Dear Conference Participants,

Welcome to the 12th International Conference on Computational Management Science taking place at Charles University in Prague!

The CMS conference is an annual meeting associated with the journal of Computational Management Science published by Springer. The aim of this conference is to provide a forum for theoreticians and practitioners from academia and industry to exchange knowledge, ideas and results in a broad range of topics relevant to the theory and practice of computational methods, models and empirical analysis for decision making in economics, engineering, finance and management. The focus is on all computational aspects of management science: theoretical and empirical studies of computational methods, models and empirical analysis. These include

- computational economics, finance and statistics;
- energy;
- scheduling;
- supply chains;
- design, analysis and applications of optimisation algorithms;
- deterministic, dynamic, stochastic, robust and combinatorial optimisation models;
- solution algorithms, learning and forecasting such as neural networks and genetic algorithms;
- models and tools of knowledge acquisition, such as data mining;

and all other topics in management science with the emphasis on computational paradigms.

The CMS 2015 puts special focus on stochastic programming (theory and applications) and it is supported by *EURO Working Group on Stochastic Programming*.

We hope you enjoy the conference and we wish you a pleasant stay in the city of culture and history – Prague.

Miloš Kopa
(Organizing committee chair)

Organizing Committee

Miloš Kopa (chair)
Charles University in Prague

Michal Houda (technical assistance)
University of South Bohemia in České Budějovice

Martin Branda
Charles University in Prague

Václav Kozmík
Charles University in Prague

Karel Lavička
Charles University in Prague

Barbora Zuzáková
Charles University in Prague

Mathilde Excoffier (web design)
Université Paris Sud XI

Programme Committee

Aharon Ben-Tal – *Technion, Israel Institute of Technology*
Alain Haurie – *Université de Geneve*
Alex Weissensteiner – *DTU – Technical University of Denmark*
Berç Rustem – *Imperial College London*
Christodoulos Floudas – *Princeton University*
Cristian Gatu – *Université de Neuchâtel*
Csaba Fabian – *Kecskemet College*
Dan Iancu – *Stanford University*
Daniel Kuhn (chair) – *École Polytechnique Fédérale de Lausanne*
David Wozabal – *Technische Universität München*
Erricos Kontoghiorghes – *Queen Mary University of London*
Georges Zaccour – *HEC Montréal*
Giorgio Consigli – *Universita di Bergamo*
Huifu Xu – *City University London*
Jitka Dupačová – *Charles University in Prague*
Laureano Escudero – *Universidad Rey Juan Carlos*
Marco Campi – *University of Brescia*
Miguel Lejeune – *The George Washington University*
Mustafa Pinar – *Bilkent University*
Nalan Gulpinar – *University of Warwick*
Panos Pardalos – *University of Florida*
Panos Parpas – *Imperial College London*
Pavel Popela – *Brno University of Technology*
Peter Winker – *Universität Giessen*
Petr Lachout – *Charles University in Prague*
Ronald Hochreiter – *WU Vienna University of Economics and Business*
Rüdiger Schultz – *University of Duisburg-Essen*
Stein-Erik Fleten – *Norwegian University of Science and Technology*
Teemu Pennanen – *King's College London*
Tomasz Radzik – *King's College London*
Vlasta Kaňková – *Academy of Sciences of the Czech Republic*
Werner Römisch – *Humboldt-Universität zu Berlin*
Wolfram Wiesemann – *Imperial College London*

Sponsors and Partners

In Partnership with

RSJ is a Prague-based investment group with the core business in financial derivatives trading on the global exchanges in London, Chicago and Frankfurt.
As a major trader RSJ focuses on interest rate futures, government bond futures, stock index futures and oil and gas futures. RSJ also manages, through a private equity fund, a broad investment portfolio in real estate, energy industry, agriculture, biotechnologies and other economic sectors. We focus on key industries for the 21st century, such as power generation from renewables, sustainable and healthy food production, information technology or life sciences.

Supported by

RSJ Foundation supports the projects of active and responsible people and supports the development of social responsibility of RSJ employees.

In Partnership with

The natural sciences have been a part of the research and teaching at Charles University since its founding in 1348. However, in the last century the explosive developments in the sciences called for the creation of a separate faculty for the pursuit of mathematics and physics; and on 1 September 1952, the Faculty of Mathematics and Physics was finally established. The faculty has gradually evolved into a respected scientific institution, holding a leading place in Czech Republic. The word "matfyz" has become synonymous with excellence in science and education.

General Information

Venue and Registration

The Conference will be held in the historical building of the Faculty of Mathematics and Physics, Charles University in Prague, at the Lesser Town Square (Malostranské náměstí) of Prague. The place is located in the very heart of the city centre, about 200 meters from the Charles Bridge on the left bank of the Vltava River. The Opening Ceremony will take place in the recently reconstructed Refectory Hall adorned with splendid ceiling paintings in the late Baroque style. The registration can be found on the first floor of the venue building near the main stairs.

Lecture Rooms

The Refectory Hall and rooms A, S8, S9, S10 are located on the first floor.

Presentation Instructions

Keynote talks last one hour including set up and questions. All presentations that are part of an invited or contributed session last 25 minutes including set up and questions. Please bring a copy of your presentation on a USB stick and in PDF format in order to avoid compatibility problems. In case you bring your own laptop, please make sure you also bring the appropriate adapter since EU power sockets are different from those in the UK and the Southern Europe.

Paper Publication

Papers presented at the conference are invited to be considered for publication in a special issue of the journal of Computational Management Science. The Guest Editors of the special issue are Miloš Kopa and Wolfram Wiesemann. Papers will go through the usual review process. The deadline for paper submissions is October 15, 2015.

Internet Access

The participants using `eduroam` at their home institutions may connect to `eduroam` at the conference venue with their login and password, too. All participants may use `MS - KONFERENCE` wifi connection. Neither login nor password is needed.

Social Events & Additional Information

Concert and Welcome Reception

The concert will take place in the Refectory Hall on Wednesday, May 27, 2015 from 19:00. The Bennewitz Quartet, founded in 1998 and named after violinist Antonín Bennewitz (1833–1926) who was a seminal figure in the creation of the Czech violin school, will perform String Quartet Op. 51 (Antonín Dvořák) and Five Pieces for String Quartet (Erwin Schulhoff). The Bennewitz Quartet are one of the top international chamber ensembles, a status confirmed not only by their victories in two prestigious competitions – Osaka in 2005 and Prémio Paolo Borciani, Italy, in 2008, but also by the acclaim of the critics. As early as 2006, the German Frankfurter Allgemeine Zeitung wrote

> *. . . the music was remarkable not just for its clarity of structure, but for the beautiful tonal palette and purity of intonation in its execution. Only very rarely does one experience such skilfully crafted and powerful harmonies . . . Great art.*

The concert will be followed by the Welcome Reception in the Refectory Hall.

Boat Trip and Conference Dinner

The conference dinner takes place on the boat Bohemia Rhapsody. The meeting point is in front of the conference building on Thursday, May 28, 2015 at 18:45.

Lunches

Lunches are available in the student restaurant (basement of the conference building) and in a large number of very diverse restaurants in the immediate vicinity of the conference venue.

Coffee breaks

During the coffee breaks, light refreshments will be served in front of Room S9 on the first floor of the venue building – just next to the registration desk.

Programme

Wednesday, May 27

8:30–9:00 Registration

9:00–9:10 Welcome and Opening Session

9:10–10:10 Keynote Session [Refectory Hall] (chair: **Werner Römisch**)

Georg Pflug
Stochastic programming: From two-stage to multi-stage to very large-stage

10:10–10:30 Coffee break

10:30–12:10 Invited Session A [Refectory Hall]

■ *Financial Optimization* (chair: **Norbert Trautmann**)

Maximilian Wimmer (Sebastian Utz)
Tri-criterion modeling for constructing more-sustainable mutual funds

Oliver Strub (Philipp Baumann)
Index tracking using unsupervised learning and mixed-binary convex programming

Dirk Banholzer (Jörg Fliege, Ralf Werner)
Enhanced calibration of the Nelson-Siegel and the Svensson model

Norbert Trautmann (Philipp Baumann, Salome Forrer)
Order splitting on a multi-slot machine in the printing industry

---

10:30–12:10 Invited Session B [Room S9]

■ *Stochastic Optimization in Energy* (chair: **David Wozabal**)

Nils Löhndorf (Andreas Eichhorn)
Multivariate time series models for stochastic-dynamic optimization

Asgeir Tomasgard (Pernille Seljom)
Short-term uncertainty in long-term energy system models: A case study with focus on wind power in Denmark

Erlon Finardi (Felipe Beltrán, Welington de Oliveira)
Scenario tree reduction via nested distance applied to the hydrothermal scheduling problem

David Wozabal (Nils Löhndorf)
Optimal gas storage valuation and futures trading

10:30–12:10 Contributed Session C [Room A]

■ *Combinatorial Optimization* (chair: **Diego Ruiz-Hernández**)

Chia-Li Wang
Deterministic self-policy for observable queues of heterogeneous customers

Peter Szabó
The Goldbach's conjecture in max-algebra

Beatriz Bernábe (Jorge A. Ruiz-Vanoye, Javier Ramírez-Rodríguez, Rogelio González Velázquez, Abraham Sánchez-López)
A bi-objective proposal to group population without drainage services

Diego Ruiz-Hernández (Mozart Menezes, Renato Guimarães)
The component commonality problem in a real multidimensional space

---

14:00–15:00 Keynote Session [Refectory Hall] (chair: **Wolfram Wiesemann**)

