



VOCAL2014

PROGRAM and ABSTRACTS

VOCAL 2014

Program and Abstracts

Sponsors



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



Hungarian Operations Research Society



National Coordinating Center for Infocommunications

Organizers

Faculty of Information Technology, University of Pannonia
Hungarian Operations Research Society

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VOCAL 2014

The 6th Veszprém Optimization Conference: Advanced Algorithms is held at the Conference Centre of the University of Pannonia in Veszprém, Hungary, December 14-17, 2014.

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.

Invited Plenary Speakers

Marco Locatelli

Universita' di Parma, Italy



An introduction to convex envelopes

In the context of non-convex optimization a relevant issue is the definition of convex underestimators. These allow to define convex relaxations and, thus, lower bounds to be used within branch-and-bound approaches. The tighter the underestimators, the better the bounds. Thus, the search for tightest convex underestimators, so called convex envelopes, is an important topic. In this talk we introduce different possible definitions of convex envelopes. We introduce some basic concepts like that of generating set and that of polyhedral and non-polyhedral convex envelopes. We discuss techniques to derive convex envelopes of some non-convex functions over different regions. Some computational experiments are shortly discussed.

András Prékopa

Rutgers University, USA



On the relationship between the discrete and continuous bounding moment problems and their numerical solutions

We present a brief survey of some of the basic results related to the classical continuous moment problems (CMP) and the recently developed discrete moment problems (DMP), clarifying their relationship and propose new methods for the solution of univariate continuous power moment problems. In the classical as well as in the recently developed discrete moment problems the coefficient function in the objective is supposed to be higher order convex, or constant in an interval while zero elsewhere, or equal to a constant at some point and zero elsewhere. The concept of a regenerative point is introduced, for the case of the DMP, that makes it possible to create lower and upper bounds for a variety of other functions in the objective. The CMP are solved by discretization and sequential application of dual type algorithms. Numerical results are presented with moments of order up to 40 and various applications are mentioned.

Leena Suhl

University of Paderborn, Germany



Optimization Models and Decision Support Techniques for Vehicle and Crew Scheduling in Public Transit

Vehicle and crew scheduling are two major planning problems arising in public bus transport companies. They aim at assigning vehicle itineraries to scheduled trips and crew itineraries to tasks resulting from the vehicle schedule. The talk addresses some recent research topics in this area that can be approached with operations research techniques. In vehicle scheduling, modeling with time-space networks implies advantages compared to traditional connection-based model formulation. Time-space network models enable optimal solution of large problems in practice, but also have some limitations. Furthermore, special practical requirements for both vehicle and crew scheduling have to be taken into account, which implies that different variants of the optimization models should be considered. Through integration of vehicle and crew scheduling further optimization potential can be realized, however, the integrated models may get quite large and complex so that their solution is a challenge with today's technologies. Several models and approaches can be combined in a decision support system (DSS), which may be used by companies operating under different goals and constraints. On top of optimization, a DSS should offer what-if-analyses to support decisions under uncertain data.

Tamás Terlaky

Lehigh University, USA



Linear Optimization: Algorithms and Their Implementations

First we present a novel, unified, general approach to investigate sufficient and necessary conditions under which four types of convex sets, polyhedra, polyhedral cones, ellipsoids and Lorenz cones, are invariant sets for a linear continuous or discrete dynamical system. The Farkas Lemma and the S-lemma are the key tools in deriving sufficient and necessary conditions for invariance.

Second, we consider invariance preserving steplength thresholds on a set when a discretization method is applied to a continuous linear or nonlinear dynamical system. Our main result, both for linear and nonlinear dynamical systems, is the existence of a uniform invariance preserving steplength threshold for a large class of discretization methods for convex compact sets, and proper cones.

Third, the computation of steplength thresholds for invariance preserving of some classes of discretization methods on a polyhedron are considered. For rational function type discretization methods a valid steplength threshold can be obtained by finding the first positive zeros of a finite number of polynomial functions. Finally, for the forward Euler method, the largest steplength threshold for invariance preserving is presented by solving a finite number of linear optimization problems.

Technical Program

December 14, 2014 (Sunday)

3:00 pm – 6:00 pm **Registration Office Open**

4:00 pm – 5:00 pm **Invited Plenary Tutorial Session**

Analysing climate and energy policy using multi-horizon
stochastic programming

Asgeir Tomasgard

5:00 pm – 5:35 pm **Tutorial Session**

Solution methods for two-stage stochastic programming
problems

Csaba Fábián

December 15, 2014 (Monday)

7:30 am – 6:00 pm **Registration Office Open**

8:30 am – 9:00 am **Opening ceremony**

9:00 am – 10:00 am **Invited Plenary Session 1**

On the relationship between the discrete and continuous bounding moment problems and their numerical solutions

András Prékopa, Anh Ninh, Gabriela Alexe

10:00 am – 11:00 am **Invited Plenary Session 2**

An introduction to convex envelopes

Marco Locatelli

11:00 am – 11:20 am **Coffee break**

11:20 am – 12:35 pm **Parallel Session 1A**

A practical tackling of an Unsplittable Multicommodity Flow Problem in telecommunication traffic engineering

Pawel Bialon

An XML schema for matrix and cone programming

Horand Gassmann, Jun Ma, Kipp Martin, Imre Pólik

Reconstruction of hv-convex planar bodies by their coordinate X-rays

Ábris Nagy, Csaba Vincze

11:20 am – 12:35 pm **Parallel Session 1B**

Solution of Stochastic Quadratic Assignment Problem Deterministic Reformulations

Radomil Matousek, Pavel Popela

Waste Transportation by Mathematical Programming:
NERUDA Model

Pavel Popela, Martin Pavlas, Radovan Somplak, Vit Prochazka

Optimization in Surgical Operation Design

Tibor Csendes, István Bársony, István Szalay

11:20 am – 12:35 pm **Parallel Session 1C**

On the generation of scenario trees for multistage
stochastic optimization

Georg Pflug

Scenario Generation using Kernels

Alois Pichler

Approximation of Continuous-State Scenario Pro-
cesses in Multi-Stage Stochastic Optimization and its
Applications

Anna Timonina

12:35 pm – 2:00 pm **Lunch**

2:00 pm – 3:40 pm **Parallel Session 2A**

On generalization of SOHS decomposition of non-com-
mutative polynomials

Kristijan Cafuta

Copositive Programming via Semi-Infinite Optimization

Mirjam Duer

The preference-based multi-objective evolutionary
algorithm with local search

*Ernestas Filatovas, Algirdas Lancinskas, Olga Kurasova,
Julius Zilinskas*

Optimality Conditions and Smoothing Approach
for Non-lipschitz Optimization

Nurullah Yilmaz, Ahmet Sahiner

2:00 pm – 3:40 pm **Parallel Session 2B**

Special Cases of Vehicle Routing Problem with Internal
Transports

Zoltán Blázsik

Decision support framework for application oriented
vehicle scheduling

József Békési, Balázs Dávid, Miklós Krész

Sequential pattern and process mining in logistics

Richárd Károly, Tamás Ruppert, János Abonyi

Optimization of Systems with Dynamic Structures

*Attila Dinh Hoangthanh, Dániel László Magyar, László
Gönczy, András Pataricza, Szilvia Varró-Gyapay*

2:00 pm – 3:40 pm **Parallel Session 2C**

Touching cylinders

Sándor Bozóki, Tsung-Lin Lee, Lajos Rónyai

Measuring centrality by a generalisation of degree

László Csató

Deriving priorities from an inconsistent pairwise
comparison matrix by using network algorithm

János Fülöp, Marcin Anholcer

Reconstruction of score sets

Antal Iványi

3:40 pm – 4:00 pm **Coffee break**

4:00 pm – 5:40 pm **Parallel Session 3A**

New Results for Batched Bin Packing

János Balogh, József Békési, György Dósa, Gábor Galambos

Multi-objective optimization of batch biodiesel production

Tamás Torgyik, László Richárd Tóth, János Abonyi

On some practical applications of graph theory

Otília Fülöp

The strip covering problem

Tamás Bartók, Csanád Imreh

4:00 pm – 5:40 pm **Parallel Session 3B**

Multi-Objective Optimization Based Data Transfer Control in Networked Control Systems

Lőrinc Márton

Neural network-based seat belt recognition

Balázs Nagy

Fuzzy controller FPGA based hardware implementation

Sándor Tihamér Brassai, Szabolcs Hajdu, Tibor Tamas

The parameter estimation of the link performance functions

József Osztyényi

4:00 pm – 5:40 pm **Parallel Session 3C**

Defining a description language for automatic processing of business processes in a decision support system

