - d_2) > 0, \\ d_2^T (Q_2 x - d_2) &= d^T (Qx^* - d). \end{aligned} \tag{2}$$

where Q_1 and Q_2 are submatrices of Q and d_1 and d_2 also are subvectors of d respectively and $F = (Q^T)^\dagger Q^T$ with $F_1(Qx^* - d)_+ = 0$ and $F_2(Qx^* - d)_+ > 0$.

Then, we can prove following theorem:

Theorem 1 Suppose that the conditions of Lemma 1 hold, and assume that $p^* = (Qx^* - d)_+$. Then, X^* is characterized by the following system

$$\begin{aligned} A_1x &\leq b_1, & Q_1x &\leq d_1, \\ A_2x &= b_2, & Q_2x &= F_2p^* + d_2, & d_2^T Q_2x &= d^T p^* + d_2^T d_2, \\ x &\geq 0. \end{aligned} \quad (3)$$

We can, therefore, rewrite (3) as a linear system as follows:

$$\begin{aligned} Ax &\leq b, \\ A_{eq}x &= b_{eq}, \\ x &\geq 0, \end{aligned} \quad (4)$$

where $A = \begin{bmatrix} A_1 \\ Q_1 \end{bmatrix}$, $b = \begin{bmatrix} b_1 \\ d_1 \end{bmatrix}$, $A_{eq} = \begin{bmatrix} A_2 \\ Q_2 \\ d_2^T Q_2 \end{bmatrix}$ and $b_{eq} = \begin{bmatrix} b_2 \\ F_2p^* + d_2 \\ d^T p^* + d_2^T d_2 \end{bmatrix}$. The alternative system to (4) is

$$A_{eq}^T u - A^T v \leq 0, \quad b_{eq}^T u - b^T v = \rho > 0, \quad v \geq 0, \quad (5)$$

where ρ is an arbitrary fixed positive number.

As we show below, the alternative system can be applied to obtain the normal solution of (1). To do so, we introduce the following unconstrained minimization problem for the residual vector of system (5).

$$\min_{u, v \geq 0} g(u, v) = \frac{1}{2} (\| (A_{eq}^T u - A^T v)_+ \|^2 + |(b_{eq}^T u - b^T v) - \rho|^2). \quad (6)$$

To solve this problem see [1,3].

Theorem 2 Suppose $X^* \neq \emptyset$ and $x^* \in X^*$, also suppose that the normal solution of (1) is denoted by $\hat{x}$, then

$$\hat{x} = \frac{(A_{eq}^T u^* - A^T v^*)_+}{(\rho - b_{eq}^T u^* + b^T v^*)}, \quad (7)$$

where $\begin{bmatrix} u^* \\ v^* \end{bmatrix}$ is the solution of (6).

References

- [1] Ketabchi S., Ansari-Piri E., On the solution set of convex problems and its numerical application, *Journal of Computational and Applied Mathematics*, 206, 288-292 (2007).
- [2] Magasarian O.L., A simple characterization of solution sets of convex programmes, *Oper. Res. Lett.*, 7, 21-26 (1988).
- [3] Mangasarian O.L., A Newton method for linear programming, Data Mining Institute, Technical Report 02-02, March (2002).

Using P-Graph for Optimising Regional Sustainable Energy Systems

Laszlo Halasz

University of Pannonia, Hungary

Michael Eder

Graz University of Technology, Austria

Nora Sandor

Graz University of Technology, Austria

Nora Niemetz

Graz University of Technology, Austria

Karl-Heinz Kettl

Graz University of Technology, Austria

Michael Narodoslawsky

Graz University of Technology, Austria

Regional adapted technology networks will become interesting in an era when renewable resources will increase their importance as a base for our economy. Regions offer on the one hand renewable resources such as biomass, wind and solar energy. On the other hand logistical considerations will require a considerably more decentralised industrial structure as key resources (agricultural by-products such as straw and manure, resources such as grass, etc.) but above all heat as a by-product of electricity production and/or industrial processes may not be transported over long distances at competitive costs and acceptable ecological impact.