Vivek Farias
Online A-B testing

15:00–15:20 Coffee break

15:20–17:00 Invited Session A [Refectory Hall]

■ *Stochastic Programming – Applications and Theory* (chair: **Rüdiger Schultz**)

Judith Klein (Christian Schlechtriem, Rüdiger Schultz)
A dietary burden calculator for fish metabolism studies

Matthias Claus (Rüdiger Schultz)
Weak continuity of risk functionals arising in 2-stage stochastic programming

Pavel Popela (Jakub Kůdela, Michal Touš, Martin Pavlas, Radovan Šomplák)
Approximating stochastic programming models for waste-to-energy problems

Rüdiger Schultz (Matthias Claus)
Distribution sensitivity of stochastic programs with dominance constraints

15:20–17:00 Contributed Session B [Room S9]

■ *Risk Measures and Portfolios* (chair: **Audrius Kabasinskas**)

Vladimír Holý (Kirill Odintsov)
The impact of dynamic portfolio management on long-term value at risk

Niclas Brok
Non-parametric portfolio optimization and commodity prices

Martin Šmíd
Multi-generation multi-portfolio generalization of Vasicek model

Audrius Kabasinskas (Miloš Kopa, Kristina Šutienė, Dalius Strebeika)
Theoretical vs empirical risk measure for mixed-stable, mixed-t and mixed-normal distributions

---

15:20–17:00 Contributed Session C [Room A]

■ *Data mining* (chair: **Panos Pardalos**)

Valery Kalyagin (Panos Pardalos)
Robust computation of the market graph

Namdar Shahrokhi Nejad
Comparing the two hierarchical clustering and K-means in the field of auto insurance fraud

João Pires da Cruz (George Overstreet, Peter Beling, Kanshukan Rajaratnam)
Sand pile modeling for machine learning algorithms for economic/financial applications

Panos Pardalos
On structural properties and clustering of market networks

17:00–17:20 Coffee (beer) break

17:20–19:00 Invited Session A [Refectory Hall]

■ *Dynamic Decision Models for Power Plants* (chair: **Stein-Erik Fleten**)

Michal Kaut (Jeanne Andersen, Asgeir Tomasgard)
Stochastic model for short-term balancing of supply and consumption of electricity

Alois Pichler
Switching options for peak power plants: Structural estimation

Stein-Erik Fleten
Linear decision rules for seasonal hydropower scheduling

17:20–19:00 Contributed Session B [Room S9]

■ *Portfolio Selection* (chair: **Kourosh Marjani Rasmussen**)

Stefan Theussl (Ronald Hochreiter)
Constrained portfolio selection based on stock rankings using R/ROI

Petr Koldanov
On stock selection for portfolio optimization

Malika Babes
Resolving the portfolio problem as a knapsack problem

Kourosh Marjani Rasmussen (Thomas Bjerring, Omri Ross)
Active index allocation with ETFs

17:20–19:00 Contributed Session C [Room A]

■ *Supply Chains and Transportation* (chair: **Carmen Galé**)

Ana Amaro
Colaborative supply chain planning: Enhancing sustainability through flexible decisions

Gabriella Dellino (Teresa Laudadio, Renato Mari, Nicola Mastronardi, Carlo Meloni)
Sales forecasting and order planning for perishable products: A computational study

Ricardo Pérez-Rodríguez (Arturo Hernández,)
An estimation of distribution algorithm-based approach for the order batching problem

Carmen Galé (Herminia I. Calvete, José A. Iranzo, Paolo Toth)
A hybrid evolutionary algorithm for the two-stage fixed-charge transportation problem

19:00–21:00 Concert and Welcome Reception

Thursday, May 28

8:30–9:00 Registration

9:00–10:00 Keynote Session [Refectory Hall] (chair: **Jitka Dupačová**)

Alexander Shapiro
Risk averse and distributionally robust stochastic programming

10:00–10:20 Coffee break

10:20–12:00 Invited Session A [Refectory Hall]

■ *Distributionally Robust Optimization* (chair: **Daniel Kuhn**)

Dimitri Papadimitriou
Learning uncertainty sets

Huifu Xu
A semi-infinite programming approach for robust reward-risk ratio optimization with matrix moments contraints

Wolfram Wiesemann
Two-stage robust integer programming

Daniel Kuhn (Grani Hanasusanto, Vladimir Roitch, Wolfram Wiesemann)
Distributionally robust joint chance constraints with conic dispersion measures

---

10:20–12:00 Contributed Session B [Room S9]

■ *Scenario Generation, Reduction and SDDP* (chair: **Ronald Hochreiter**)

Ronald Hochreiter
Open source multi-stage scenario tree generation

Paulo Vitor Larroyd (Vitor de Matos, Erlon Finardi)
Assessment of inflow scenario generation per basin in the long term hydrothermal scheduling

Václav Kozmík (Jitka Dupačová)
SDDP for multistage stochastic programs: Preprocessing via scenario reduction

Davi Valladão (Thuener Silva, Marcus Poggi)
Dynamic asset allocation via SDDP with concealed discrete states

10:20–12:00 Contributed Session C [Room A]

■ *Scheduling I* (chair: **Martin Branda**)

Rajmund Drenyovszki
Comparison of scheduling methods of flexible appliances in consumption admission control algorithm

Murat Kocamaz (Ural Gökay Çiçekli)
Optimization of spreading machines scheduling with a genetic algorithm

Zuzana Němcová
Cost optimizing methods for deterministic queuing systems

Martin Branda
Formulations and solution techniques for a stochastic interval scheduling problem

13:45–14:45 EWGSP Meeting [Refectory Hall] (chair: **Miloš Kopa**)

14:45–16:00 Invited Session A [Refectory Hall]

■ *Large-scale Multistage Stochastic Mixed 0–1 Programs* (chair: **Laureano Fernando Escudero**)

María Araceli Garín (Laureano Fernando Escudero, Celeste Pizarro Romero, Aitziber Unzueta)
Scenario cluster Lagrangean decomposition for large-scale multi-stage mixed 0–1 stochastic problems

Laureano Fernando Escudero (Juan Francisco Monge, Dolores Romero Morales)
Stochastic dynamic programming for multiperiod mixed 0–1 problems under uncertainty with TSD risk averse functional

Unai Aldasoro (Laureano Fernando Escudero, María Merino, Gloria Pérez)
Parallel branch-and-fix coordination based metaheuristic algorithms for solving large-scale multistage stochastic mixed 0–1 problems

---

14:45–16:00 Contributed Session B [Room S9]

■ *Stochastic programming theory* (chair: **Shabbir Ahmed**)

Werner Römisch (René Henrion)
Conditioning of two-stage stochastic programming problems

Michal Houda (Jianqiang Cheng, Abdel Lisser)
Chance constrained 0–1 quadratic programs using copulas

Shabbir Ahmed (James Luedtke, Yongjia Song, Weijun Xie)
Nonanticipative duality for chance constrained optimization

14:45–16:00 Contributed Session C [Room A]

■ *Robust and stochastic optimization* (chair: **Francesca Maggioni**)

Carlos Raoni Mendes (Bruno Flach, Marcus Poggi)
A robust risk-mitigation approach for project management

Nalan Gulpinar
Robust asset-liability management for investment products with guarantees

Francesca Maggioni (Marida Bertocchi, Florian Potra)
Stochastic versus robust optimization for a transportation problem

16:00–16:15 Coffee (beer) break

16:15–17:30 Invited Session A [Refectory Hall]

■ *Nominations and Bookings in Gas Transportation* (chair: **Rüdiger Schultz**)

Ralf Gollmer (Rüdiger Schultz, Claudia Stangl)
An approach to nomination validation in gas transport

Claudia Stangl (Benjamin Hiller, Robert Schwarz)
Building nominations for real-life gas transportation networks

Sabrina Nitsche (Rüdiger Schultz)
Checking feasibility in gas networks for balanced entry and exit flows

---

16:15–17:30 Contributed Session B [Room S9]

■ *Finance – Solvency, Pensions* (chair: **Giorgio Consigli**)

Sebastiano Vitali (Miloš Kopa, Vittorio Moriggia)
Pension fund optimal investment policy

Jakub Černý
Impact of the change of survival function on CVA

Giorgio Consigli
Solvency II-compliant dynamic risk control: A case study of a P/C insurance portfolio

16:15–17:30 Contributed Session C [Room A]

■ *Energy* (chair: **Maria Teresa Vespucci**)

Emre Tokgöz (Iddrisu Awudu)
Cost effective energy optimization by solving facility allocation on Riemannian manifolds

Paula Carroll (Damian Flynn, Alexander Melhorn, Mingsong Li)
Unit commitment benchmark data and MILP computational performance

Maria Teresa Vespucci (Diana Moneta, Paolo Pisciella, Giacomo Viganò)
Optimization models for the operation of medium-voltage AC networks

18:45–22:00 Boat Trip and Conference Dinner

Friday, May 29

8:30–9:00 Registration

9:00–10:40 Contributed Session A [Room S8]

■ *Computational Finance* (chair: **Sergio Ortobelli**)

Troels Martin Range (Lars Peter Østerdal)
Finite first order dominance: A network-flow characterization and an algorithm for the bivariate case

Kanshukan Rajaratnam (Peter Beling, George Overstreet)
Consumer loan scoring and regulatory capital decisions in the context of uncertain economic conditions

Barbora Zuzáková
Multistage portfolio optimization with risk premium constraints

Sergio Ortobelli (Tommaso Lando)
On the use of conditional expectation estimators