Ádám Mokcsay, Márton Frits, Tünde Tarczali

Online Algorithms for a Generalized Parallel Machine Scheduling Problem

István Szalkai, György Dósa

A new parameter learning algorithm, for solving the hard combinatorial problem Bin Packing with General Const Function

Attila Benkő, György Dósa, Zsolt Tuza

Parallel Machine Scheduling and Preventive Maintenance in Electric Power Systems

György Dósa, László Varga

7:00 pm **Organ concert in St. Michael's Cathedral**

December 16, 2014 (Tuesday)

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

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

Optimization Models and Decision Support Techniques
for Vehicle and Crew Scheduling in Public Transit
Leena Suhl

10:00 am – 10:20 am **Coffee break**

10:20 am – 12:25 pm **Parallel Session 4A**

Synchronous product generation for controller optimization
Vince Molnár, András Vörös

Trajectory optimization of discrete event systems
Ákos Hajdu, Róbert Németh, András Vörös, Szilvia Varró-Gyapay

Complexity analysis of conic optimization
Bolor Jargalsaikhan, Mirjam Dür, Georg Still

Day-ahead power markets with coupled regions
Richárd Molnár-Szipai, Attila Egri, Marianna E.-Nagy, Boglárka G.-Tóth, Tibor Illés

Decompositions of graphs into induced subgraphs
Csilla Bujtás, Zsolt Tuza

10:20 am – 12:25 pm **Parallel Session 4B**

Petri net reduction rules for PNS problems
Szilvia Varró-Gyapay

Optimal design of large-scale energy systems using
the P-graph methodology
Adrián Szlama, István Heckl

Global branching tree for S-graph based throughput maximization

Tibor Holczinger, Ákos Orosz

Generic software tool for the evaluation, comparison and ranking of methods for short-term batch process scheduling problems

Éles András , Máté Hegyháti

A combinatorial modeling tool for event-based batch process scheduling: the eS-graph

Máté Hegyháti

11:20 am – 12:35 pm **Parallel Session 4C**

Handling data dependent execution times of software loops in the high level design of real time systems

György Rácz, Tibor Gergely Markovits, György Pilászy, Péter Arató

Android Malware Analysis Based On Memory Forensics

András Gazdag, Levente Buttyán

Novel Approaches for Object Position Estimation in Wireless Sensor Networks

Gergely Zachár, Gyula Simon

UHF RFID with user interface (UI-TAG)

József Bánlaki, Miklós Hoffmann, Tibor Juhász

Signal Processing in Distributed Systems with Limited Resources

György Orosz, László Sujbert

12:35 pm – 2:00 pm **Lunch**

2:00 pm – 3:40 pm **Parallel Session 5A**

Soft correlated equilibrium in simple congestion games

Ferenc Forgó

Make-or-buy optimisation with harmony search algorithm

Péter Veres, Tamás Bányai, Béla Illés

Lexicographic allocations and extreme core payoffs: the case of assignment games

Tamás Solymosi, Marina Núñez

The non-emptiness of the weak sequential core

Tibor Németh, Miklós Pintér

2:00 pm – 3:40 pm **Parallel Session 5B**

Solving a Huff-like Stackelberg problem on networks

Kristóf Kovács, Boglárka G.-Tóth

Separation algorithms for nonlinear chance-constrained problems with applications to hydro scheduling

Andrea Lodi, Enrico Malaguti, Giacomo Nannicini, Dimitri Thomopulos

On a specialized Branch and Bound method for a MINLP on Networks: Maximal Covering Problem with Continuous Demand

Boglárka G.-Tóth, Emilio Carrizosa, Rafael Blanquero

The linear complementarity problem and matrix classes

Marianna E.-Nagy

2:00 pm – 3:40 pm **Parallel Session 5C**

Economic and technological analysis of the development of a virtual machine room

József Domokos, Konrád József Kiss, Örs Darabont

Sensor networks for intrusion detection

Bence Koszteczky, Gyula Simon

Fast radio interferometric measurement on low power
COTS radio chips

Miklós Maróti, András Bíró, György Kalmár, András Bata

Composability of Cyber-Physical Systems

Attila Szarvas, Csanád Erdős, Tamás Dabóczy,

3:40 pm – 4:00 pm **Coffee break**

4:00 pm – 5:15 pm **Parallel Session 6A**

Risk-averse two-stage models: computational aspects
and application to gas-purchase planning

Csaba Fábíán, Christian Wolf, Achim Koberstein, Leena Suhl

Pension Plan Problem - Stochastic Dominance and
Investor's Behavior

Sebastiano Vitali, Milos Kopa, Vittorio Moriggia

Transmission Lines Switching in Electric Power
Networks by Means of Nonlinear Stochastic Program-
ming

*Francesco Piu, Alois Pichler, Asgeir Tomasgard,
Maria Teresa Vespucci*

4:00 pm – 5:15 pm **Parallel Session 6B**

Developing tailored MILP solver for process network
synthesis with time constraints

László Szili, Botond Bertók, Márton Frits

Time constrained process-network synthesis: Solv-
ing production scheduling problems

Márton Frits, Botond Bertók

Analysis of Search Strategies for Parallel Imple-
mentation of a Process-Network Synthesis Solver

Anikó Bartos, Botond Bertók

4:00 pm – 5:15 pm **Parallel Session 6C**

How to build a useful chordal graph?

Mihály Hujter

The connection between the binary and the Gaussian Markov networks and its application in dimension reduction

Edith Kovács, Tamás Szántai

Comments on Prékopa's Some Theoretical Papers: Stochastic Set Functions and Log-concavity Beyond Stochastic Programming

Davaadorjin Monhor

7:00 pm – 10:00 pm **Banquet in Hotel Villa Medici**

December 17, 2014 (Wednesday)

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

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

Optimization Theory and Dynamical Systems: Invariance and Invariance Preserving Discretization

Tamás Terlaky

10:00 am – 10:20 am **Coffee break**

10:20 am – 12:25 pm **Session 7A**

The method exact quadratic regularization for global optimization

Anatolii Kosolap

Discrete optimization genetic algorithm for competitive facility location

Algirdas Lancinskas, Pascual Fernandez, Blas Pelegrin, Julius Zilinskas

Empirical Study of Particle Swarm Optimization Mutation Operators

Vytautas Jancauskas

On completely positive modeling of quadratic problems

Nguyen Van

Infeasible interior-point method for symmetric optimization using a positive-asymptotic barrier

Petra Renáta Takács, Zsolt Darvay

10:20 am – 12:00 pm **Session 7B**

Comparison of scheduling methods for disabled appliances in Consumption Admission Control for Smart Grids

András Oláh, Rajmund Drenyovszki, Lóránt Kovács, Kálmán Tornai, Dávid Tisza

Jensen-Shannon Divergence-based Algorithms for
Analysis of Household's Electricity Consumption Data
Series

*István Pintér, Lóránt Kovács, András Oláh, Rajmund
Drenyovszki, Dávid Tisza, Kálmán Tornai*

Classification of Consumption Data in Smart Grid
Based on Prediction

Kálmán Tornai

An evaluation of one-class and two-class classifica-
tion algorithms for keystroke dynamics authentication

Margit Antal, László Zsolt Szabó

10:20 am – 12:25 pm **Session 7C**

Optimal resource cost for batch processes

Ákos Orosz, Tibor Holczinger

Combinatorial approach for the scheduling of Au-
tomated Wet-etch Stations

Olivér Ósz, Balázs Kovács, Máté Hegyháti

Handling Limited Wait and Zero Wait policies with the
S-graph framework

Benjámín Tóth, Máté Hegyháti

New results for scheduling two uniform machines
with known optimum

Zoltán Vincze, György Dósa

Heat Exchanger Network Retrofit: Mathematical
Optimisation incorporating Pinch Analysis

Jun Yow Yong, Petar Varbanov, Jiri Jaromír Klemes

12:25 pm – 2:00 pm **Lunch**

2:00 pm – 3:40 pm **Session 8A**

Supply chain coordination with buyback contract in uncertain environments

Alireza Ghaffari

Manufacturing cell formation by crossing minimization based co-clustering

Csaba Pigler, Ágnes Fogarassy-Vathy, János Abonyi

Observability and controllability based reliability analysis of complex networks and dynamical systems - The COND MATLAB toolbox

Dániel Leitold, Ágnes Fogarassy-Vathy, János Abonyi

On the 2-domination number of networks

Csilla Bujtás

2:00 pm – 3:40 pm **Session 8B**

Performance analysis of sparse data structure implementations

Péter Böröcz, Péter Tar, József Smidla, István Maros

A numerically adaptive implementation of the simplex method

József Smidla, Péter Tar, István Maros

A comparison of degeneracy aware methods of the dual simplex algorithm

Bálint Stágel, Péter Tar, István Maros

Parallel search path for the simplex method

Péter Tar, József Smidla, István Maros

2:00 pm – 3:40 pm **Session 8C**

Integrated optimization of biomass transportation and processing by solving a multiple traveling salesman problem

András Király, Tibor Chován, Maria Christidou, Evangelos Karlopoulos, János Abonyi

Process Simulation and Optimal Design of Rectisol Technology for High CO_2 capture

Xia Liu, Yu Qian, Siyu Yang, Petar Varbanov, Jiri Jaromír Klemes

Information retrieval based system for detecting data leakage

Adrienn Skrop

The role of identification and tracking in aspect of quality assurance Paper based and / or electronic?