Currently optimising regional energy technologies is seen as a problem of optimising single sectors (e.g. industry), single activities (e.g. transportation) or the implementation of new technologies (e.g. photovoltaic) or new and environmentally acceptable energy carriers (e.g. biofuels). The big challenge however is the optimisation of regional technology systems across sectors, using a network of technologies that put regional renewable resources to their most profitable use.

Process synthesis using the p-graph method (Friedler et al., 1995; Halasz et al., 2005) is employed to find stable options for technology networks linking (regional as well as imported) resources and demands of regional actors (including households and business). These

networks will be optimised on the base of optimal value added for the regional actors, using the picture of the region as a "company". Examples of the application of this method to regions of various size as well as regional sustainable industrial parks will be presented.

Friedler F, Varga JB, Fan LT. Decision-mapping: a tool for consistent and complete decisions in process synthesis. *Chemical Engineering Science* 1995;50:1755-1768.

Halasz L, Povoden G, Narodoslawsky M. Sustainable processes synthesis for renewable resources. *Resources, Conservation and Recycling* 2005; 44:293-307

Algorithmic Synthesis of Process Networks with Time Constraints by the P-graph Framework

Botond Bertók

University of Pannonia, Hungary

Károly Kalauz

University of Pannonia, Hungary

Zoltán Süle

University of Pannonia, Hungary

L.T. Fan

Kansas State University, U.S.A.

Ferenc Friedler

University of Pannonia, Hungary

P-graph approach for process-network synthesis (PNS) originally conceived for conceptual design of chemical processes (Friedler et al. 1992) provides appropriate tools for generating and analyzing structural alternatives for business processes. However, extension of the original framework to handle constraints specific to business processes may improve the practical applicability of the proposed methodology. To satisfy the deadline is a crucial aspect in business process and supply chain design. In our lecture time constraints on the availability of the resources, activities, and deadlines for the final targets are incorporated to the mathematical model, as well as, to solution algorithms of PNS.

The approach based on the P-graph framework appears to be the only one capable of executing process-network optimization giving rise to an algorithmically and mathematically proven solution for all steps involved, comprising superstructure generation, construction of the mathematical model, optimization, and the solution interpretation. In the P-graph framework, algorithm MSG produces the maximal structure, i.e., the superstructure, for the PNS problem. This maximal structure serves as the input to the generation and solution of the mathematical model by algorithm ABB.

The current work presents an addition to a former methodology to model business processes formally and to algorithmically

synthesize optimal business processes by the P-graph framework. Recent extension introduces time constraint in the mathematical model and solution method for PNS. Extension of the superstructure and the relaxed mathematical model for solving PNS problems with fix charged linear cost function and a method for representing decisions on the precedence of activities by structural decisions will be presented in our lecture.

Generation of Redundant Structures to Guarantee Predefined Level of Reliability in Business Processes

Károly Kalauz

University of Pannonia, Hungary

Zoltán Süle

University of Pannonia, Hungary

Botond Bertók

University of Pannonia, Hungary

Ferenc Friedler

University of Pannonia, Hungary

L.T. Fan

Kansas State University, U.S.A

Business Process Modeling Notation (BPMN) facilitates organizations, discerning of their own internal business procedures in terms of graphical notation and standardizing the communication pertaining to these procedures. BPMN in turn defines a Business Process Diagram (BPD), which is a flowcharting technique tailored for generating graphical models of business process operations. The transformation steps from the BPD diagram to the P-graph representation is introduced by us presenting opportunity for examining the structural properties of business processes algorithmically.

Several robust and reliable process optimization algorithms have been developed and implemented on the basis of the P-graph framework by Friedler and his collaborators in the last decade. The current work reveals a methodology that provides an adequate basis to model business processes mathematically and formally as well as to algorithmically synthesize optimal and alternative business processes. The methodology integrates widely deployed business process modeling notations and combinatorial foundations of algorithmic process synthesis. A novel algorithm of the methodology for mathematical formulation and solution generates alternative structures to increase reliability of business processes. The applied reliability measures are defined in our lecture as well, which come from the probability calculus. Major steps of the generation are the

structure generation and estimation of the reliability of a business process structure.