9:00–10:40 Contributed Session B [Room S9]

■ *Stochastic programming* (chair: **Petr Lachout**)

Vadym Omelchenko
The valuation of the gas storage by means of ADP, machine learning and the stable Ornstein Uhlenbeck model

Paolo Pisciella (Maria Teresa Vespucci)
A demand side management model for load scheduling in healthcare facilities

Vlasta Kaňková
Empirical data in stochastic optimization problems: survey and open questions

Petr Lachout
Optimal gain from a controlled kin tree

9:00–10:40 Contributed Session C [Room S10]

■ *Computational Statistics* (chair: **Karel Sladký**)

Pavel Boček
Free software tools for directional multiple-output quantile regression

Jan Voříšek
Bimodality testing of diffusion processes

Jiří Rozkovec
Simulations as a computational tool for discrete Markov chains

Karel Sladký
Risk-sensitive optimality in Markov decision processes: Policy and value iterations

10:40–11:00 Coffee break

11:00–12:00 Keynote Session [Room S9] (chair: **Daniel Kuhn**)

Dick den Hertog
Two ways to solve a robust nonlinear optimization problem: via the primal or the dual

---

14:00–15:40 Contributed Session A [Room S8]

■ *Simulations* (chair: **Ladislav Lukáš**)

Radek Hendrych
Recursive calibration of conditionally heteroskedastic models

Hana Tomášková (Petra Marešová, Jitka Kühnová)
A simulation model of the evolution of the population with Alzheimer's disease

Felipe Baesler
Simulation optimization for operating room scheduling

Ladislav Lukáš
Numerical realization of discrete time European option pricing with underlying asset obeying a subdiffusion process in Mathematica

14:00–15:40 Contributed Session B [Room S9]

■ *Decision Analysis* (chair: **Francisco Javier Santos-Arteaga**)

Richard Cimler (Martin Gavalec, Hana Tomášková)
Optimization algorithms in the online decision support with preference matrix

Javier de Frutos (Guiomar Martin-Herran)
Pollution control in a multiregional setting: A differential game with spatially distributed controls

Francisco Javier Santos-Arteaga (Debora Di Caprio, Madjid Tavana)
Modelling sequential information acquisition behavior in rational decision making

Karel Lavička
Temporal decomposition of chance constraints in portfolio selection problem

---

14:00–15:40 Contributed Session C [Room S10]

■ *Scheduling II* (chair: **Nikolai Krivulin**)

Jufang Li (Xiaogeng Chu, Ting Xi, Zhongxiang Chang, Wei Wang)
Joint mission planning of multiple satellites for searching maritime target

Zang Yuan (Song Liu, Jufang Li, Wei Zhang, Shuzhao Yang)
Generating high quality initial solutions based on data for agile Earth observation satellites mission scheduling

Zhongshan Zhang (Pei Wan, Renjie He, Jufang Li)
Research on method about task planning of clock synchronization between satellite and ground of GNSS

Nikolai Krivulin
Tropical optimization problems: Solution methods and application examples

Abstracts

Plenary Sessions

Stochastic programming: From two-stage to multi-stage to very large-stage

Georg Pflug

Single or two-stage stochastic programs are quite common and relatively easy to solve. The real difficulties arise with multistage problems, both from the modeling and from the algorithmic side; but many applications need multiple decision periods, even a large number of them. While in single- or two-stage problems the notion of available information is not relevant, it becomes crucial in multistage situations. Simplifications and the "fight against the curse of dimensionality" are necessary. We review some results about approximation techniques and discuss the differences between discretization and sampling methods. In particular, the stochastic dynamic (dual) decomposition method is illustrated in comparison to dimension reduction techniques coming from the "ANOVA" decomposition of reproducing kernel spaces. The definition of "distances" between stochastic dynamic decision problems is crucial for the understanding of approximability. Multistage distances based on various classes of functions or based on specific choices of metrics are presented. We investigate classes of problems with good approximability and those for which the complexity cannot be well reduced by approximations. There are still many open problems and there is much room for new fresh ideas.

georg.pflug@univie.ac.at

Online A-B testing
Vivek Farias

We consider the problem of A-B testing when the impact of a treatment is marred by a large number of covariates. This is the situation in a number of modern applications of A-B testing (such as in adTech and e-commerce) as well as in more traditional applications (such as clinical trials). Randomization can be highly inefficient in such settings, and thus we consider the problem of optimally allocating test subjects to either treatment with a view to maximizing the efficiency of our estimate of the treatment effect. Our main contribution is to show that what was thought of as a high-dimensional, intractable problem is, in fact, tractable under a broad set of assumptions. Specifically, we provide a tractable (and practical) algorithm for this problem in the online setting where subjects arrive, and must be assigned, sequentially. We also characterize the value of optimization and show that it can be expected to grow large with the number of covariates. Finally, using a real-world impression dataset, we show that our algorithms can be expected to yield substantial improvements to efficiency in practice. Joint work with Nikhil Bhat and Ciamac Moallemi.

vivekf@mit.edu

Risk averse and distributionally robust stochastic programming
Alexander Shapiro

Risk averse approach to stochastic programming differs from the risk neutral in that expectation operator is replaced by a suitable risk measure. Distributionally robust formulation of stochastic programming is dealing with worst distribution from a specified family of distributions. It is known that under certain regularity conditions these two approaches are dual to each other. In this talk we discuss a general theory and connections between these methods. In particular we consider implications to chance constrained formulations of stochastic programs and multistage stochastic programming problems.

ashapiro@isye.gatech.edu

Two ways to solve a robust nonlinear optimization problem: via the primal or the dual

Dick den Hertog

Optimization problems are often affected by uncertainty. A slight change in the parameters of the problem may render a previously optimal solution infeasible or suboptimal. Robust Optimization is a methodology that avoids infeasibility and decay of the solution. In basic versions of Robust Optimization, the constraints have to hold for all parameter realizations in a prespecified (infinite) uncertainty set. We describe two structured ways to reformulate such semi-infinite problems into computationally tractable optimization problems:

1. Via the primal problem.

We provide a systematic way to construct the robust counterpart of a nonlinear uncertain inequality that is concave in the uncertain parameters. We use convex analysis (support functions, conjugate functions, Fenchel duality) and conic duality in order to convert the robust counterpart into an explicit and computationally tractable set of constraints. It turns out that to do so one has to calculate the support function of the uncertainty set and the concave conjugate of the nonlinear constraint function. Conveniently, these two computations are completely independent.

This is joint work with A. Ben-Tal and J.-Ph. Vial.

2. Via the dual problem

We show how to solve a robust nonlinear (convex-concave) optimization problem by explicitly deriving its dual. Given an optimal solution of this dual, we show how to recover the primal optimal solution. The fascinating and appealing property of this approach is that any convex uncertainty set can be used, i.e. the support function of the uncertainty set is not needed. We obtain computationally tractable robust counterparts for many new robust nonlinear optimization problems, including problems with robust quadratic constraints, second order cone constraints, and SOS-convex polynomials.

This is joint work with B.L. Gorissen.

We compare the two approaches, and discuss advantages and disadvantages. If time permits, we extend both approaches to Globalized Robust Optimization.

`d.denhertog@uvt.nl`

Invited and Contributed Sessions

Nonanticipative duality for chance constrained optimization
Shabbir Ahmed, James Luedtke, Yongjia Song, Weijun Xie

We propose two new Lagrangian dual problems for chance-constrained stochastic programs based on relaxing nonanticipativity constraints. We compare the strengths of the associated dual bounds and derive two new related primal formulations. We demonstrate that for chance-constrained linear programs, the continuous relaxations of these primal formulations yield bounds equal to the proposed dual bounds. We propose a new heuristic method and two new exact algorithms based on these duals and formulations, and present computational evidence demonstrating their effectiveness.

sahmed@isye.gatech.edu

Parallel branch-and-fix coordination based metaheuristic algorithms for solving large-scale multistage stochastic mixed 0–1 problems
Unai Aldasoro, Laureano Fernando Escudero, María Merino, Gloria Pérez

Three metaHeuristic algorithms so-named H-BFCs are presented as spin-offs of the exact Branch-and-Fix Coordination (BFC) algorithm presented elsewhere for solving multistage stochastic mixed 0–1 problems. Some steps to guarantee solution's optimality are relaxed in the BFC algorithm. The parallel branching scheme on the 0–1 variables and the iterative incumbent solution exchange obtains tighter bounds of the original problem. A broad experience is reported for assessing the quality of the heuristic solution. Parallel computing provides a perspective for solving very large-scale instances.

unai.aldasoro@ehu.es

Colaborative supply chain planning: Enhancing sustainability through flexible decisions

Ana Amaro

Sustainable development introduces important supply chain, SC, operability requirements and a major challenge is placed on collaborative network design and operational policies. A novel optimal planning formulation is proposed to help SC decision processes. The contribution focus on collaborative SC criteria to enhance sustainability. Flexibility requirements are target for resilience purposes. A Mixed Integer Linear Model formulation is obtained which is implemented in the GAMS language and solved using the CPLEX solver. An industrial case-study illustrates the model applicability.

aamaro@iscac.pt

Resolving the portfolio problem as a knapsack problem

Malika Babes

In this work, we deal with the portfolio problem. We formalize it as a knapsack problem. We resolve this last one by defining an arborescent method which we run thereafter in parallel on 2 machines. We show that the process can easily be generalized on more than 2 machines. The obtained results demonstrate the effectiveness of the developed method. The tree which we develop consists, in each node, to decide if we retain a given object or not. This makes it easy to test all possible cases. After the separation of solutions in a tree, we deal with the evaluation of each node.