László Szabó

3:40 pm – 4:00 pm **Coffee break**4:00 pm – 5:15 pm **Session 9A**

Self-adaptive multi-layer sensor network model

Szilárd Jaskó, Simon Gyula

Dynamic modeling and identification of a domestic refrigerator

Tamás Schné, Szilárd Jaskó, Gyula Simon

On Combining the P-graph Framework and Absorbing Markov Chains for Assessing the Reliability and Cost of Organization-based Multiagent System Design Models

Juan Carlos Garcia Ojeda, Botond Bertók, Ferenc Friedler, L.T. Fan

4:00 pm – 5:15 pm **Session 9B**

Branch-and-Bound Method for Determining Expected Profit under Uncertainties by the P-graph Framework
Zoltán Süle, János Baumgartner, Éva König, Botond Bertók

Comparison of optimization techniques in the P-graph framework for the design of supply chains under uncertainties
Éva König, Zoltán Süle, Botond Bertók

Reliability Analysis of Business Processes by P-graph Methodology
János Baumgartner, Tünde Tarczali, Zoltán Süle

5:15 pm **End of the conference.**

Abstracts

New Results for Batched Bin Packing

János Balogh

University of Szeged, Hungary

József Békési

University of Szeged, Hungary

György Dósa

University of Pannónia, Hungary

Gábor Galambos

University of Szeged, Hungary

In the one-dimensional bin packing a list of real numbers from the interval $[0, 1)$ is given, and we want to assign each of them to a unique capacity bin. Our aim is to minimize the number of used bins. In case of online problems the input is not known completely before the algorithm starts working. In this case the elements come one by one and the algorithm should assign the item to a bin immediately. Later this assignment can not be modified. In addition to this classical model many variants are possible. In case of the so called batched bin packing problem (BBPP) - defined by Gutin et al. - the elements come in batches and one batch is available for packing in a given time. Each batch may contain different sizes of items. In case of K batches we denote the problem by K -BBPP. In [1] the authors gave a 1.3871 lower bound for the asymptotic competitive ratio (ACR) of any on-line 2-BBP algorithm. In this talk we investigate the cases 3-BBPP and 4-BBPP, and we gave 1.5121 and 1.5392 lower bounds for the ACR, respectively. We determine these bounds as solutions of linear optimization problems, and we use theoretical analysis.

References

- [1] G. Gutin, T. Jensen, and A. Yeo, Batched bin packing. *Discrete Optimization*, 2(1): 71-82, 2005.

A practical tackling of an Unsplittable Multicommodity Flow Problem in telecommunication traffic engineering

Pawel Bialon

National Institute of Telecommunicationa, Poland

We present a practical approach to calculate connection paths in a Content-Aware Network (CAN) with a variant of the Unsplittable Multicommodity Flow Problem (UMCFP).

The calculated paths must satisfy certain demands for capacity (respective to the taken network hierarchization approach) and for a small number of path-additive measures like delay, loss ratio.

The main concern in the research was to make the approach feasible for a practical use in the management module of a real CAN system, constructed as a part of the Future Internet Engineering (IIP) FP7 project outcome. The needs were e.g. 1) a quick return with a reasonable solution within a short and fairly predictable time; 2) good behavior in the absence of a feasible solution (returning approximately-feasible solutions, showing how to modify the demands to retain feasibility); 3) flexibility to changes in the problem formulation. On the other hand, a certain level of network overdimensioning / surplus in the available resources is exploited.

The solving heuristics reduces the UMCFP to a series of multi-constrained shortest path problems (MCSP), each involving the original constraints on additive measures plus a penalty used to tackle the common capacity constrains in the outer loop. Solving a MCSP can involve a randomization and scalarization approach and an iterative updating of weights. Various aspects of the method are analyzed theoretically and experimentally.

Special Cases of Vehicle Routing Problem with Internal Transports

Zoltán Blázsik

Department of Computational Optimization, SzTE, Hungary

Long before that we consider in [2] the mathematical model of *HPPIT* as a common generalization of TSP [4] and the Linear Ordering Problem [6]. In [1] we recently present a new optimization model where the objective function is a mixed linear function of the two used in the Vehicle Routing Problem [5] and the LOP, and analyse some heuristic algorithms for the solution of the mathematical model. Several applications leading to special cases. There are well-solvable investigated special combinatorial optimization problems with extra cost matrix properties. There are another well known graph problems too, but these could not describe the general practical life, so the examination of new viewpoints may become important. In this talk we deal with special cases in profit C and cost D matrices of *VRPIT* [3].

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Touching cylinders

Sándor Bozóki

Institute for Computer Science and Control HAS (MTA SZTAKI);
Corvinus University of Budapest, Hungary

Tsung-Lin Lee

National Sun Yat-sen University, Taiwan ROC

Lajos Rónyai

Institute for Computer Science and Control HAS (MTA SZTAKI);
Budapest University of Technology and Economics, Hungary

The problem of finding the maximal number of mutually touching infinite cylinders (to be shortened by touching cylinders) is discussed. Best known upper bound is 24 by Bezdek [1]. An arrangement of 6 touching cylinders [3] provides a lower bound. We recently confirmed Littlewoods conjecture [6, 7]: 7 is a lower bound, too [2]. Our research is continued by analysing the family of 7 touching cylinders. It is still open whether 7 is maximal. Finite variants of the problem [4, 5] and applications in Physics to nanotubes [8] are also mentioned in the talk.

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On the 2-domination number of networks

Csilla Bujtás

University of Pannonia, Hungary

In a graph $G = (V, E)$, a set $D \subseteq V$ is called k -dominating set, if each vertex not in D has at least k neighbors in D . The k -domination number $\gamma_k(G)$ is the minimum cardinality of such a set D . The notion of k -dominating set can be interpreted naturally in the frame of sensor networks. We just looking for a set of head sensors such that in the case of the failure of any at most $k - 1$ heads, the network continues operating.

In the talk, we give an algorithm for the construction of 2-dominating sets, which also yields upper bounds on the 2-domination number in terms of the minimum degree and the number of vertices. Our proof technique uses a weight-assignment to the vertices where the weights are accordingly changed during the procedure. Originally, this approach was introduced with the aim of proving upper bounds on the game domination number [1] [2] [3], but it appears to be efficient in studying other domination-type graph invariants, as well.

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On generalization of SOHS decomposition of non-commutative polynomials

Kristijan Cafuta

University of Ljubljana, Slovenia

At VOCAL 2008 it was presented how to find a sum of hermitian squares (SOHS) decomposition of a non-commutative polynomial (in symmetric variables with Real coefficients) using semidefinite programming for which purpose we have developed a freely available open source Matlab toolbox called NCSOSTools. This was the beginning of a series of publications on various problems of polynomial optimization problems with non-commuting variables including trace optimization and constrained optimization, for example. All these algorithms have also been implemented in NCSOSTools.

In this talk we will set foundations for the beginning of generalization with adapting the initial results in two directions by using semidefinite programming. First, we will replace symmetric variables with non-symmetric variables and therefore extend the theory of SOHS decompositions of non-commutative polynomials on symmetric matrices to non-symmetric matrices. And second, we will replace Real coefficients with matrix coefficients (over Reals) and therefore extend the theory of SOHS decompositions of non-commutative polynomials to the matrix-valued non-commutative polynomials.