When the business processes are planned, the option of the redundancy is primary because with redundant elements can guarantee higher level of reliability of final targets. If the goals in a business process can be reached only one way without redundancy, then the reliability of the goals is unambiguous, so it cannot be improved. A novel algorithm of the methodology for mathematical formulation and solution generates the most reliable or n-most reliable business processes.

Manifold Learning by Semidefinite Facial Reduction

Babak Alipanahi

University of Waterloo, Canada

Nathan Krislock

INRIA Rhône-Alpes, France

Ali Ghodsi

University of Waterloo, Canada

The problem of nonlinear dimensionality reduction is most often formulated as a semidefinite programming (SDP) problem. Currently SDP problems of only limited size can be directly solved using current SDP solvers. To overcome this difficulty, we propose a novel SDP formulation for dimensionality reduction based on semidefinite facial reduction. The key observation is that in manifold learning, the structure of a large chunk of the data can be preserved as a whole, instead of dividing it into very small neighborhoods. This observation leads to a new formulation that significantly reduces the size and the number of constraints of the SDP problem. Our method is a stable, fast, and scalable algorithm for manifold learning, allowing us to solve very large problems. We obtain high quality solutions without the need for post-processing by local gradient descent search methods, as is often required by other large-scale SDP-based methods for manifold learning. We also provide a supervised version of our algorithm that incorporates the class label information into the embedding.

Computation of Huber's M -estimator using a primal-dual active-set method with a long step rule

Tanja Binder

University of Marburg, Germany

Ekaterina Kostina

University of Marburg, Germany

We consider parameter estimation problems in dynamic systems using Huber's M -estimator,

$$\begin{aligned} \min_p \quad & \sum_j \rho_\gamma((\eta_j - m(t_j, x(t_j), p))/\sigma_j) = \sum_j \rho_\gamma(F_{1j}(x, p)), \\ \text{s.t.} \quad & F_2(x, p) = 0, \end{aligned} \tag{8}$$

where x are the states of the modeled system and p are the unknown parameters, and

$$\rho_\gamma(z) = \begin{cases} \frac{1}{2}z^2, & \text{if } |z| \leq \gamma, \\ \gamma|z| - \frac{1}{2}\gamma^2, & \text{if } |z| > \gamma. \end{cases}$$

The equality constraints $F_2(x, p) = 0$ contain discretized dynamic model. Problem (8) is solved by means of the Gauss-Newton method which iteratively computes new iterates by solving locally linearized subproblems. The special structure of these problems can be exploited to simplify and speed up computations. We developed a solution method for the dual problems of the linearized subproblems, which are convex quadratic programming problem with bounded variables. The method combines a primal-dual active-set method with the long step rule of the simplex method for linear problems with bounded variables. Numerical experiments demonstrate the effectiveness of the approach.

Newton's method in eigenvalue optimization for incomplete pairwise comparison matrices

Kristóf Abele-Nagy

Corvinus University of Budapest, Hungary

Sándor Bozóki

MTA SZTAKI, Corvinus University of Budapest, Hungary

In multi-attribute decision making, pairwise comparison matrices are often used for weighing the attributes. A pairwise comparison matrix is called incomplete if some of its elements are not given by the decision maker. In order to extend the eigenvector method, originally proposed for complete case, to incomplete matrices, one needs to solve an eigenvalue minimization problem. Both univariate and multivariate Newton's method are investigated and implemented. Results indicate that this technique can be applied not only for the computation of the weights but also for measuring the level of inconsistency during the filling in process. A practical benefit of the latter is that decision maker gets an immediate feedback in case of a typing error or when s/he enters an element which highly contradicts to the previous ones. Algorithms are illustrated by some numerical examples.

A Multiobjective Dynamic Nonlinear Robot Assignment Problem

István Maros

University of Pannonia, Hungary

Sampo Ruuth

Helsinki University of Technology, Finland

Kimmo Nieminen

Helsinki University of Technology, Finland

Robots will be used under rapidly changing and highly dangerous circumstances such as rescue operations in a radioactive environment or a fire as well as military operations. The robots are sent to several targets in order to carry out various tasks.