malikababes@yahoo.fr

Simulation optimization for operating room scheduling
Felipe Baesler

This paper presents a study on operating room scheduling in Chile. Patient flow was represented using a discrete simulation that considered the randomness associated with the primary activities of the entire process. A simulated annealing algorithm was connected to the simulation to search for better patient schedules. Additionally, three dispatching rules, Shortest Processing Time, Longest Processing Time and First-In, First-Out were used. The results showed that the simulated annealing approach, obtained schedules that were 18 % better than the hospital's scheduling practices.

fbaesler@udd.cl

Enhanced calibration of the Nelson-Siegel and the Svensson model
Dirk Banholzer, Jörg Fliege, Ralf Werner

The Nelson-Siegel and the Svensson model are two of the most widely used models for the term structure of interest rates. However, even though the models are simple and intuitive, their calibration to available market data turns out to be a numerically challenging task, various difficulties have been reported. In this paper, we propose a novel technique for calibrating these models to market rates, which is based on the observation that the related optimisation problem can be formulated as a separable nonlinear least-squares problem in which the linear parameters can be implicitly eliminated.

dirk.banholzer@soton.ac.uk

A bi-objective proposal to group population without drainage services

Beatriz Bernábe, Jorge A. Ruiz-Vanoye, Javier Ramírez-Rodríguez, Rogelio González Velázquez, Abraham Sánchez-López

As part of the process to support the decision making in population problems, and with the goal of pushing forward the selection of projects that will provide funds to the population sector that partially has drainage system and drinking water at home, a multiobjective method will be applied based on the non-comparable orders that a set of solutions provides that will respond to the selection of good groupings that portray the urgency to attend population sectors with insufficient drainage and water services. We present a method based on the order theory to find the Pareto Frontier with VNS.

beatriz.bernabe@gmail.com

Stochastic versus robust optimization for a transportation problem

Francesca Maggioni, Marida Bertocchi, Florian Potra

In this paper we analyze the effect of two modelling approaches, stochastic programming and robust optimization, to a real case of a transportation problem under uncertainty. Stochastic Programming (SP) and Robust Optimization (RO) are considered two alternative techniques to deal with uncertain data both in a single period and in a multi-period decision making process. The transportation problem is inspired by a real case of gypsum replenishment in Italy and it can be classified as a transportation problem under uncertainty where a set of retailers is served by a set of suppliers.

francesca.maggioni@unibg.it

Free software tools for directional multiple-output quantile regression

Pavel Boček

Recently, two directional multiple-output regression quantile methods have been proposed that generalize the well-known standard quantile regression to the case of multivariate responses. Unfortunately, both of the new methods lead to a rather special parametric programming optimization problem difficult to solve, which hinders their wide dissemination. Our presentation targets this drawback and presents two new and free software tools for solving the whole computational side of both methods, namely a toolbox for Octave or Matlab and a package for R.

bocek@utia.cas.cz

Formulations and solution techniques for a stochastic interval scheduling problem

Martin Branda

Interval scheduling deals with the problem of assigning jobs to machines where the starting and finishing times of the jobs are fixed. We focus on the stochastic operational problem where the finishing times of the jobs can be influenced by unpredictable circumstances leading to uncertain delays. Our goal is then to find a robust schedule which remains feasible with the highest attainable probability. We formulate the problem as stochastic integer programming with probabilistic objective and robust coloring problem. We propose numerical results based on exact and heuristic algorithms.

martin.branda@seznam.cz

Non-parametric portfolio optimization and commodity prices
Niclas Brok

Commodity prices are known to deviate from the normal distribution with performance driven by continuous supply and demand shocks leading to time-varying volatility and heavy tails. We look at choosing a tactical portfolio of commodities based of non-parametric risk aggregators for portfolio optimization. More specifically, we look at the Omega ratio, Conditional Value-at-Risk and Conditional Drawdown-at-Risk measures and compare the performance of these selection rules to widely used parametric or naive portfolio selection rules such as the Markowitz rule and 1/N.

niclasbrok@gmail.com

Unit commitment benchmark data and MILP computational performance
Paula Carroll, Damian Flynn, Alexander Melhorn, Mingsong Li

The Unit Commitment problem is the subject of renewed interest due to competitive market systems and a focus on integrating renewable energy sources into the grid. Transmission System Operators have indicated a need to optimise models at 15 minute demand intervals rather than hourly. These concerns have driven interest from the community of practitioners for improved algorithmic performance. A standardised benchmark test set based on an Irish case study that represent the variability of wind power are proposed and the computational impact on a standard MILP model assessed.

paula.carroll@ucd.ie

Impact of the change of survival function on CVA

Jakub Černý

A new banking regulation, Basel III, comes with a standardized credit valuation adjustment (CVA) formula based on piecewise constant default intensity assumption. Many papers consider stochastic default intensity which is a correct approach, but it forces us to do a lot of time-consuming simulations. A compromise is the assumption of time-varying default intensities. In particular, we investigate an interest rate swap CVA formula based on Gaussian copula with constant correlation between exposure and default time (wrong-way risk) using different parametric models for the survival function.

jcerny@karlin.mff.cuni.cz

Optimization algorithms in the online decision support with preference matrix

Richard Cimler, Martin Gavalec, Hana Tomášková

This article focuses on the simplification of decision-making with the preference matix. Basic methods used in the solution of multi-criteria decision-making problems is the Analytic Hierarchy Process (AHP). Among the algorithms presented in this article, ranks and non-standard approaches. Software online support referred to in this document, it helps not only the calculation, but even with the creation of preferential (consistent) matrix. Computer support is therefore offered to the experts during the process of creating a preferential matrix.

richard.cimler@uhk.cz

Weak continuity of risk functionals arising in 2-stage stochastic programming

Matthias Claus, Rüdiger Schultz

Measuring and managing risk has become crucial in modern decision making under stochastic uncertainty. In 2-stage stochastic programming, mean risk models are essentially defined by a parametric recourse problem and a quantification of risk. From the perspective of qualitative robustness theory, we discuss sufficient conditions for continuity of the resulting objective functions with respect to perturbation of the underlying probability measure. Our approach covers a vast class of both stochastic-programming related risk measures and relevant recourse models.

matthias.claus@uni-due.de

Solvency II-compliant dynamic risk control: A case study of a P/C insurance portfolio

Giorgio Consigli

We consider a 10 year nonlinear multistage stochastic program for a portfolio manager facing stochastic liabilities from the property and casualty business and risk capital constraints compliant with an evolving regulatory framework (e.g. Solvency II).Numerical results are presented for specifications of the dynamic optimization problem under alternative correlation assumptions over a long-term horizon with non-homogeneous decision stages. The gap between a 1-year standard risk capital allocation policy and the dynamic risk capital consumption is analyzed as a function of time and space.

giorgio.consigli@unibg.it

Sand pile modeling for machine learning algorithms for economic/financial applications

João Pires da Cruz, George Overstreet, Peter Beling, Kanshukan Rajaratnam

Economic and accounting variables such as income, assets, capital, etc. are used to describe each agent in an economic system, that are characterized by probability distributions with infinite variance. This can be shown analytically, empirically and computationally. Current machine learning algorithms are typically inefficient to handle such problems, where the error grows with the size of sample. We develop an algorithm based on sand piles and on the physics of multiplicative processes that overcome the described limitations imposed by current machine learning methods.

joao.cruz@closer.pt

Sales forecasting and order planning for perishable products: A computational study

Gabriella Dellino, Teresa Laudadio, Renato Mari, Nicola Mastronardi, Carlo Meloni

This research investigates some approaches for sales forecasting of perishable products, estimating the impact on order planning policies. ARIMA, ARIMAX and transfer function models are compared and forecasting quality is evaluated by standard statistical indicators. Based on these forecasts an optimal order plan minimizing stockouts and outdating is computed, while maximizing product freshness, including delivery constraints. An experimental study is carried out on a set of real data for about 300 items over 30 retailers. Results on risk assessment for order management policies are discussed.

g.dellino@ba.iac.cnr.it

Comparison of scheduling methods of flexible appliances in consumption admission control algorithm

Rajmund Drenyovszki

Our paper investigates the possible scheduling methods of flexible appliances for Smart Grid application. The scheduling is part of our earlier proposed Consumption Admission Control algorithm (CAC). CAC is a new concept for controlling the demand side by the means of automatically enabling/disabling electric appliances to make sure that the demand is in match with the available supplies, based on the statistical characterization of the need. The scheduling can be based on a greedy, random or more sophisticated algorithm, and its main objective is to modify the load shape.

drenyovszki.rajmund@gamf.kefo.hu

Stochastic dynamic programming for multiperiod mixed 0–1 problems under uncertainty with TSD risk averse functional

Laureano Fernando Escudero, Juan Francisco Monge, Dolores Romero Morales

Multiperiod mixed 0–1 linear optimization under uncertainty is considered, where a time stochastic dominance risk averse functional is proposed . It uses (cross node) stochastic dominance constraints induced by mixed integer-linear recourse as the risk measure to control the negative impact of the solution for non-wanted scenarios at selected periods. It includes first-order and second-order constraints. A stochastic dynamic programming (SDP) approach is proposed, where one has to overcome the difficulty due to cross node constraints for keeping the decomposable nature of the model.

laureano.escudero@urjc.es

Scenario tree reduction via nested distance applied to the hydrothermal scheduling problem