Measuring centrality by a generalisation of degree

László Csató

Corvinus University of Budapest, MTA-BCE "Lendület" Strategic
Interactions Research Group, Hungary

Identification of key nodes is a fundamental issue in network analysis. We propose a centrality measure called generalised degree, which takes the importance of neighbours into account. It improves on degree by redistributing its sum over the network with the consideration of the global structure. Its application is supported by a set of favourable properties. Generalised degree has a graph interpretation and can be calculated iteratively. We also give a sufficient condition for the measure to be rank monotonic, excluding counterintuitive changes in the centrality ranking after certain modifications of the network, and extensively discuss its relation with degree.

Optimization in Surgical Operation Design

Tibor Csendes

University of Szeged, Hungary

István Bársony

Kecskemét College, Hungary

István Szalay

University of Szeged, Hungary

A new treatment of some oncological diseases is brachytherapy, the insertion of low level radiation isotopes into the organ to be healed. This cure has much less intensive side effects than traditional radiation therapy, while having the same healing effects. The mathematical problem we investigate is to determine how to position the 50-90 capsules in such a way that the organ to be healed obtains at least the given level of dose, while the surrounding other tissues absorb a dose that is less than the prescribed level. The related nonlinear optimization problem is of moderate dimension (120-270). The resulting global optimization problem is very redundant, and it shows several forms of symmetries as well. The last improvements on the algorithm considering an artificial model are reported.

A new parameter learning algorithm, for solving the hard combinatorial problem Bin Packing with General Const Function

Attila Benkő

University of Pannonia, Hungary

György Dósa

University of Pannonia, Hungary

Zsolt Tuza

University of Pannonia and Alfréd Rényi Institute of Mathematics,
Hungary

We deal with a new engineering problem that we call Bin Packing with General Const Function.

Mainly we mean under this expression that the objective depends not only on the quality of the packing, but it is also influenced by the speed of the packing procedure; i.e., the objective also depends on the current time of closing (and delivering) the bins. In this way we can handle also the time needed for making the packing, so, we are looking for a "good and fast" packing.

In a recent manuscript we dealt with the offline version of the problem, designed polynomial-time algorithms finding exact offline solutions on a large class of problem instances, and proved non-approximability in general.

Now we propose a new method that we call the "Evolution of Algorithms" for the online setting, to solve this (algorithmically very hard) problem.

This method belongs to the class of parameter-learning algorithms. We define a neighborhood structure among parameters of an algorithm, and using a metaheuristic (simulated annealing in this paper) in some sense the best parameters are chosen to solve the problem. We show the efficiency of the proposed method by several computer tests. The method can be applied also to solve other hard combinatorial optimization problems.

Copositive Programming via Semi-Infinite Optimization

Mirjam Duer

University of Trier, Germany

Copositive programming (CP) can be regarded as a special instance of linear semi-infinite programming (SIP). We study CP from the viewpoint of SIP and discuss optimality and duality results. Different approximation schemes for solving CP are interpreted as discretization schemes in SIP. This leads to sharp explicit error bounds for the values and solutions in dependence on the mesh size. Examples illustrate the structure of the original program and the approximation schemes.

This is joint work with Faizan Ahmed and Georg Still.

The linear complementarity problem and matrix classes

Marianna E.-Nagy

Budapest University of Technology and Economics, Hungary

The linear complementarity problem (LCP) is an intensely studied problem in mathematical programming due to its theoretical importance and the wide range of applications. The LCP is an NP-complete problem. Although there are several algorithms to solve LCPs, but each of them requires some kind of special properties of the coefficient matrix for finiteness, efficiency and reliability. For example, if the coefficient matrix is sufficient, then we are able to solve the LCP problem in polynomial time with interior point methods (IPM).

On the other hand, IPM algorithms use the property of the matrix only locally. Therefore, even if the coefficient matrix of an LCP is not sufficient, an IPM algorithm may find a solution if it 'evades' the bad regions. This motivates us to define the local version for the LCP and IPM related matrix classes and investigate their properties. Furthermore, we would like to make a classification of LCP problems considering not only their coefficient matrix, but the right hand side of the problem as well.

Risk-averse two-stage models: computational aspects and application to gas-purchase planning

Csaba Fábián

Kecskemet College, Hungary

Christian Wolf

University of Paderborn, Germany

Achim Koberstein

European University Viadrina, Germany

Leena Suhl

University of Paderborn, Germany

We present the on-demand accuracy approach of Oliveira and Sagastizabal in a form which shows that this approach, when applied to two-stage stochastic programming problems, combines the advantages of the disaggregate and the aggregate models. Moreover, we generalize the on-demand accuracy approach to constrained convex problems, and show how to apply it to risk-averse two-stage stochastic programming problems.

We consider the CVaR-constrained model of Ahmed, and the stochastic ordering-constrained model of Dentcheva and Martinez. The proposed methods are evaluated in a computational study.

The preference-based multi-objective evolutionary algorithm with local search

Ernestas Filatovas

Vilnius University, Lithuania

Algirdas Lancinskas

Vilnius University, Lithuania

Olga Kurasova

Vilnius University, Lithuania

Julius Zilinskas

Vilnius University, Lithuania

The main target of multi-objective evolutionary approaches is to find a set of well-distributed compromising solutions that precisely approximate the entire Pareto front. Although there are various evolutionary strategies for solving multi-objective optimization problems, however, they can be computationally expensive for complex practical problems. Moreover, a reasonable number of solutions should be provided for a decision maker so that he/she could make an adequate decision avoiding complex analysis of large amount of information. Therefore, optimization methods based on decision maker's preferences are useful in which the region of interest of the Pareto front is approximated. Incorporation of the decision maker's preferences into multi-objective evolutionary strategies became the relevant trend during the last decade, and several preference-based evolutionary algorithms have been proposed in the literature.

Our research is focused on improvement of one well-known preference-based evolutionary algorithm R-NSGA-II by incorporating the local search strategy based on single agent stochastic search. The proposed hybrid algorithm has been experimentally evaluated by solving a set of well-known multi-objective optimization test instances of different scope. It has been experimentally shown that incorporation of the local search strategy has positive impact to the quality of the algorithm in the sense of the precision of the optimization.

Soft correlated equilibrium in simple congestion games

Ferenc Forgó

Corvinus University of Budapest, Hungary

Simple congestion games model situations where players choose service facilities and their payoff depends only on how many of them use the chosen facility. Correlated equilibrium and its generalizations can help improve system performance (social welfare) while maintaining stability and the self-enforcing nature of equilibrium. Soft correlated equilibrium (Forgó, Mathematical Social Sciences, 2010, 60:186-190) can increase social welfare even in cases where other kinds of correlation do not help. Its efficiency measured by the mediation value and the enforcement value (Ashlagi I, Monderer D and Tennenholtz M (2008) On the value of correlation. Journal of Artificial Intelligence 33:575-613) is determined in 2,3 and 4-person games and bounds are computed for the general n-person case. The main tool of analysis is the solution of linear programs with parameters in the coefficient matrix. The notorious prisoners dilemma is also interpreted as a congestion game and its mediation and enforcement values are shown to be ∞ and 2, respectively. A version of the n-person prisoners dilemma is also cast in the form of a congestion game.

Deriving priorities from an inconsistent pairwise comparison matrix by using network algorithm

János Fülöp

Research Group of Operations Research and Decision Systems, MTA
SZTAKI, Hungary

Marcin Anholcer

Poznan University of Economics, Poland

In several multiattribute decision problems, pairwise comparison matrices (PCMs) are applied to derive the priorities of the decision alternatives. In the practice, PCMs are often inconsistent. In such a situation, a usual approach is to approximate the PCM with a consistent one. A natural way is to minimize the sum of squares of the elementwise differences, i.e. minimizing in Frobenius norm. Unfortunately, this way can lead to solving nonconvex optimizations problems with multiple isolated local optimal solutions. In the talk we consider the problem of minimizing in the maximum norm. We show that this problem can be reduced to solving a sequence of linear programs. In addition, after applying the logarithmic transformation, we can formulate the obtained LP subproblems as shortest path problems, and solve them more efficiently. We analyze and completely characterize the form of the set of optimal solutions, and provide an algorithm that results in a unique optimal solution.