The robots we are considering here are able to send and receive messages to and from each other as well as solve nonlinear assignment problems. When the robot salvo is en-route to their targets several events may happen. A number of co-operative robots may get jammed as a consequence of disturbances. Some robots may already have reached their targets. Some robots may not be able to reach all targets. The system being investigated enables the surviving robots to work together in real time and change their pre-set tasks if necessary in order to maximize their effectiveness. In this paper we present a method which solves the reallocation problem using a piecewise linear network algorithm. Experimental results up to 493 targets and 500 robots show that the reallocation of the robots can be done in real time.

Computational performance of simplex and MBU-simplex algorithms using different anti-cycling pivot rules

Tibor Illés

Eötvös Loránd University of Sciences, Hungary

Adrienn Nagy

Alvicom Kft, Hungary

The simplex algorithm is one of the most widely used solution method for the linear programming problems arising in many application areas. Several different versions of the simplex algorithm have been developed and implemented in the last 60 years. Although numerical implementations of simplex algorithms became more and more sophisticated, still we can experience such computations where cycling occur. State-of-the-art solvers try to overcome this situation, in the worst case, by restarting the computation from a different basis and following different route on the polyhedron, based on the previous computational experience. This leads to much longer computational time than it is necessary for numerically difficult problems.

Cycling of pivot algorithms and their computer implementations is still a theoretical and practical issue. In spite of these, in practice only two versions of simplex method are used; the traditional primal and dual simplex method.

In our talk, we compare the traditional primal simplex (P-SA) with the monotone build-up simplex algorithm (P-MBU-SA) of Anstreicher and Terlaky (1994). Against cycling phenomena we use several index selection rules (minimal index, Last In First Out - LIFO and Most Often Selected Variable - MOSV) that guarantee finiteness of pivot algorithms, at least in theory.

In order to provide a uniform test environment for different algorithms and their variants depending on the anti-cycling pivot rules, we use the callable library of XPRESS-MP. In our implementations, the theoretical version of the algorithms is implemented without further, known computational techniques that, usually, accelerate the computations. Our implementations are tested on NETLIB problems and compared with solutions of XPRESS-MP, too.

From our tests become obvious the superiority of LIFO and MOSV rules over the minimal index selection rule. If you would like to know the winner in the race between variants of P-SA and variants of P-MBU-SA, please attend our talk.

Simplex based solution of convex quadratic programming problems

Zsolt Csizmadia

FICO, United Kingdom

With the steady increase in the number of applications of mixed integer quadratic programming problems, the demand for efficient, easy to warm start algorithms to solve convex quadratic programming problems become one of the defining factors for both free and commercial solver development.

The talk considers the numerical behavior of different simplex algorithm based approaches to the convex quadratic programming problem, comparing the advantages of direct simplex based methods against the disadvantages inherent with pivoting in the Karush-Kuhn-Tucker system.

The presented results are based on research related to the enhancements of the simplex based quadratic solver in the FICO Xpress-MP suite.

General linear complementarity problems: algorithms and models

Zsolt Csizmadia

FICO, United Kingdom

Tibor Illés

Eötvös Loránd University of Sciences, Hungary

Adrienn Nagy

Alvicom Kft, Hungary

Marianna Nagy

Tilburg University, Netherlands

Linear complementarity problems (LCP) are usually NP-hard problems. The largest matrix class where the interior point algorithms (IPA) are polynomial is the class of $P^*(\kappa)$ -matrices, for given nonnegative real parameter κ . The union for all possible κ parameters of $P^*(\kappa)$ -matrices forms the class of P^* -matrices. This class of matrices has been introduced by Kojima et al. in 1991.

Cottle et al. (1989) defined the class of sufficient matrices (SU). It has been proved that several variants of the criss-cross algorithm are finite for LCPs with sufficient matrices. After all of these, it is a natural question: What is the relation between the sufficient and P^* -matrices? Väliaho (1996) proved that the P^* -matrices are exactly those which are sufficient.