Erlon Finardi, Felipe Beltrán, Welington de Oliveira

Scenario tree reduction has received considerable attention due to the quest of using small scenario trees capable to represent the underlying stochastic process. In this work, we apply the Nested Distance (ND) to construct moderate-sized multistage scenario tree for the Brazilian Hydrothermal Scheduling Problem. An analysis with scenario trees obtained by employing the ND algorithm proposed by G. Pflug & A. Pichler shows that reduced trees obtained by eliminating 90 % of scenarios provide approximate solutions to the problem with errors less than 1 % and CPU time reduction of around 50 %.

erlon.finardi@ufsc.br

Linear decision rules for seasonal hydropower scheduling

Stein-Erik Fleten

The purpose of seasonal planning in the context of hydropower scheduling is to provide estimates for the value of water in the reservoirs at the end of the horizon for the short-term operational planning. As usual in reservoir management, the challenge is to balance current revenues against uncertain future revenues, that is, whether to save water or use more now. We consider this problem for a price-taking pure hydropower producer, operating in a well-functioning electricity market. Uncertainty is present both in prices and inflow, and we explore a linear decision rules approach.

stein-erik.fleten@iot.ntnu.no

Pollution control in a multiregional setting: A differential game with spatially distributed controls

Javier de Frutos, Guiomar Martin-Herran

We analyze differential game models where pollution control is spatially distributed among a number, possibly large, of agents with predetermined spatial relationships. The analysis emphasizes the effects that could be expected as a consequence of the different geographical relationships among decision makers. The game has one state variable (pollution stock) distributed among one large region divided in subregions which control their own emissions of pollutants. The emissions are also represented as a distributed variable. The dynamics of the state variable is defined by a parabolic PDE.

frutos@mac.uva.es

A hybrid evolutionary algorithm for the two-stage fixed-charge transportation problem

Carmen Galé, Herminia I. Calvete, José A. Iranzo, Paolo Toth

The two-stage fixed-charge transportation problem involves the distribution of a commodity from plants to customers through intermediate depots, while minimizing overall costs incurred. These costs refer to fixed and variable costs on arcs. We propose a hybrid evolutionary algorithm to solve the problem. The chromosome controls the arcs that can be used. The fitness is computed as the objective function value of a good feasible solution of the problem, which is obtained by using optimization techniques and local search. The computational results show the efficiency of the algorithm.

cgale@posta.unizar.es

Scenario cluster Lagrangean decomposition for large-scale multistage mixed 0–1 stochastic problems

María Araceli Garín, Laureano Fernando Escudero, Celeste Pizarro Romero, Aitziber Unzueta

We present a methodology for obtaining strong bounds on risk neutral and risk averse (with first- and second-order time stochastic dominance constraints) multistage stochastic problems. The whole problem is represented by a mixture of the splitting and the compact representation. The dualization of the nonanticipativity constraints of some variables in the risk neutral version and the additional dualization of the cross scenario group constraints in the risk averse model,allows to decompose each of them into a set of independent cluster submodels. Computational results are presented.

mariaaraceli.garin@ehu.es

An approach to nomination validation in gas transport

Ralf Gollmer, Rüdiger Schultz, Claudia Stangl

For every entry and exit of the network, a gas network operator (TSO) sells independent capacity rights to transfer gas into or out of the network up to a certain maximal amount. A nomination is a balanced vector of in-/outflows within these rights. Checking the technical feasibility of nominations is a basic task for deciding which capacities could be offered. In the stationary case this task amounts to a large non-convex mixed-integer problem. Our approach uses a nonlinear model with reduction of the number of variables, most of the binary variables being chosen a priori by heuristics.

ralf.gollmer@uni-due.de

Robust asset-liability management for investment products with guarantees

Nalan Gulpinar

This paper presents a computationally tractable robust optimization approach to managing assets and liabilities for guaranteed investment contracts and equity-linked products. We suggest practical data-driven approaches for implementation of the models, and present numerical results using generated and real market data to illustrate the performance of the robust asset and liability management strategies.

nalan.gulpinar@wbs.ac.uk

Recursive calibration of conditionally heteroskedastic models

Radek Hendrych

The conditionally heteroskedastic processes (e.g. the GARCH models) are frequently employed to investigate and model financial time series data. They are routinely estimated by computationally complex off-line estimation methods. However, in many empirical applications (especially in the context of high-frequency financial data) it seems necessary to apply numerically more effective techniques to calibrate and monitor such processes. The aim of the contribution is to present improved generalizable recursive estimation techniques derived using the universal on-line identification scheme.

hendrych@stavex.com

Open source multi-stage scenario tree generation
Ronald Hochreiter

Most published multi-stage scenario tree generation techniques are masterpieces of mathematical theory and complex notation. However, if one needs to apply a certain methodology for a new stochastic optimization model things turn out to be complicated. It takes a long time to understand and re-engineer the implementation of published methods. In this talk, we remove all esoteric overhead from multi-stage scenario generation and present an open-source multi-stage scenario tree generator. Applications in the field of Finance and Energy are shown.

ronald.hochreiter@wu.ac.at

The impact of dynamic portfolio management on long-term value at risk
Vladimír Holý, Kirill Odintsov

Value at Risk (VaR) is widely used risk measure assessing the risk of loss on a portfolio of financial assets. In a longer time horizon the portfolio can undergo changes in its composition. These changes can highly influence the long-term VaR. We focused on a method of long-term VaR calculation that accounts for the dynamic changes of the weights in the portfolio. These considered changes are the result of a set of optimization problems. For the computation of dynamic VaR we used Monte Carlo methods. In the end we analyzed the effects of the added dynamics on the long-term VaR.

holv00@vse.cz

Chance constrained 0–1 quadratic programs using copulas
Michal Houda, Jianqiang Cheng, Abdel Lisser

We study 0–1 quadratic programs with joint probabilistic constraints. The row vectors of the constraint matrix are assumed to be normally distributed but are not supposed to be independent. We propose a mixed integer linear reformulation and provide an efficient semidefinite relaxation of the original problem. The dependence of the random vectors is handled by the means of copulas. Finally, numerical experiments are conducted to show the strength of our approach.

houda@ef.jcu.cz

Theoretical vs empirical risk measure for mixed-stable, mixed-t and mixed-normal distributions
Audrius Kabasinskas, Miloš Kopa, Kristina Šutienė, Dalius Strebeika

Financial data in small emerging markets often exhibits heavy tails and so called passivity effect (significant number of zero returns). However, if fat-tails in empirical data are observed, then there are no theoretical explicit formulas for risk estimation and only computational approaches can be used. In this paper, mixed alpha-stable, mixed Gaussian and mixed Student's t models are applied for the analysis of return data of Lithuanian pension funds from pillar. Risk measures VaR and CVaR are estimated from return data, and then compared to simulated data when using mixed laws.

audrius.kabasinskas@ktu.lt

Robust computation of the market graph
Valery Kalyagin, Panos Pardalos

Market graph is an important structure in market network analysis. Different statistical procedures were proposed in the literature to market graph identification. It is known that market graph calculation in Pearson correlation network is not stable. In the present paper we propose a sample graph statistical procedure for market graph identification in sign similarity network and prove it stability in the class of elliptically contoured distributions. As a result we obtain statistical procedure for market graph calculation which is stable (robust) in Pearson correlation network too.

vkalyagin@hse.ru

Empirical data in stochastic optimization problems: survey and open questions
Vlasta Kaňková

Economic and financial processes are mostly influenced by random and decision factors. The decision parameter can be usually determined by an optimization problem depending on a probability measure. In applications mostly the problem has to be solved on the data base. A relationship between real and approximate optimal values was studied mostly under "classical" assumptions. An effort arises to relax these assumptions. The aim of the contribution is to give a survey of results obtained under new relaxed assumptions and to introduce problems waiting for solution.

kankova@utia.cas.cz

Stochastic model for short-term balancing of supply and consumption of electricity

Michal Kaut, Jeanne Andersen, Asgeir Tomasgard

In this talk, we will present a two-stage stochastic mixed-integer model for the intra-hour balancing problem faced by system operators in electricity systems with large penetration of wind power production. In the model, the system operator has to balance supply and consumption in order to maintain balance in the system, where some of the supply consists of uncertain wind power production. We also describe our procedure for generating scenarios, based on wind power prediction errors, and present results of a realistic case using system data from Denmark.

michal.kaut@sintef.no

A dietary burden calculator for fish metabolism studies

Judith Klein, Christian Schlechtriem, Rüdiger Schultz

Due to the increased use of plant commodities in fish feed, residues of pesticides can be found in fish feed. The talk is on a worst case calculation of dietary burden based on nutrition needs of two important aquaculture species Trout and Carp. The deterministic problem where all data is available at the time of decision can be solved by standard linear programming techniques. Deterministic availability of data being the case only rarely, if ever, the talk addresses stochastic programming extensions of the basic model. Both risk neutral and risk averse approaches will be discussed.

judith.klein@uni-due.de

Optimization of spreading machines scheduling with a genetic algorithm

Murat Kocamaz, Ural Gökay Çiçekli

This paper held in Hugo Boss Factory which located in Izmir-Turkey. In this department, there are five tables available for spreading operations. This study aims to solve the spreading sequencing problem by using genetic algorithm. Proposed scheduling approach use a genetic algorithm based planner.The total makespan of the production orders on the spreading machines can be minimized. The comparison results obtained between the actual production cycle and the proposed model using genetic algorithm. Results demonstrate that optimized schedules improve the capacity usage of production department.