On some practical applications of graph theory

Otília Fülöp

Budapest University of Technology and Economics, Hungary

This paper provides two different applications of graph theory. The structure of the paper is as follows. After a short introduction of networks (Section I) in Section II we solve a practical connectivity problem considered in special networks. Section III presents a totally different area, namely the problem of chirality in pharmacology and chemistry. Here we deal only with hole-free compact planar objects with non self-intersecting perimeter that divides the plane into an interior and an exterior region. The simplest approach is to say that an object is chiral or achiral (i. e. it has a non-superimposable mirror image or not).

One can think that there is no other possibility. On the other hand a few scientists recognized that it is possible to measure the degree of chirality. For example Frank Harary, R.W. Robinson, P.G. Mezey, A.I. Kitaigorodski, K. Mislow, J. Siegel, G. Gilat, D. Avnir and A.Y. Meyer have important contributions in this field. In Section IV we show that the degree of chirality of such an object can be measured using a star graph construction.

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On a specialized Branch and Bound method for a MINLP on Networks: Maximal Covering Problem with Continuous Demand

Boglárka G.-Tóth

Budapest University of Technology and Economics, Hungary

Emilio Carrizosa

University of Sevilla, Spain

Rafael Blanquero

University of Sevilla, Spain

Covering problems are well studied in the Operations Research literature under the assumption that both the set of users and the set of potential facilities are finite. In this talk we address the following variant, which leads to a Mixed Integer Nonlinear Program (MINLP): locations of p facilities are sought along the edges of a network so that the expected demand covered is maximized, where demand is continuously distributed along the edges.

This MINLP has a combinatorial part (which edges of the network are chosen to contain facilities) and a continuous global optimization part (once the edges are chosen, which are the optimal locations within such edges).

A branch and bound algorithm is proposed, which exploits the structure of the problem: specialized data structures are introduced to successfully cope with the combinatorial part, inserted in a geometric branch and bound. Three different bounding rules are built to tightly overestimate the objective function, and a heuristic rule is constructed to choose the best bound for every sub-problem.

Computational results are presented, showing the appropriateness of our procedure to solve covering problems for small (but non-trivial) values of p .

An XML schema for matrix and cone programming

Horand Gassmann

Dalhousie University, Canada

Jun Ma

JTechnologies, USA

Kipp Martin

University of Chicago, USA

Imre Pólik

SAS Institute, USA

Cone programming and matrix programming are relatively new areas of mathematical optimization that have received considerable attention in recent years due to their applicability in the solution of stochastic programs as well as relaxations to hard mixed integer programs. Solver implementations do exist, but benchmarking is hampered because there are few accepted input formats in which to communicate instances to the solvers. This talk presents efforts to facilitate the formulation of matrix and cone programming problems within the OSiL framework, a unified representation format for a large variety of mathematical optimization problem instances. OSiL is part of the OptimizationServices project, an open source project under the COIN-OR umbrella. A prototype implementation communicating with the CSDP solver is also described.

Android Malware Analysis Based On Memory Forensics

András Gazdag

Budapest University of Technology and Economics, Hungary

Levente Buttyán

Budapest University of Technology and Economics, Hungary

Live forensics solutions have long been proven powerful in various research fields. The rise of mobile platforms has created numerous new challenges for the researchers. The adoption of the widely used technologies of the traditional PC environment has limitations due to the lack of wider control over the mobile operating system. In this paper we present a new malware analysis solution for the Android platform using a memory forensics approach. We explore the required modification of the Android system to be able to use it as a memory analysis environment and demonstrate the solution with an implementation. We propose possible analysis targets for the acquired memory image. Based on the information gathered from the analysis steps we present a methodology of behaviour analysis of android applications, furthermore we show the power of this approach analysing and evaluating Android malwares. Finally we evaluate our implementation with well-known malware family samples illustrating its efficiency and effectiveness.

Supply chain coordination with buyback contract in uncertain environment

Alireza Ghaffari

Azarbaijan Shahid Madani University, Iran

Some products have remarkable short life cycles and experience considerable price drops afterward. Due to this phenomenon in this type of commodities, incentive contracts are usual exercises, especially in the high-tech industries. Increasing innovation in such industries in addition to the uncertain characteristics of market demand may prevent the retailers to order not too much of a product to satisfy the market demand.

In this paper, the effect of buyback contract in supply chain coordination is considered using the uncertainty theory introduced by Liu in 2007. This contract is intended to potentially counterbalance the negative impact of double marginalization outcome.

How to build a useful chordal graph?

Mihály Hujter

Budapest University of Technology and Economics, Hungary

Long time ago the em rigid circuit graphs were introduced and studied by Hajnal, Surányi, and Dirac [3] [5]. Later these graphs got the name *perfect elimination graphs*, and even later these graphs were called *triangulated graphs*; however, nowadays their most common names are *chordal graphs*. We will shortly list the most important results on chordal graphs. Then we are going to show why they are so important in *Gauss elimination* and in *probability bounding*. (We will mainly focus on latter topic.)

Independently of each other, three papers found an important idea how chordal graphs can be used to improve the famous em Hunter bound. (This bound is sometimes called the Hunter–Worsley bound because six years after Hunter, Worsley rediscovered the same method [6] [7].) *Bukszár* and *Prékopa* introduced the so-called *cherry trees*, and among these graphs an important subclass belongs to the chordal graphs [2]. *Dohmen* designed sophisticated bounds related to both the inclusion-exclusion formulas and the chordal graphs [4]. The method and formula of *Boros* and *Veneziani* seems to be the most explicit [1]. At the end of our talk we study the question how one can find the best member of a large family of probability bounding formulas. Our algorithmic methods are based on the structural properties of chordal graphs.

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The strip covering problem

Tamás Bartók

University of Szeged, Hungary

Csanád Imreh

University of Szeged, Hungary

We consider the problem where one have to cover some parts of a unit width strip with rectangles without rotation. Each rectangle is given by the pair (h_i, w_i) of its height and width. The goal is to maximize the height of the covered strip. We suppose that the width of the items is at most 1. The problem is the dual of the widely investigated strip packing problem (see [3] for a survey on strip packing). Our model is an extended version of the restricted strip covering (see [1,2] for details and application on settling sensors to cover an area).

We note that the problem is NP-hard, one can reduce easily the partition problem to strip cover by using items of width $1/2$. Therefore we studied approximation algorithms for the solution of the problem. Moreover we present a local search based heuristic algorithm, and compare it to the approximation algorithms by experimental analysis.

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Reconstruction of score sets

Antal Iványi

Eötvös University, Faculty of Informatics, Hungary

The textitscore set of a tournament is defined as the set of its different outdegrees. In 1978 Reid [4] published the conjecture that for any set of nonnegative integers D there exists a tournament T whose degree set is D . Reid proved the conjecture for tournaments containing $n = 1, 2$, and 3 vertices. In 1986 Hager [1] published a constructive proof of the conjecture for $n = 4$ and 5 vertices. Yao [5] in 1989 presented an arithmetical proof of the conjecture, but general polynomial construction algorithm is not known. In [3] we described polynomial time algorithms which reconstruct the score sets containing only elements less than 7. In [2] we improved this bound to 9.

In the talk we report on algorithms resulting a new bound equal to 12.

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Empirical Study of Particle Swarm Optimization Mutation Operators

Vytautas Jancauskas

Vilnius University, Lithuania

Particle Swarm Optimization (PSO) is a global optimization algorithm for real valued problems. One of the known positive traits of the algorithm is fast convergence. While this is considered a good thing because it means the solutions are found faster it can lead to stagnation at a local minimum. There are several strategies to circumvent this. One of them is the use of mutation operators to increase diversity in the swarm. Mutation operators, sometimes called turbulence or craziness operators, apply changes to solutions outside the scope of the PSO update rules. Several different such operators are proposed in the literature mostly based on existing approaches in evolutionary algorithms. However, it is impossible to say which mutation operator to use in which case and why. There is also some controversy whether mutation is necessary at all. We use an algorithm that generates test functions with given properties - number of local minima, dimensionality, global minimizer attraction region placement and attempt to explore the relationship between function properties and mutation operator choice. An empirical study of the operators proposed in literature is given with extensive experimental results. Recommendations for choosing appropriate mutation operators are proposed.

Complexity analysis of conic optimization

Bolor Jargalsaikhan

University of Groningen, Netherlands

Mirjam Duer

University of Trier, Germany

Georg Still

University of Twente, Netherlands

Linear conic optimization concerns linear problems with a cone constraint, for example the semidefinite cone, second order cone, or the copositive cone. Depending on the cone, the complexity of solving a conic problem may vary. For example, solving a semidefinite problem is known to be polynomial, whereas copositive programming is NP-hard since the maximum clique problem can be formulated as a copositive program.