Using the concept of EP-theorem of Cameron and Edmonds (1990) and the LCP duality theorem of Fukuda and Terlaky (1992), Fukuda et al. (1998) were able to generalize the criss-cross algorithm for LCP problems with arbitrary matrices. The generalized criss-cross algorithm for LCPs with rational data stops in finite number of iterations with one of the following stopping criteria: (i) primal LCP has been solved and the encoding size of the solution has a polynomial bound, (ii) dual LCP has been solved and the encoding size of the solution has a polynomial bound, (iii) the matrix of the problem is not sufficient matrix and there is a certificate whose encoding size has a polynomial bound.

Since 1998, it was an interesting open question whether the result of Fukuda et al. can be obtained using some generalization of

IPAs or not? We modified some IPAs such that their stopping criteria are the same as those of the generalized criss-cross algorithm. The modified interior point algorithms running time is still polynomial, but does not give in all cases a solution for solvable LCPs [third stopping criterion, the matrix is not sufficient, but the LCP might have a solution].

Some of our interior point algorithms that solve LCPs with arbitrary matrices in the sense of the EP-theorem have been published recently. Goal of this talk is to introduce algorithms that may solve general LCPs and to show their computational performance on the well-known exchange market model of Arrow and Debreu.

1. Illés T., Nagy M. and Terlaky T., Polynomial Interior Point Algorithms for General Linear Complementarity Problems, *Algorithmic Operations Research*, Vol. 5 (1): 1-12, 2010.
2. Illés T., Nagy M. and Terlaky T., EP theorem for dual linear complementarity problem, *Journal of Optimization Theory and Application*, Vol. 140:233-238, 2009. (Electronic version available <http://www.springerlink.com/content/w3x6401vx82631t2/>)
3. Illés T., Nagy M. and Terlaky T., Interior point algorithms for general linear complementarity problems, *Journal of Global Optimization*, in print, 2008. (Electronic version available <http://www.springerlink.com/content/547557t2077t2525/>)
4. Csizmadia Zs. and Illés T., New criss-cross type algorithms for linear complementarity problems with sufficient matrices, *Optimization Methods and Softwares*, Vol. 21, No. 2:247-266, 2006.

Some combinatorial optimisation problems in multimedia systems

Tibor Szkaliczki
MTA SZTAKI, Hungary

The multimedia systems offer a wide application area for optimisation. The presentation introduces three combinatorial optimisation problems arising during the design and operation of multimedia delivery systems. The efficient solution of the problems considered can enhance significantly the performance of the servers and improve the quality of the provided services. The main issues we focus on are the host recommendation, utility optimisation for multimedia adaptation and piece selection for layered video streaming. Common requirement to all solution methods is that they should be performed very fast in order to provide short startup delay and continuous streaming. We give an overview of the algorithms implemented in our joint projects with multimedia experts. Both heuristics and adaptation of well-known combinatorial optimisation algorithms are applied to solve the problems concerned. The approaches are related to typical problems and solutions in discrete mathematics such as facility location problem, knapsack problem, monotonic optimisation, linear programming and evolutionary algorithms.

On the handicap of a sufficient matrix

Marianna Nagy

Tilburg University, Netherlands

Etienne de Klerk

Tilburg University, Netherlands

The class of sufficient matrices is important in the study of the linear complementarity problem (LCP). The worst-case iteration complexity of the interior point methods for LCP's with sufficient coefficient matrices depends on the parameter κ which is at least as large as the handicap of the coefficient matrix. For example, the complexity of the predictor-corrector algorithm by Potra and Liu (2005) is $O((1 + \kappa)\sqrt{n}L)$, where L is the bit size of the problem data. We show that the handicap may be exponential in the bit size of the coefficient matrix. This implies that the iteration bound is not polynomial in L .