murat.kocamaz@gmail.com

On stock selection for portfolio optimization

Petr Koldanov

Independent sets in market graph are known to be suitable for portfolio optimization if one first selects the stocks by some stock's attribute. In the present paper the problem of stock selection in market network is discussed from statistical point of view for stocks selection by risk and by Sharp ratio. A series of extensive numerical experiments are conducted to investigate properties of multiple decision statistical procedures for different loss functions and different correlation matrix. Practical statistical tests for stock selection are derived from results of our investigation.

pkoldanov@hse.ru

SDDP for multistage stochastic programs: Preprocessing via scenario reduction

Václav Kozmík, Jitka Dupačová

Even with recent enhancements, computation times for large-scale multistage problems with risk-averse objective functions can be very long. Therefore, preprocessing via scenario reduction could be considered as a way to significantly improve the overall performance. Stage-wise backward reduction of single scenarios applied to fixed branching structure of the tree is a promising tool for efficient algorithms like SDDP. We provide computational results which show acceptable precision of the results for the reduced problem and a substantial decrease of the total computation time.

vaclav@kozmik.cz

Tropical optimization problems: Solution methods and application examples

Nikolai Krivulin

We consider problems formulated and solved in terms of tropical mathematics to minimize functions defined on vectors over semifields with idempotent addition and invertible multiplication, subject to constraints given by vector equations and inequalities. We start with an overview of known tropical optimization problems and available solution methods. Then, we examine new problems and give direct solutions in a compact vector form ready for practical implementation. Finally, we apply the results obtained to solve real-world problems in project scheduling, location analysis and decision making.

nikolai_krivulin@hotmail.com

Distributionally robust joint chance constraints with conic dispersion measures

Daniel Kuhn, Grani Hanasusanto, Vladimir Roitch, Wolfram Wiesemann

We study distributionally robust joint chance constrained programs where the uncertain parameters are described through their mean values and upper bounds on general dispersion measures. We derive a tractable problem reformulation when the dispersion measure is conic and the uncertain parameters only affect the right-hand side vector of the chance constraint. We also show that the problem becomes intractable if the left-hand side coefficient matrix is affected by uncertainty or the support of the uncertain parameters is restricted to a polyhedron.

daniel.kuhn@epfl.ch

Temporal decomposition of chance constraints in portfolio selection problem

Karel Lavička

In this talk, we present a solution of a two-stage portfolio selection problem with probabilistic constraint joint over both time stages. We introduce a temporal decomposition of probabilistic constraint, which alows us to write dynamic programming equations similar to the risk neutral case. Recourse function in this problem depends on one additional risk parameter that has to be optimize together with the portfolio allocation. The solution shows how to adjust risk aversion in the second stage in order to keep the investment safe. We compare our numerical results with naive solution that keeps the risk aversion constant over time. Only two-stage problem is considered, but our approach can be generalized to another, even multi-stage, problems.

k.lavicka@seznam.cz

Optimal gain from a controlled kin tree
Petr Lachout

We will present a model of a branch of a kin with controlled growth. Each member of the kin is evaluated by a vector of individual characteristic giving a gain of the individual. The goal is to control growth of the population and stop it to receive an optimal gain.
References:
[1] Dupačová, J.: Scenario based stochastic programs: Resistance with respect to sample. Ann. Operation Research 64(1996), 21-38.
[2] Dupačová, J.; Bertocchi, M.: From data to model and back to data. A bond portfolio management problem. Euro. J. Oper. Res. 134(2001), 261-278

lachout@karlin.mff.cuni.cz

Assessment of inflow scenario generation per basin in the long term hydrothermal scheduling
Paulo Vitor Larroyd, Vitor de Matos, Erlon Finardi

The Long-Term Hydrothermal Scheduling (LTHS) plays an important role in power systems that rely heavily on hydroelectricity because the goal of this problem is to define an optimal policy for the use of water. To incorporate the inflows uncertainties, the LTHS problem is modeled as a Multi-stage Stochastic Linear Problem (MSLP). The Brazilian system has hundreds of huge hydro plants and the size of MSLP grows with the number of random variables. In this work, we assess the consequences of modeling inflows per reservoir or per basin. Results are shown considering the Brazilian power system.

paulo.larroyd@posgrad.ufsc.br

Joint mission planning of multiple satellites for searching maritime target

Jufang Li, Xiaogeng Chu, Ting Xi, Zhongxiang Chang, Wei Wang

According to the rolling property of the mission planning process, we respectively establish a single stage joint scheduling model and a multi-stage joint scheduling model which will maximally decrease the uncertainty of the target location measured by entropy. Probability distributions of the target location in each divided grid are updated after each time some observation results by certain satellites are returned. Taking the expected information gained as state representation, we also propose a reinforcement learning based algorithm to solve the multiple stage joint scheduling problem.

lijufang@nudt.edu.cn

Multivariate time series models for stochastic-dynamic optimization

Nils Löhndorf, Andreas Eichhorn

An important aspect of stochastic optimization in practice is that of finding a representative set of scenarios to model uncertainty. This talk presents a multivariate time series model that is particularly well-suited for stochastic-dynamic optimization. The model circumvents the need for scenario generation by deriving scenarios directly from multivariate time series data. The performance of the modeling approach is assessed based on historical data of natural inflows from 50 rivers that make up more than half of Austria's hydropower generation.

nils.loehndorf@wu.ac.at

Numerical realization of discrete time European option pricing with underlying asset obeying a subdiffusion process in Mathematica
Ladislav Lukáš

The paper deals with numerical realization of European option pricing in discrete time setting with Mathematica. Theoretical framework of the pricing problem considered assumes an option underlying asset to obey a subdiffusion process being specified as time-changed mixed Brownian-fractional Brownian motion. Recently, such type of pricing formulae was published in literature. We have developed Mathematica notebook solving the pricing problem given. Algorithmic details and core code snippets are discussed, and results of various numerical experiments relating sensitivity are presented.

lukasl@kem.zcu.cz

A robust risk-mitigation approach for project management
Carlos Raoni Mendes, Bruno Flach, Marcus Poggi

We study the problem of determining optimal activity execution modes and risk mitigation plans within a project's execution context subject to multiple sources of uncertainty. The uncertain environment is modeled as an adversary who selects a worst-case (highest impact) combination of risks given the decision maker's actions and we devise a strategy based on robust optimization to account for that. We present a reformulation scheme coupled with a cut-generation algorithm to solve the proposed problem and illustrate the approach by a series of computational experiments.

carlosraoni@gmail.com

Cost optimizing methods for deterministic queuing systems
Zuzana Němcová

The contribution compares two proposed methods for the cost optimization of the deterministic queuing system based on the control of the queue lengths. The first method is based on the simulation of the future states and on this basis the appropriate time and type of the modification of the system setup is suggested. The second method uses the evaluation of the previous system state. The decision is then based on the comparison of the criteria of productivity and the queuing costs. The change with the highest priority is then accomplished.

zuzana.nemcova@uhk.cz

Checking feasibility in gas networks for balanced entry and exit flows
Sabrina Nitsche, Rüdiger Schultz

Checking feasibility of balanced entry and exit flows is a routine task for gas transportation companies. In the steady state situation, feasibility of flow can be modeled by a system of polynomial equations and box constraints. In the talk we address solving the equality system, with flows arising as parameters, by Gröbner bases methods from computational algebra. Some first numerical results will be presented.

sabrina.nitsche@uni-due.de

The valuation of the gas storage by means of ADP, machine learning and the stable Ornstein Uhlenbeck model
Vadym Omelchenko

In this study, we present our methodology of the valuation of the gas storage where we apply approximate dynamic programming and machine learning for modelling the uncertainty of prices. The residuals are modeled by the stable Ornstein-Uhlenbeck process. We compare different optimization approaches for the valuation of the Gas storage and discuss the calibration of the models of prices.

vadim224@yahoo.com

On the use of conditional expectation estimators
Sergio Ortobelli, Tommaso Lando

This paper discusses two different methods to estimate the conditional expectation. We compare the two approaches by verifying which one better estimates the true distribution of $E(Y|X)$. In particular, if we assume that the two-dimensional variable (X, Y) is elliptically distributed, the comparison can be performed in terms of goodness-of-fit tests. Moreover, we illustrate and discuss their properties and we propose some tests deriving from their use in different financial and statistical applications.

sol@unibg.it

Learning uncertainty sets
Dimitri Papadimitriou

Set induced robust optimization is intrinsically dependent on the features of uncertainty sets. When considering data-driven stat. methods, the key question becomes how to perform inference tasks (density estimation and hypothesis test) from samples and when considering model-driven methods how to produce and select an hypothesis which best explains the data. In both cases, the goal is to minimize the difference between the solution obtained using the true distribution vs. estimated/modeled distribution. We compare these methods on network optimization MIPs involving demands and traffic flows.

dimitri.papadimitriou@alcatel-lucent.com

On structural properties and clustering of market networks
Panos Pardalos

In this talk we discuss structural problems of market networks and present results from clustering analysis. We show that the market graph possess a clear clustered structure only for higher correlation thresholds. By studying the internal structure of the graph clusters we found that they could serve as an alternative to traditional sector classification of the market.

pardalos@ufl.edu

An estimation of distribution algorithm-based approach for the order batching problem

Ricardo Pérez-Rodríguez, Arturo Hernández

An estimation of distribution algorithm-based approach is proposed for the order batching problem in an order-picking warehouse. A probability model is built to describe the characteristics exhibited by the parents as a distribution of the solution space. In a series of extensive numerical experiments, an acceptable performance using the algorithm mentioned is shown against different evolutionary algorithms known in the literature.