In this talk, we discuss problems related to conic programming, such as checking membership in a cone or finding a separating hyperplane. In particular, we show that if a primal problem is "weakly" solvable in polynomial time, then the dual problem is also "weakly" solvable in polynomial time.

The method exact quadratic regularization for global optimization

Anatolii Kosolap

University of Chemical Engineering, Ukraine

The existing methods in global optimization can be classified as deterministic and probabilistic. Deterministic ones include: Lipschitzian, Branch and Bound, Cutting Plane, Difference of Convex Function, Outer Approximation, Reformulation-Linearization, Interval methods. They demand the exponential number of iterations for finding global extremum. The probabilistic methods include random search, genetic and evolutionary methods. However, these methods allow to find global extremum only with some probability.

There are following modern research in global optimization: semidefinite, polyconvex optimization and exact quadratic regularization. Semidefinite optimization is used for the solution of general quadratic and polynomial problems.

In this paper we propose new method of exact quadratic regularization for deterministic global optimization (EGR). This method can be used for the solution of a wide class of multiextreme problems. It allows to divide multiextreme problems into two classes of complexity. The first one is the problem of minimizing the norm of a vector on a convex set, and the second maximizing. Effective methods of local optimization are used for this problems.

The EQR finds the best solutions for a wide range test problems in global optimization. New method a simple for making the software. The EQR is used for solving of discrete problems, packing of spheres, sensor networks, Lennard-Jones clusters. The comparative numerical experiments have shown that new method is a very efficient and promising.

Solving a Huff-like Stackelberg problem on networks

Kristóf Kovács

Budapest University of Technology and Economics, Hungary

Boglárka G.-Tóth

Budapest University of Technology and Economics, Hungary

In competitive facility location the general aim is to locate one or more facilities for an existing or a newcomer chain maximizing its market share or profit. When competitors are likely to react with their own expansion, the owner has to take that into account. This leads to a bi-level optimization problem, where the optimal location of the first player, the emphleader, has to be determined depending on the location of the second player, the emphfollower, who decides its location with the knowledge of the location of the leader. We suppose that the follower's decision is rational, maximizing their profit. This problem is called the emphStackelberg problem.

We considered static competition with inelastic demand. Demand is concentrated in a discrete set of points, called demand points. The objective function to be maximized is the profit obtained by the chain, to be understood as the income due to the market share captured by the chain minus its operational costs. The location space in our model is a network, with the vertices being demand points and the facilities located on the edges.

The problem of the follower is solved using a emphBranch and Bound method, with emphinterval arithmetic and emphDC bounds, that is built in the B&B algorithm for the leader, where similar methods were used for the bound calculations. In the talk computational results for small and medium sized networks will be presented.

Discrete optimization genetic algorithm for competitive facility location

Algirdas Lancinskas

Vilnius University, Lithuania

Pascual Fernandez

University of Murcia, Spain

Blas Pelegrin

University of Murcia, Spain

Julius Zilinskas

Vilnius University, Lithuania

The competitive facility location problem (CFLP) is important for firms providing a service or goods to customers and have to compete with other firms for the market in a certain geographical area. Specifically we deal with CFLP for an entering firm where a new firm is going to enter the market by establishing a set of new facilities. The determination of locations for the new facilities usually leads to solution of global optimization problem with various properties and constraints.

Our research is focused on discrete CFLP for an entering firm where locations of the new facilities must be selected from a given set of candidate locations. We proposed a heuristic algorithm developed under the genetic algorithms meta-heuristic. The algorithm is specially adopted for CFLP and distinguishes by runtime adjustment of the parameters such as population size and probabilities for performing genetic operators.

The performance of the proposed algorithm has been experimentally investigated by solving a set of CFLP instances of different scope and models for customers' behavior. The performance has been compared with the performance of the state-of-the-art algorithms suitable for solution of the relevant problem.

The results of the investigation shows that the proposed algorithm is suitable to solve discrete CFLP for firm expansion of different scope and is competitive with the state-of-the-art algorithms present in the literature.

Process Simulation and Optimal Design of Rectisol Technology for High CO_2 capture

Xia Liu

South China University of Technology, China

Yu Qian

South China University of Technology, China

Siyu Yang

South China University of Technology, China

Petar Varbanov

University of Pannonia, Hungary

Jiri Jaromír Klemes

University of Pannonia, Hungary

Coal gasification system usually makes use of methanol-based Rectisol technology for acid gas removal to capture CO_2 . However, the conventional process capture CO_2 rate is usually near 60 % only (Ni and Li, 2011). This contribution proposes an advanced Rectisol process with high CO_2 capture ratio, through CO_2 intensified desorption on rising CO_2 -rich methanol temperature of and decreasing flash pressure. The major tool is simulation of the conventional process (Sun and Smith, 2013), and the optimal thermodynamic model for Rectisol development. This contributes to the foundation of optimal design and analysis on proposed process.

The simulation results revealed that the thermodynamic model PC-SAFT is optimal for chilled methanol absorption, the PSAK is more concise model for CO_2 desorption. For the optimal design of CO_2 desorption of proposed process CO_2 capture rate range of 60 - 90 % can be achieved. Also very high 99.9 % H_2S recovery can be reached. When the capture rate increases, the stripper gas N_2 input and tail gas outlet both decrease accordingly. The energy consumption increases with capture rate increase, however, the unit specific energy consumption decreases - at 90 % capture rate is around 0.96GJ/t CO_2 , compared with the previous 60 % capture rate at 1.05GJ/t CO_2 . CO_2 capture ratio of the new process increases while the unit energy consumption is reduced.

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Solution of Stochastic Quadratic Assignment Problem Deterministic Reformulations

Radomil Matousek

Brno University of Technology, FME, Czech Republic

Pavel Popela

Brno University of Technology, FME, Czech Republic

The Quadratic Assignment Problem (QAP) belongs to difficult non-linear integer programming problems. We study the case where distance and flow parameters of QAP are random, so the Stochastic Quadratic Assignment Problem (StoQAP) is formulated. Therefore, the problem can be modelled by stochastic programming approach and various deterministic reformulations are considered and their properties are discussed. The insight is mostly achieved by analysis of explanatory examples. The important application areas are shortly listed and historical remarks and comparisons to similar problems are mentioned together with references to existing solution techniques. The computational experience with classical algorithms and original metaheuristics is shared with readers. The solution software implementation involves mathematical programming related solvers and a source code of authors. The use of Stochastic Quadratic Assignment Problem Library (StoQAPLib) of randomly generated test problems is presented together with their development. The obtained results are further discussed and visualized for comparisons and evaluations of algorithms and their implementations. Further research directions towards efficiently solvable transformations of models are noticed at the end.

Day-ahead power markets with coupled regions

Richárd Molnár-Szipai

Budapest University of Technology and Economics, Hungary

Attila Egri

Budapest University of Technology and Economics, Hungary

Marianna E.-Nagy

Budapest University of Technology and Economics, Hungary

Boglárka G.-Tóth

Budapest University of Technology and Economics, Hungary

Tibor Illés

Budapest University of Technology and Economics, Hungary

The coupling of day-ahead power markets is a cornerstone of the wider goal of integrating the European power market. By combining the implicit auctions of regional markets and the previously explicit auction of cross-border capacities, this system facilitates the optimal utilization of resources, which induces increased trading, narrower price spreads between the regions, and an overall more stable supply and pricing.

The goal of our research supported by electrical engineers is extending the currently used models, and developing robust and efficient algorithms to solve these variants.

In the first stage of this research we implemented different formulations of the currently used model, which is a mixed integer program with linear constraints and convex quadratic objective functions. We then tested these implementations on a real dataset using multiple solvers.

Comments on Prékopa's Some Theoretical Papers: Stochastic Set Functions and Log-concavity Beyond Stochastic Programming

Davaadorjin Monhor
Óbuda University, Hungary

Prékopa's theoretical and application contributions to various areas of operations research, specially contributions to stochastic programming are well-known in the operations research community. He started his research as theoretical mathematician and produced a number of theoretical papers on probability theory and theory of stochastic processes. These works are primarily known to the community of relevant theoretical field, but seem to be not much known in the operations research community. The fundamental results of log-concave measures established by Prékopa are used in diverse areas of mathematics, outside stochastic programming. The aim of the talk is to bring some of these issues to the attention of the community of OR, and to comment on the significance of them.