It is of practical interest to decide if a given matrix M is $\mathcal{P}_*(\kappa)$, for some given nonnegative value κ . Complexity results by Tseng (2000) imply, however, that deciding whether there exists a finite κ for which a given matrix is $\mathcal{P}_*(\kappa)$ is an NP-hard problem. We therefore also investigate semidefinite programming based heuristics for computing a (finite) value κ such that a given matrix is $\mathcal{P}_*(\kappa)$, if such a value exists. We show that our heuristic provides a suitable value of κ for the so-called $\mathcal{P}$ -matrices (where all principle minors are positive).

Positive Edge: A new rule to identify non-degenerate simplex pivots

Vincent Raymond

GERAD and 'Ecole Polytechnique de Montr'eval, Canada

François Soumis

GERAD and 'Ecole Polytechnique de Montr'eval, Canada

Abdelmoutalib Metrane

GERAD, Canada

Jacques Desrosiers

HEC Montr'eval and GERAD, Canada

The *positive edge* is a new pricing rule for the primal simplex: it identifies, with a probability error less than 2^{-28} , variables allowing for non-degenerate pivots. Its computational complexity is the same as for the reduced cost.

The preliminary comparisons made with CPLEX show its high potential. We designed a very simple algorithm using two external procedures to identify non-degenerate and negative reduced cost variables. It has been tested on 14 medium-sized aircraft fleet assignment instances, 2 large-scale manpower planning problems, and 9 PDS instances from the Mittelman library. All these problems are highly degenerate. On the first group, our algorithm is 7 times faster than CPLEX on average and the number of pivots is reduced by a factor 2. On the second and third groups, it is 50% faster and the number of pivots is decreased by 2.4 and 3.6, respectively.

It has also been tested on Fome12 and Fome13 from the Mittelman library. For these highly dense problems, our simple implementation failed. The integration of the positive edge rule within a primal simplex code should prevent such cases by eliminating the external procedures and taking advantage of partial pricing strategies.

Implementing the simplex method as a cutting-plane method

Csaba Fábián

Kecskemét College, Hungary

Olga Papp

Eötvös Loránd University, Kecskemét College, Hungary

Krisztián Eretnék

Eötvös Loránd University, Hungary

Simplex-type methods and convex cutting-plane methods receive renewed attention in present years. These approaches recently resulted dramatic improvements in solving special stochastic programming problems. In this paper we show that the simplex method can be interpreted as a convex cutting-plane method. Our aim is to show that a direct link exists between these areas. (This may facilitate the transfer of the existing powerful tools developed for the one or the other of these areas.) We focus on special linear programming problems like finding the largest ball that fits into a given polyhedron. We present a computational study of a simplex implementation technique inherited from the cutting-plane interpretation.

NCP functions

Aurél Galántai

Óbuda University, Hungary

We give some characterizations of NCP functions that may help the construction of new ones. This is supplemented by some negative results showing the nonexistence of NCP functions of certain types. Furthermore we develop and analyze several new methods for the construction of NCP functions.

Time-Optimal Diafiltration Process: Dynamic Optimization Approach

Radoslav Paulen

Institute of Information Engineering, Automation and Process Control,
STU in Bratislava, Slovakia

Miroslav Fikar

Institute of Information Engineering, Automation and Process Control,
STU in Bratislava, Slovakia

Greg Foley

School of Biotechnology, Dublin City University, Ireland

Zoltán Kovács

Institute of Biopharmaceutical Technology, University of Applied
Sciences Giessen-Friedberg, Germany

Peter Czermak

Kansas State University, USA

In this paper we address the problem of minimization of running time of a diafiltration process. Diafiltration is usually employed when we want to increase the concentration of one component of a solution, while decrease the concentration of the other. This concentration (dilution) is carried out at filtration membrane module thanks to effective molecular size differences of the components, and beside, it is attained by adding a solute-free diluant (e.g. water) to the diafiltration feed tank. At membrane module, stream which passes through membrane (permeate) is separated from retentate which is further recirculated to the feed tank. Our task is to determine optimal time-dependent control of diluant adding in the feed tank.

Previous attempts on this optimization problem considered arbitrarily constructed schemes, which may be, but need not to be, optimal. We employ control vector parametrization method as the one of numerical methods of dynamic optimization, in order to find optimal function $\alpha(t)$ which is defined as a ratio between diluant and permeate flowrate (flux).