ricardo.perez@cimat.mx

Switching options for peak power plants: Structural estimation

Alois Pichler

We introduce a method for structural estimation based on a nonparametric representation of the dynamics of an exogenous state variable. The method is illustrated in the context of switching options. Our goal is to uncover economic primitives associated with the irreversible cost of switching. Our approach extends recent contributions in structural estimation, combining nonparametric statistics with nonlinear programming. Our case study is that of mothballing, starting up, and abandoning peak power plants. Our results provide reasonable and useful estimates of maintenance and switching costs.

aloisp@ntnu.no

A demand side management model for load scheduling in healthcare facilities

Paolo Pisciella, Maria Teresa Vespucci

We propose a model for defining the optimal scheduling of electric powered devices with the aim of reducing energy expenditures in a healthcare facility. The model considers day ahead prices and weather forecasts in order to schedule AC and ventilation settings minimizing total costs while maintaining a minimum comfort treshold.

paolo.pisciella@unibg.it

Approximating stochastic programming models for waste-to-energy problems

Pavel Popela, Jakub Kůdela, Michal Touš, Martin Pavlas, Radovan Šomplák

The purpose of the paper is to introduce and discuss the sequence of approximating stochastic programs for WtoE problems. The model development leads from the initial newsvendor-like case to the complex input-output model with rich internal structure involved in multistage programs. They include deterministic, stochastic WS, and scenario-based HN approaches. The operational control of energy-producing plant is linked with investment decision about the related waste-to-energy plant. Properties of models and links between their solutions are discussed. Computations are based on real-world data.

popela@fme.vutbr.cz

Consumer loan scoring and regulatory capital decisions in the context of uncertain economic conditions

Kanshukan Rajaratnam, Peter Beling, George Overstreet

We incorporate forecasts of future economic conditions into acquisition decisions for consumer loan portfolios. The decision maker must choose both a set of applicants to grant credit and the level of regulatory capital. Our goal is to show methods to construct the unconditional efficient frontier (EF) in the profit-market share space. We prove that all efficient operating points on the unconditional EF is constructed from the set of feasible points on the EF conditioned on each economic scenario. This reduces the computation run time when constructing the unconditional EF through simulation.

kanshukan.rajaratnam@uct.ac.za

Finite first order dominance: A network-flow characterization and an algorithm for the bivariate case

Troels Martin Range, Lars Peter Østerdal

Determining whether or not one distribution is superior to another distribution is fundamental in economics. This superiority can be shown by one distribution first order dominates the other. We argue that checking multivariate finite first order dominance can be conducted by solving a bipartite network-flow problem related to the classical transportation problem. We further construct a linear time complexity algorithm for checking first order dominance in the bivariate case.

tra@sam.sdu.dk

Active index allocation with ETFs

Kourosh Marjani Rasmussen, Thomas Bjerring, Omri Ross

ETFs have taken down many barriers allowing individuals and small investment houses to trade some of the most exotic instruments in a transparent and price efficient manner. Still, most of the attention received by ETFs has focused on their ability to track indexes and offer simplified diversification. In this paper we focus on extending the role of ETFs from an index tracking tool to a viable alternative to active trading seeking high risk-adjusted returns. We present a selection criteria in the construction of ETF portfolios that consistently outperform a specific index with similar risk.

kmra@dtu.dk

Conditioning of two-stage stochastic programming problems
Werner Römisch, René Henrion

A condition number for linear-quadratic two-stage stochastic optimization problems is introduced as the Lipschitz modulus of the multifunction assigning to a (discrete) probability distribution the solution set of the problem. Being the outer norm of the Mordukhovich coderivative of this multifunction, the condition number can be estimated from above explicitly in terms of the problem data by applying appropriate calculus rules of generalized differentiation. The general results are illustrated for two-stage models with simple recourse.

romisch@math.hu-berlin.de

Simulations as a computational tool for discrete Markov chains
Jiří Rozkovec

This paper deals with a usage of simulations in discrete absorbing Markov chain to evaluate its basic characteristics. The process being researched is a running race with several checkpoints where the runner can fail at given probability. If he fails, he has to get back to the starting point and start the whole race again. The main question is how many steps the racer expects to make to pass all the checkpoints and how many starts he concurrently performs. At the same time there are also stated some interesting statistics of the process considering the number of steps as a random variable.

jiri.rozkovec@tul.cz

The component commonality problem in a real multidimensional space

Diego Ruiz-Hernández, Mozart Menezes, Renato Guimarães

Component commonality is an efficient mechanism to mitigate the negative impact of a highly diversified product line. In this work, we develop a novel algorithmic approach aimed at transforming a continuous multidimensional component commonality problem into a discrete decision problem. We show that our formulation is equivalent to the k-median facility location problem, and provide a collection of descent-greedy algorithms aimed at handling substantially large instances. Results of a number of computational experiments which testify for the good performance of our heuristics are presented.

d.ruiz@cunef.edu

Modelling sequential information acquisition behavior in rational decision making

Francisco Javier Santos-Arteaga, Debora Di Caprio, Madjid Tavana

In this paper, we define and study the sequential information acquisition process of a decision maker (DM) when allowed to acquire any finite amount of information from a set of products defined by vectors of characteristics. This process depends both on the values of the characteristics observed and the number and potential realizations of the remaining characteristics. Each time an observation is acquired, DMs modify the probability of improving upon the products already observed with the number of observations available and recalculates their information acquisition incentives accordingly.

fsantosarteaga@unibz.it

Distribution sensitivity of stochastic programs with dominance constraints

Rüdiger Schultz, Matthias Claus

In recent years, optimization problems whose constraints involve stochastic orders have gained increased attention in stochastic programming. For the models addressed, the orders are specified by stochastic dominance applied to random variables given by linear or mixed-integer linear recourse. Results comprise (semi) continuity of optimal values and metric regularity of feasible sets.

ruediger.schultz@uni-due.de

Comparing the two hierarchical clustering and K-means in the field of auto insurance fraud

Namdar Shahrokhi Nejad

Considering the importance of fraud in the field of auto insurance and since the K-means and Hierarchical Clustering are the most widely used in the field of auto insurance, we are going to compare these two methods in this study. In order to compare the both methods, clustering has been made on 116 data related to the cases of Auto third party insurance fraud in Iran Insurance which were extracted during the years of 2010 to 2013. These cases have been randomly extracted from the available archives. And the results are explained.

namdar.shahrokhi@yahoo.com

Risk-sensitive optimality in Markov decision processes: Policy and value iterations
Karel Sladký

The article is focused on the risk-sensitive optimality in Markov Decision Chains, where expectation of the stream of one-stage costs (rewards) generated by a Markov chain is evaluated by an exponential utility function with a given risk sensitivity coefficient. Recall that for the risk sensitivity coefficient equal zero we arrive at traditional optimality criteria. Policy and Value Iterations methods for finding optimal policies along with bounds on suboptimal policies are discussed.

sladky@utia.cas.cz

Multi-generation multi-portfolio generalization of Vasicek model
Martin Šmíd

Recently, Merton-Vasicek model became one of the standards in credit risk management. We present a generalization of this model allowing multiple subportfolios of loans possibly starting at different times and lasting more than one period. We propose a natural computationally efficient ways of linking our model to macro-economic environment and estimating its parameters. A case study based on aggregate US mortgage data is presented.

martinsmid.eu@gmail.com

Building nominations for real-life gas transportation networks
Claudia Stangl, Benjamin Hiller, Robert Schwarz

Checking the feasibility of bookings belongs to the key tasks in gas pipeline operation. The customer orders a booking, that means a maximal in- or output of gas, at a node on the underlying gas network. The gas transportation company has to decide whether to agree to the booking or not. In its most basic form, they have to be able to sent all balanced nominations within the bookings on the exits and entries through the network. In this talk a method is presented to generate nominations for a given booking to decide afterwards whether the booking is feasible or not.

claudia.stangl@uni-due.de

Index tracking using unsupervised learning and mixed-binary convex programming

Oliver Strub, Philipp Baumann

Passive asset managers replicate indices by investing only in a subset of the index constituents, which is less risky than active strategies and generates lower transaction costs. The problem of finding the best subset, which can be formulated as a mixed-binary convex program, is hard to solve. We propose an approach that combines unsupervised learning algorithms to detect promising subsets, and mixed-binary convex programming to compute the asset weights. We also analyze regularization techniques. Our approach compares well to existing ones regarding running time and tracking precision.

oliver.strub@pqm.unibe.ch

The Goldbach's conjecture in max-algebra

Peter Szabó

The Goldbach's conjecture, states that each even number is the sum of two odd primes, is one of the unsolved, classic problems of number theory. In this paper, we present a max-algebraic version of Goldbach's conjecture based on application of an optimisation algorithm ([1]). The result allows to apply max-algebraic methods to the conjecture research.