Reconstruction of hv-convex planar bodies by their coordinate X-rays

Ábris Nagy

University of Debrecen, Hungary

Csaba Vincze

University of Debrecen, Hungary

Parallel X-rays are real functions that measure the intersection of a given set with lines parallel to a fixed direction in $\mathbb{R}^2$. The reconstruction problem concerning parallel X-rays is to reconstruct a compact subset of $\mathbb{R}^2$ if the parallel X-rays of this set into some directions are given. Introducing generalized conic functions seem to be an effective tool in geometric tomography since coordinate X-rays are determined by them (almost everywhere) and these functions have better regularity properties than X-rays. Given the coordinate X-rays of a hv-convex planar body K we can introduce an algorithm that gives a sequence of polyominoes L_n such that L_n tends to a set K^* with respect to the Hausdorff distance, where K^* has the same coordinate X-rays as K almost everywhere. If K is determined by its coordinate X-rays then $L_n \rightarrow K$. Moreover the algorithm works even if only finitely many noisy measurements of the coordinate X-rays are given. The main step of this algorithm can be introduced as solving a constrained polynomial 0-1 programming problem. This problem is later linearized. Greedy versions can be also implemented combined with a quota system scheme.

The parameter estimation of the link performance functions

József Osztényi

Kecskemét College, Hungary

The link performance function is a mathematical representation of the relation between flow (i.e. traffic volume) and travel cost (i.e. travel time) for any given link in the network. The results are presented of the calibration of performance functions. Two types of functions are presented: (a) piecewise linear functions and (b) non-linear functions, based on the widely used Bureau of Public Roads form. These functions are intended for use in network equilibrium studies requiring the assignment of explicit car flows.

On the generation of scenario trees for multistage stochastic optimization

Georg Pflug

University of Vienna, Austria

Multistage stochastic optimization problems are very involved variational problems. For a numerical solution, discrete approximations are necessary. We present algorithms, which calculate optimal approximations of a given discrete-time stochastic process by a discrete-time discrete-value stochastic process, which can be viewed as a valuated tree. The basis of the algorithm are results on distances of stochastic processes as well as stochastic recursions.

Some examples illustrate how the algorithm works: The approximation quality can be prespecified and this choice determines the runtime of the algorithm and the size of the discrete approximation.

Scenario Generation using Kernels

Alois Pichler

Norwegian University of Science and Technology, Norway

Approximations in Stochastic Optimization are typically based on scenario trees. These stochastic processes cannot be observed directly, typically just paths (or trajectories) can be observed.

In this talk we employ kernels, which are well established in nonparametric estimation to estimate densities, to construct scenario trees out of a sample of observed trajectories. Further, the approximation quality is investigated.

The non-emptiness of the weak sequential core

Tibor Németh

Budapest University of Technology and Economics, Hungary

Miklós Pintér

Corvinus University of Budapest, Hungary

The weak sequential core of transferable utility games with uncertainty is considered. We give a necessary and sufficient condition for the non-emptiness of the weak sequential core. We show that a transferable utility game with uncertainty has non-empty weak sequential core if and only if it is core- Pi -balanced.

Keywords: Transferable utility game with uncertainty, Weak sequential core, Universally Pi -balancedness on the cores, Non-transferable utility game, Core, Pi -balancedness

Transmission Lines Switching in Electric Power Networks by Means of Nonlinear Stochastic Programming

Francesco Piu

University of Bergamo, Italy

Alois Pichler

Norwegian University of Science and Technology, Norway

Asgeir Tomasgard

Norwegian University of Science and Technology, Norway

Maria Teresa Vespucci

Bergamo University, Italy

Switching off selected transmission lines of an electricity network can lead to savings in the total production costs. This, perhaps surprising, fact has gained increasing interest in the recent past, as the overall profitability of a given network can be increased. Energy is often produced in different places than in the past, for example in off-shore wind parks as in Germany, Denmark and many other countries. This situation offers the opportunity of re-designing the existing power flow network and to incorporate switching possibilities in the network. The central problem consists in finding and identifying those transmission lines, which provide the highest savings potential, while the power supply has to be secure at the same time in the whole area. This paper employs stochastic programming to elaborate the difficulties of the whole problem. In particular possibilities of how to reduce the problem to a tractable size are elaborated.

Waste Transportation by Mathematical Programming: NERUDA Model

Pavel Popela

Brno University of Technology, FME, Czech Republic

Martin Pavlas

Brno University of Technology, FME, Czech Republic

Radovan Somplak

Brno University of Technology, FME, Czech Republic

Vit Prochazka

NHH Bergen, Norway

Efficient waste management represents an important challenge in the Czech Republic, and hence, the amount of land-filled waste has to be reduced. The goals in recycling and power generation motivate the development of the complex mathematical model for optimal waste transport within the region. The aim of the paper is to present the model and all its elements step-by-step, discuss its mathematical properties and show its use for real-world data. A traditional network flow model is extended for the graph with specific nodes representing various processing units. The edges and the graph structure reflect various types of transport (e.g., lorries on roads, trains on railways). The cost curves and their nonlinearities are suitably represented. The huge size of the data set leads to aggregation of data and to general model approximations in preprocessing phase to achieve solvability within given time limits. Software implementation is based on GAMS core model description and solvers (CPLEX, CONOPT, and BARON) that are chosen by selected model transformation. The implementation also supports an easy input data access and visualization of results. The efficient data representation is especially useful in postprocessing phase for gate fee identification and sensitivity analysis. The model also serves for computational studies required by the largest Czech energy producer CEZ. Further research will focus on dynamic extensions of the model, improving the representation of varying supply and demand during the year. The waste resource identification will also be involved to balance expenses of waste producers.

Lexicographic allocations and extreme core payoffs: the case of assignment games

Tamás Solymosi

Corvinus University of Budapest, Hungary

Marina Núñez

University of Barcelona, Spain

We consider various lexicographic allocation procedures for coalitional games with transferable utility where the payoffs are computed in an externally given order of the players. The common feature of the methods is that if the allocation is in the core, it is an extreme point of the core. We first investigate the general relationships between these allocations and obtain two hierarchies on the class of balanced games. We show that when a marginal worth vector is in the core, it coincides with the corresponding leminal (the vector of lexicographic minima over the set of coalitionally rational payoff vectors) and also with the lemaral (the vector of lexicographic maxima over the set of dual coalitionally rational payoffs) associated to the reverse order of the players. Similarly, if a leminal / lemaral is in the core, it coincides with the corresponding lemicol / lemacol (the vector of the lexicographically minimized / maximized payoffs over the core). The roles of the allocations in these implications are not symmetric.

Secondly, we focus on assignment games and sharpen some of these general relationships. Our main result is the coincidence of the sets of lemarals, lemacols, and extreme core points. As byproducts, we show that, similarly to the core and the coalitionally rational payoff set, also the dual coalitionally rational payoff set of an assignment game is determined by the individual and mixed-pair coalitions, and present an efficient and elementary way to compute these basic dual coalitional values. This provides a way to compute the Alexia value (the average of all lemacols) with no need to obtain the whole coalitional function of the dual assignment game.

The connection between the binary and the Gaussian Markov networks and its application in dimension reduction

Edith Kovács

Budapest College of Management, Hungary

Tamás Szántai

Budapest University of Technology and Economics, Hungary

By a classical result the zeros in the inverse of the covariance matrix represent the missing edges of the associated Markov network graph in the case of Gaussian distributions. A missing edge of the Markov network means that the random variables represented by the not connected nodes are independent by conditioning all the other random variables. Moreover in the case of Gaussian distribution the three Markov properties (pairwise, local and global) are equivalent due to the Hammersley-Clifford theorem.

In our lecture we establish some relations between multivariate binary discrete random variables and the inverse of their covariance matrix. Then we will show how this connection can be used to split some high order multidimensional stochastic problems into smaller ones.

Infeasible interior-point method for symmetric optimization using a positive-asymptotic barrier

Petra Renáta Takács

Babes-Bolyai University, Romania

Zsolt Darvay

Babes-Bolyai University, Romania

We propose a new small-update primal-dual infeasible interior-point method (IIPM) for symmetric optimization (SO) by using Euclidean Jordan algebras. Different kinds of interior-point methods (IPMs) can be obtained by using search directions based on kernel functions. Some search directions can be also determined by applying an algebraic equivalent transformation on the centering equation of the central path. Using this method we introduce a new search direction, which can not be derived from a usual kernel function. For this reason, we define the notion of positive-asymptotic kernel function which induces the class of corresponding barriers. In general, the main iterations of the IIPMs are composed of one feasibility and several centering steps. We prove that in our algorithm it is enough to take only one centering step in a main iteration in order to obtain a well-defined algorithm. Moreover, we conclude that the algorithm finds solution in polynomial time and has the same complexity as the currently best known IIPMs.