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Measurement-based Optimisation of Batch Process by Integrated Two-Time-Scale Scheme

Marian Podmajersky

Institute of Information Engineering, Automation and Mathematics,
FCFT STU in Bratislava, Slovakia

Benoit Chachuat

Department of Chemical Engineering, McMaster University, ON,
Canada

Miroslav Fikar

Institute of Information Engineering, Automation and Mathematics,
FCFT STU in Bratislava, Slovakia

Modern real-time optimisation methods for chemical processes incorporate measurements to cancel out an influence of uncertainty. The theory of neighbouring-extremal control has been developed for this purpose as it forces the first-order variation of the necessary conditions of optimality to zero by the use of measurements. The advantage of this method is ability to control in on-line manner, without costly re-optimisation. The drawback with this approach, is its poor performance in the presence of large parametric and structural model mismatch, when applied to chemical processes. On the other hand, similar approaches such as, model predictive control (MPC) or run-to-run optimisation, are more resistant to model mismatch but they require time-consuming on-line re-optimisation that restricts their applications to slow dynamic systems. This paper proposes to combine both approaches in order to mitigate their deficiencies, thereby leading to an integrated two-time-scale scheme with enhanced performance and tractability for dynamic real-time optimization. The performance of the proposed control scheme is tested on a fed-batch reactor.

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Using greedy-type graph colorings for relatively useful bounds in operations research

M. Hujter

BME, Hungary

In operations research, there are many applications of different graph coloring algorithms. This talk will survey a few recent results. Some algorithms are actually greedy methods. Typically, we try to save both colors and time. Designing a good trade-off is not easy. We do not want to waste more than two or three percent in objective function value but we want at least fifty percent saving in time.

We study two areas in details: For some geometrical packing problems you might feel that you are close to an optimal arrangement but the correct proof would be very time-consuming. However, by using a simple graph coloring method, you can get an easy proof showing your results are not very bad.

For Bonferroni-type bounds you may apply graph coloring heuristics to design relatively useful probability bounds.

Combinatorial optimization and Cross Entropy Method

Afet Oneren

Eastern Mediterranean University, Cyprus

Arif Akkeles

Eastern Mediterranean University, Cyprus

Filiz Bilen

Eastern Mediterranean University, Cyprus

The Cross Entropy (CE) method developed by Reuven Rubinstein is powerful and versatile technique for combinatorial optimization problems. It is a new generic approach to combinatorial optimization, multi-external optimization and rare event simulation. The CE methodology is presented with a basic algorithm, its modifications and applications in combinatorial optimization. We concentrated on combinatorial problems and solution methodology of these problems. Powerful ways of CE via comparison with other algorithms are discussed.

Parallel greedy algorithms for the permutation flow shop problems

Zoltán Horváth

Széchenyi István University, Hungary

Pál Pusztai

Széchenyi István University, Hungary

For the NP-hard permutation flow shop problems there exist several heuristic methods. In this paper we present an iterated greedy algorithm with parallel local improvements. The resulting code is implemented on multicore processors. We display computational results on standard and more industrial problems and conclude scalable methods.

Parallel Gene Transfer Operators of Bacterial Evolutionary Algorithm

András Horváth

Széchenyi István University, Hungary

Miklós Hatwágner

Széchenyi István University, Hungary

In real-life engineering and design applications, the speed of the optimization process is crucial because these jobs are often time-limited. In case of using BEA to optimize complex systems, the algorithm spends most of its running time with the evaluation of the objective functions, which are typically complete numerical simulations.

One possible way of speeding up software is the use of multiple CPUs at the same time. Unfortunately, the original BEA is not fully suitable for parallelization. There are several possible modifications of the original genetic operators to solve this problem. We examine several versions of the gene transfer using master-slave architecture and how the parameter settings of them affect the wall clock times.