Bibliography:

[1] Szabó, P.: An iterative algorithm for computing the cycle mean of a Toeplitz matrix in special form. Kybernetika. Vol. 49, no. 4 (2013), p. 636-643. ISSN: 0023-5954.

peter.szabo@tuke.sk

Constrained portfolio selection based on stock rankings using R/ROI

Stefan Theussl, Ronald Hochreiter

Assume that the investor's preference (1) is represented by a ranking of stocks and the top n ranked assets form the investor's portfolio. However, risk management (2) may impose certain constraints e.g., limits on aggregated country and sector weights in a global portfolio. In this talk we show that following (1) by meeting (2) is a mixed binary programming problem which can be solved using standard mathematical programming solvers. We use R, a language for statistical computing and graphics, and the contributed package ROI to model and solve the optimization problem at hand.

stefan.theussl@rbinternational.com

Cost effective energy optimization by solving facility allocation on Riemannian manifolds

Emre Tokgöz, Iddrisu Awudu

In this paper, a recently developed novel technique for solving the Location Routing Problem on Manifold surfaces named Manifold Location Routing Problem (MLRP) is used to design an efficient and effective renewable energy distribution system for a single facility. A Mixed Integer Nonlinear Programming Problem is formulated and solved by using a heuristic method. This technique is applied to determine the location of a single ethanol distribution center that delivers from suppliers to customers after processing the raw material. Numerical results corresponding to this case study are displayed.

emre.tokgoz@quinnipiac.edu

Short-term uncertainty in long-term energy system models: A case study with focus on wind power in Denmark

Asgeir Tomasgard, Pernille Seljom

When wind power constitutes a larger share of the electricity production mix, credible and reliable modelling of its operation in long-term investment models becomes increasingly important. In this paper the intermittent characteristics of wind power are modelled as a stochastic parameter in a long-term TIMES model of the Danish heat and electricity sector. Often in long-term odels the short-term uncertainty of wind power is taken into account by a deterministic constraint that ensures excess back-up capacity. Using a stochastic model lead to lower total energy system costs.

asgeir.tomasgard@sintef.no

A simulation model of the evolution of the population with Alzheimer's disease

Hana Tomášková, Petra Marešová, Jitka Kühnová

The aging population is the most characteristic feature of the demographic trend of developed European countries. The most frequently mentioned diseases in old age include dementia. Treatment of dementia is a significant economic problem. This article presents a simulation model of the evolution of the population with a focus on Alzheimer's disease. The simulation model is built on the base of statistical data about the EU. The Model simulates the potential growth of the number of patients with Alzheimer's disease while maintaining the current trend of the development of the population.

hana.tomaskova@uhk.cz

Order splitting on a multi-slot machine in the printing industry
Norbert Trautmann, Philipp Baumann, Salome Forrer

We study the imprinting of customer-specific designs on napkin pouches. Given customer orders are to be split among several slots of printing plates such that the total costs are minimized subject to several constraints. We present two alternative mixed-binary linear programming formulations which eliminate symmetric solutions explicitly or implicitly, respectively, from the search space. The implicit formulation performs significantly better in terms of average integrality gap and number of instances solved to feasibility.

norbert.trautmann@pqm.unibe.ch

Dynamic asset allocation via SDDP with concealed discrete states
Davi Valladão, Thuener Silva, Marcus Poggi

The Stochastic Dynamic Dual Programming (SDDP), a promising solution technique for large-scale problems, is not suitable for the asset allocation problem due to asset return temporal dependency. SDDP assumes stagewise independence assuring a unique cost-to-go function for each time stage. This works proposes an extension of SDDP to solve real asset allocation problems for multiple periods modelling time dependence of as a Hidden Markov Model with concealed discrete states. We present three different risk aversion representations and analyse empirical results.

davimv@puc-rio.br

Optimization models for the operation of medium-voltage AC networks

Maria Teresa Vespucci, Diana Moneta, Paolo Pisciella, Giacomo Viganò

A medium-voltage AC network with distributed generation and storage devices is considered for which set points are assigned in each time period of a given time horizon on the basis of forecasted values of some parameters. When realized values differ from forecasts, new set points need to be determined in order to restore feasibility. We propose a NLP model that minimizes distributor's dispatching costs, while ensuring service quality and satisfying security requirements as well as local control constraints. An interior point algorithm is developed that exploits the problem structure.

maria-teresa.vespucci@unibg.it

Pension fund optimal investment policy

Sebastiano Vitali, Miloš Kopa, Vittorio Moriggia

We present the definition of an individual optimal portfolio allocation in a Pension Plan prospective. We propose a Multistage Stochastic Program including a multi-criteria objective function and introducing stochastic dominance constraints with respect to a benchmark wealth. The optimal choice is the portfolio allocation that minimizes the AVaRD of the final wealth and satisfies the wealth targets in the final stage and in an intermediate one. Numerical results show that we can achieve a time evolving balanced portfolio satisfying the investor's wishes.

sebastiano.vitali@unibg.it

Bimodality testing of diffusion processes
Jan Voříšek

Stationary distribution of diffusion processes with polynomial drift function belongs to the exponential family. This class is flexible with respect to skewness, kurtosis and multimodality and have unique maximum likelihood estimators (Cobb, 1983). For estimation using transition density a closed-form expansion was proposed (Ait-Sahalia ,2008). For cubic drift with given parameters bimodality is indicated by the negative sign of Cardan's discriminant. A statistical test for bimodality is constructed and the necessary condition for bimodality, which allows simplified testing, introduced.

vorisek@karlin.mff.cuni.cz

Deterministic self-policy for observable queues of heterogeneous customers
Chia-Li Wang

Suppose that arriving customers at a queueing system are heterogeneous in the preference of service. They first observe the number of customers in the system upon arrival, and then decide to join for service or balk depending on expected personal gain. We consider the deterministic decentralized decisions under a very general service discipline, and investigate the existence and uniqueness of the Nash equilibrium self-policy. It is shown that the system can have any non-negative number of self-policies, but at most one being Nash equilibrium.

cwang@mail.ndhu.edu.tw

Two-stage robust integer programming
Wolfram Wiesemann

In this talk we study two-stage robust optimization problems with integer recourse, which have largely resisted solution so far. To this end, we approximate the problems by their corresponding K-adaptability problems, in which the decision maker pre-commits to K second-stage policies here-and-now and implements the best of these policies once the uncertain parameters are observed. We study the approximation quality and the computational complexity of the K-adaptability problem, and we propose two mixed-integer linear programming reformulations that can be solved with off-the-shelf software.

ww@imperial.ac.uk

Tri-criterion modeling for constructing more-sustainable mutual funds
Maximilian Wimmer, Sebastian Utz, Ralph E. Steuer

We study a cross section of US mutual funds to assess the extent to which sustainability measures are embedded in their portfolios. Our methodology makes heavy use of points on the nondominated surfaces of many tri-criterion portfolio selection problems in which sustainability is modeled, after risk and return, as a third criterion. With the mutual funds acting as a filter, the question is: How effective is the mutual fund industry in carrying out its charge? Our findings are that the industry has substantial leeway to increase the sustainability quotients of its portfolios at even no cost.

maximilian.wimmer@ur.de

Optimal gas storage valuation and futures trading
David Wozabal, Nils Löhndorf

We price a gas storage under gas price uncertainty and risk aversion. The model is formulated as a stochastic version of rolling instrinsic planning. The price process is represented by a scenario lattice, which is found by discretizing the original continuous price process combining ideas from mass transportation and moment matching. To solve the problem, we use Approximate Dual Dynamic Programming. Numerical experiments show that our approach outperforms the deterministic rolling intrinsic solution as well as state of the art approaches from the recent literature.

david.wozabal@tum.de

A semi-infinite programming approach for robust reward-risk ratio optimization with matrix moments contraints
Huifu Xu

We consider a distributionally robust reward-risk ratio optimization model where the ambiguity set is constructed through simple inequality moment constraints and develop numerical methods for solving the problem: first, we transform the robust optimization problem into a nonlinear semi-infinite programming problem and then use the well known entropic risk measure to construct an approximation of the semi-infinite constraints, we solve the latter by an implicit Dinkelbach method (IDM). Finally, we apply the proposed robust model and numerical scheme to a portfolio optimization problem.

huifu.xu.1@city.ac.uk

Generating high quality initial solutions based on data for agile Earth observation satellites mission scheduling

Zang Yuan, Song Liu, Jufang Li, Wei Zhang, Shuzhao Yang

Agile earth observation satellites mission scheduling is useful and complex. Many bio-inspired intelligent optimization algorithms can hardly be used in practice for too much time cost in iteration and many heuristic based on greedy rules are still applied to real projects. In this paper, a compromise approach is proposed, which mixes intelligent optimization algorithms with heuristic based on greedy rules by rapidly generating high quality initial solutions based on data. The experiment results show that the approach is more effective in solving this problem.

zang.yuan@nudt.edu.cn

Research on method about task planning of clock synchronization between satellite and ground of GNSS

Zhongshan Zhang, Pei Wang, Renjie He, Jufang Li

Though the main GNSS have joined crosslinks, in order to improving the positioning precision, the frequent task requirement of clock synchronization between satellite and ground doesn't reduce. This paper analyses this task planning problem and shows many different features from traditional scheduling problem, then proposes two resolving methods. One is to establish multi-objective optimization model and solved it by multi-objective algorithm. Another is to combine two optimization goals into one and solving it. The simulation on COMPASS shows that different method has different performance.

jiangshan.jt@163.com

Multistage portfolio optimization with risk premium constraints
Barbora Zuzáková

A multistage stochastic optimization is a tool which enables to manage portfolio in constantly changing financial markets by periodically rebalancing its structure in order to achieve desired target. This paper presents a decision-making process where the objective function is to maximize investor's expected utility over a finite time horizon, namely we consider a class of non-separable multivariate utility functions. Features of utility functions already contain the information on investor's risk attitude thus basically no risk constraints are necessary. However, the solution cannot guarantee that the investor does not find himself in an undesirably risky position within the investment horizon. We therefore suggest a reformulation of the underlying problem by adding an extra constraint on an upper bound of risk premiums.

zuzakova@karlin.mff.cuni.cz

Author Index