Separation algorithms for nonlinear chance-constrained problems with applications to hydro scheduling

Andrea Lodi

University of Bologna, Italy

Enrico Malaguti

University of Bologna, Italy

Giacomo Nannicini

SUTD, Singapore University of Technology and Design, Singapore

Dimitri Thomopulos

University of Bologna, Italy

Midterm hydro scheduling problem is about optimizing the performance of a hydro network over a period of few months. This decision problem is affected by uncertainty on energy prices, demands and rainfall, and we model it as a nonlinear chance-constrained mathematical program.

This is a Multi-stage problem where at each stage we have to decide how much water to release from the reservoirs, and as a consequence, how much energy to produce. The production function is nonlinear and it is approximated by a concave function. In addition, the inflows and the demands are random, thus the profit over the entire time horizon is therefore nondeterministic.

We present a Branch-and-Cut algorithm based on the approach recently proposed by Luedtke (Math. Prog. 146, 2014), which uses Benders-type cuts. However, in our case the feasible region induced by each scenario is a general convex set instead of a polyhedron. Furthermore, we introduce a separation algorithm for the corresponding scenario subproblems that exploits projection and KKT conditions, and has some clear advantages over generalized Benders decomposition.

We report some computational experiments using a test case with a three-stage, 90-scenario stochastic tree and data of the Greek Power System.

Approximation of Continuous-State Scenario Processes in Multi-Stage Stochastic Optimization and its Applications

Anna Timonina

International Institute for Applied Systems Analysis, Austria

Nowadays, governments and people, companies and technologies in our fast-developing and changing world starting to face more and more situations and problems, where they need to take decisions under uncertainty in multi-period environment. The multi-stage stochastic optimization is a well-known mathematical tool for the solution of multi-period decision-making problems under uncertainty. However, the explicit theoretical solution of a multi-stage optimization program may be difficult or even impossible to obtain due to its functional form. Therefore, our goal is to study numerical methods for the solution of the problem by the use of approximation techniques, that are challenging, important and, very often, irreplaceable solution methods in the multi-stage stochastic optimization.

As soon as the decisions need to be taken in the multi-period environment, but the historical time-series data is available only for the past, we work with stochastic processes given by their continuous-state probability distributions estimated data-based and we assume that these distributions may change over periods in line with their conditional distributions. The focus is on the approximation methods of these stochastic processes by scenario trees.

Most of the existing algorithms of scenario approximation are forward procedures, that start with the root of the approximate tree and go up to its leaves, assigning values and probabilities to the nodes conditionally on the past only (for example: stage-wise optimal quantization, Monte Carlo generation etc.). However, all these algorithms lose a part of crucial information by neglecting the fact, that the set of possible future scenarios at any particular node is smaller (or equal at the root) than the set of all future scenarios of the tree. Therefore, in order to minimize the approximation error in the multi-stage stochastic problems it is not enough to generate scenarios based only on the past, but it is necessary to introduce information about possible future scenarios. We focus on

the backtracking scenario approximation that implements both information about the past and available information about possible future scenarios by the combination of the forward procedure with the backward step on the tree. The backward step starts with the leaves of the tree and goes down to the root taking into account probability distributions on every subtree.

On completely positive modeling of quadratic problems

Nguyen Van

Universität Trier, Germany

Copositive programming deals with linear optimization problems over the copositive cone and its dual, the completely positive cone. The motivation to study this type of problem is that many nonlinear quadratic problems (even with binary constraints) can be cast in this framework.

In order to have strong duality in conic optimization, strict feasibility of the problems is required. Strict feasibility is also advantageous in numerical solution approaches, for example when inner approximations of the copositive cone are used. We show that not all of the known completely positive formulations of quadratic and combinatorial problems are strictly feasible and discuss conditions which ensure this property.

Parallel Machine Scheduling and Preventive Maintenance in Electric Power Systems

György Dósa

University of Pannonia, Hungary

László Varga

E.ON Energy Supply Company, Hungary

In order to avoid failures of generating units in power systems, it is important to carry out preventive maintenance. The maintenance increases the outage capacity in those periods when the maintenance is performed. Two methods are applied for maintenance scheduling. The reserve-leveling approach aims at keeping the amount of reserve almost the same level through the year by withdrawing units from the low electric load periods. The other approach considers the uncertainties in the loads and the availability of generating units using risk-leveling methods which seek to spread the risk, measured by some kind of reliability index.

Together with maintenance scheduling a lot of production scheduling problems are NP-hard that is unlikely to find polynomial algorithms for the solution. In these cases efforts have been directed toward devising approximation algorithms, which find near-optimal schedules. Well-studied problem of the scheduling theory is the non-preemptive scheduling of tasks with different processing times on identical, parallel machines, where the objective is the minimization of the makespan. Based on the observation that the maintenance scheduling and the makespan minimization are equivalent problems, in our presentation effective approximation algorithms are shown for the leveled reserve as well as the leveled risk scheduling. A case study shows that the developed algorithms can achieve a substantial leveling in the reliability indices over the planning horizon.

Pension Plan Problem - Stochastic Dominance and Investor's Behavior

Sebastiano Vitali

University of Bergamo, Italy

Milos Kopa

Charles University in Prague, Czech Republic

Vittorio Moriggia

University of Bergamo, Italy

We present the definition of an individual optimal portfolio allocation in a Pension Plan prospective. In particular, we propose a multistage stochastic program (MSP) which includes a multi-criteria objective function. Moreover, we introduce three different formulations of the problem: one with deterministic wealth targets, and two with stochastic dominance constraints with respect to a benchmark wealth. The optimal choice is the portfolio allocation that minimizes the Average Value at Risk Deviation of the final wealth and satisfies the wealth targets in the final stage and in an intermediate stage. Other constraints regard the pension funds rules and the investor's attitude. The stochasticity arises from the investor's salary process and the returns of the assets. Finally, we propose a formulation which include also the stochastic investor's behavior. All the stochastic processes are dependent each other. Numerical results show that we can achieve a time evolving balanced portfolio satisfying the investor's wishes.

Optimality Conditions and Smoothing Approach for Non-lipschitz Optimization

Nurullah Yilmaz

Suleyman Demirel University, Türkiye

Ahmet Sahiner

Suleyman Demirel University, Türkiye

In this study, we introduce optimality conditions for non-lipschitz objective functions, and we propose a smoothing technique for non-lipschitz objective functions. This approach base on the hyperbolic smoothing function as in the paper [1] (A. Bagirov, Hyperbolic smoothing functions for nonsmooth minimization, Optimization, Vol. 62, No. 6, 759-782, 2013). Finally, we design an algorithm to solve for this smoothing techniques.

Heat Exchanger Network Retrofit: Mathematical Optimisation incorporating Pinch Analysis

Jun Yow Yong

University of Pannonia, Hungary

Petar Varbanov

University of Pannonia, Hungary

Jiri Jaromír Klemes

University of Pannonia, Hungary

Heat integration has been introduced to the chemical industries for over 30 years and proven successful in saving utilities. However with ever increasing energy price and market demand, chemical plants have to modify processes to increase the production while decrease the utility usage. Numerous methodologies have been developed in retrofitting existing heat exchanger network (HEN) over the years, which can be generally categorised into Pinch Analysis (PA) methods, mathematical optimisation (MO) methods and combination of both. While MO methods are able to handle large number of streams, the interaction and engineering judgement with the user is usually low. Moreover, most case studies used in the MO researches do not contain any Pinches or able to retrofit HEN without involving the Pinch. In the work of Asante and Zhu (1997), they identified Network Pinch and able to overcome it by either repiping, resequencing heat exchangers, splitting streams. The utility can be further recovered by adding new heat exchangers. However, the overcoming of the Network Pinch in their work was performed manually. Superstructure, which is used mostly in MO methods, has its weakness in the sequence of heat exchangers. Hence, this paper is the continuation of our previous research by incorporating PA into MO methods in HEN retrofit. It will consider the usage of binary variables for resequencing of heat exchangers. GAMS will be used to target the maximum utility saving by retrofitting the HEN.

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