Gaussian Transductive Regression

Gábor Takács

Széchenyi István University, Hungary

In the problem of regression, the task is to predict the value of a target feature from the values of some input features, based on a data matrix that contains corresponding input-target pairs. In the classical case, all entries of the data matrix are known. In the transductive case, the target feature is known only for a (usually small) subset of rows. This setting is common in practice, since labeling an input is typically expensive (it often requires human interaction). In this talk, I present a novel algorithm for transductive regression that achieves promising results on partially labeled test datasets.

Reliability of Process-Networks

Zoltan Kovacs

University of Pannonia, Hungary

Botond Bertók

University of Pannonia, Hungary

Ferenc Friedler

University of Pannonia, Hungary

L.T. Fan

Kansas State University, U. S. A.

Complex production systems often have the flexibility to provide multiple alternative configurations of unit operations for producing the desired products. The question addressed is whether each of the products can be produced if one or more of the unit operations are not available. The current contribution introduces an algorithmic procedure to calculate the reliability of having at least one configuration of the available unit operations for producing each of the desired products. The level of availability or reliability of each individual unit operation is assumed to be predefined.

P-graph Representation and Structural Analysis of Business Process Models

Tünde Tarczali

University of Pannonia, Hungary

Helga Kadanoczki

University of Pannonia, Hungary

Edina Osz

University of Pannonia, Hungary

Gergely Zachár

University of Pannonia, Hungary

Károly Kalauz

University of Pannonia, Hungary

Zoltán Süle

University of Pannonia, Hungary

Design and management of business processes are key factors for companies to be competitive. The standard Business Process Modeling Notation (BPMN) provides the capability of understanding the internal business procedures in a graphical notation for the organizations. BPMN defines a Business Process Diagram (BPD), which is based on a flowchart technique designed for creating graphical models of business process operations. Business process analysis and optimization can be supported by software tools, with which potential decision alternatives can be defined and revealed. Currently, there is no available software on the market that supports exploring or generating structural alternatives for business processes.

The aim of our research is to develop a technique based on P-graph methodology that provides an adequate basis to describe and model business processes, as well as to algorithmically synthesize optimal and alternative cases. Activities in the business processes are represented by O-type nodes, while the set of data and events are M-type nodes in P-graphs. BPMN involves additional structural information to general process networks, e.g., mutual exclusions of tasks. In order to handle these specific requirements the P-graph based algorithms have been extended. The optimal (cost, reliability, etc.) business process can be determined by SSGLP algorithm, after

the BPD - P-graph transformation and the alternative structure generation. The transformation method, as well as algorithms for generating structural alternatives for business processes have been elaborated and implemented. The proposed methodology has been tested with a reference problem from our recent R&D projects.

Scheduling of Bus Maintenance by the P-graph Methodology

Róbert Adonyi

University of Pannonia, Hungary

István Heckl

University of Pannonia, Hungary

Ferenc Olti

University of Pannonia, Hungary

Ferenc Friedler

University of Pannonia, Hungary

The P-graph (process graph) framework is applied herein for the bus maintenance planning in public transport. Public transportation is an essential part of the life of each major city. A number of logistics task has to be handled day by day in order to ensure uninterrupted operation. Malfunctions can result in additional cost, delays, discomfort and a bad reputation. Undisturbed operation requires solving both scheduling and planning optimization models. The construction of the time table is only the first such model and the time table changes only infrequently. On the other hand, the assignment of specific buses for each line and the assignment of drivers to buses have to be performed daily because the availability of the buses and the availability of the drivers changes incessantly. For example, a driver can go to sick leave, a new driver might be hired, or a bus may break down. Beside urgent repairs, buses also need regular maintenance which is carried out in the night shift. Repairs and maintenance tasks have to be scheduled to make sure enough bus is available each day. Our aim is to develop such a P-graph based model for maintenance scheduling which is capable to take into account the full unused time of the buses in a day not only the night period. Using this method certain maintenance tasks can be scheduled between the morning and afternoon rush hours. The appropriate scheduling of maintenance is especially important if the average age of the buses is high and thus the break downs are common. Without proper maintenance scheduling, it is highly difficult to ensure the required number of serviceable bus for each morning shift.

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