18th International Conference on

Mathematical Methods in Economy and Industry

and Summer School on Computational Finance

September 8-12, 2014

Smolenice Castle, Slovakia

Book of Abstracts
and Conference Programme

Organized by:

Comenius University, Bratislava, Slovakia

Mathematical Institute of Slovak Academy of Sciences, Bratislava, Slovakia

Book of Abstracts and Conference Programme
Conference name and place: 18th International Conference on Mathematical Methods in Economy and Industry and Summer School on Computational Finance 2014, 8-12.9.2014, Smolenice
Edited by Mária Trnovská (with the help of Daniel Ševčovič and Pedro Pólvora)
Cover design: Pedro Pólvora
Publisher: Faculty of Mathematics, Physics and Informatics, Comenius University, Mlynská dolina, 842 48 Bratislava, Slovakia
Number of copies: 65

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ISBN 978-80-8147-022-6

Contents

GENERAL INFORMATION

This volume includes the abstracts of contributions to MMEI 2014 - the 18-th International Conference on Mathematical Methods in Economy and Industry, held in Smolenice, Slovakia, September 8-12, 2014. It also includes abstracts of lectures presented for students at the Summer School on Computational Finance. The conference and summer school are organized by the Department of Applied Mathematics and Statistics of the Faculty of Mathematics, Physics and Informatics of Comenius University, Bratislava, Slovakia in cooperation with the Mathematical Institute of Slovak Academy of Sciences, Bratislava, Slovakia.

Presentation Guide

All presentations are made in English. The main lecture room is located on the first floor near the dining hall. The small lecture (Hunting Salon) is located on the second floor near the main castle staircase.

The time schedule for invited lectures of the conference is 50 minutes including 5 minutes for discussion. Contributed session talks are scheduled for 25 minutes including 5 minutes for discussion. The presentation should be prepared in either Adobe Acrobat PDF file format or as a Microsoft Power Point presentation. Please upload your presentation to the presentation computer 15 minutes before the beginning of the session. You can use your own computer for presentation if it is necessary (please contact the conference organizers for assistance).

Meals

Breakfasts, lunches and dinners will be served at the dining hall in the first floor, near the main castle staircase.

Breakfast 7:30 - 9:00

Lunch 12:00 - 13:00

Dinner 19:00 - 20:00

Conference Dinner and Live music Performance on Wednesday (19:00 - 22:00)

Wine tasting on Thursday 20:00 - 22:00 at the Smolenice Castle Chapel

Refreshments during coffee breaks will be served in the lobby at the main lecture room in the first floor. Individual refreshments can be purchased in the bar in front of the main dining room (opened each day till 21:30).

Internet Access and Facilities

There is a free WiFi internet access in the Smolenice Castle. There will be a printing service available for participants.

SCOPE AND TOPICS OF THE CONFERENCE

The conference traditionally covers a wide range of mathematical methods applied to economy and industry. The emphasis is laid on optimization theory, both deterministic and stochastic. Topics of interest include but are not limited to

- Mathematical Programming
- Combinatorial Optimization
- Nonsmooth Optimization
- Stochastic Optimization
- Optimal Control
- Economic Models
- Mathematical Finance
- Numerical methods
- Statistics
- Simulation

HISTORY OF THE MMEI CONFERENCE SERIES

The series of International Conferences on Mathematical Methods in Economy and Industry (MMEI) was founded by Prof. František Nožička and started in 1973. The subtitle Joint Czech-German-Slovak Conference was added because its organization rotates among Czech Republic, Germany and Slovak Republic. The following list contains MMEI conferences so far:

1.	24.9.1973	-	28.9.1973	Zadov, Czechoslovakia (UK PRAHA)
2.	21.10.1974	-	24.10.1974	Heiligendamm, DDR (HU Berlin)
3.	9.2.1976	-	13.2.1976	Zvíkovske Podhradí, Czechoslovakia (UK PRAHA)
4.	2.10.1977	-	8.10.1977	Vitte/Hiddensee, DDR (HU Berlin)
5.	11.2.1979	-	16.2.1979	Smolenice, Czechoslovakia (VSE Bratislava)
6.	28.9.1980	-	3.10.1980	Vitte/Hiddensee, DDR (HU Berlin)
7.	30.8.1982	-	3.9.1982	Praha, Czechoslovakia (UK PRAHA)
8.	26.10.1984	-	31.10.1984	Sellin/Rügen, DDR (HU Berlin)
9.	20.9.1992	-	25.9.1992	Loučná, Czechoslovakia (UK Praha and HU Berlin)
10.	25.9.1995	-	30.9.1995	Bardejovské kúpele, Slovakia (TU Košice)
11.	1.6.1998	-	5.6.1998	Liberec, Czech Republic (TU Liberec)
12.	21.7.2002	-	26.7.2002	Arnstadt, Germany (HU Berlin)
13.	26.5.2003	-	30.5.2003	Hejnice, Czech Republic (TU Liberec)
14.	23.5.2005	-	27.5.2005	Arnstadt, Germany (HU Berlin)
15.	4.6.2007	-	7.6.2007	Herľany, Slovakia (P.J. Šafárik University and TU Košice)
16.	15.6.2009	-	18.6.2009	České Budějovice, Czech Republic (University of South Bohemia)
17.	24.6.2012	-	28.6.2012	Berlin, Germany (WIAS and HU Berlin)
18.	8.9.2014	-	12.9.2014	**Smolenice, Slovakia** (FMFI UK and MU SAV Bratislava)

CONFERENCE VENUE

The conference will be held in the **Congress Centre Smolenice of the Slovak Academy of Sciences**, less than 60 kilometers from Bratislava, the capital of Slovak Republic.

History

First written documents about the existence of Smolenice date back to the 13th century, although its origin is as ancient as the Neo-Feudalism. Several aristocratic families had been the landlords there - for instance, in 1388 King Sigmund had issued a Deed of Donation to give Smolenice to Chieftain Ctibor of Ctiborice. In 1438, Count George from Pezinok and Svätý Jur became the new landlord there.

In the 15th century the importance of Smolenice increased considerably, because a castle was built there which became the centre and seat of the Smolenice estate. Early in the 16th century, Smolenice had been gained by the Orszagh family. In 1777, Ján Pálffy takes the Smolenice estate as pawn. The Pálffy family did not live at the castle, which had decayed considerably during the life of Krištof III, the last of the Erdödy family - they lacked money for maintenance. The decay was complete during the Napoleon Wars - the main castle building and the tower had burnt down.

The construction of the Smolenice Castle of today started early in the 20th century by Jozef Pálffy Jr., the landlord of Smolenice and Dobrá Voda estates. First work on the fortification walls started in 1887 already on the bastions. Bastions from the old castle were preserved, with height extension and new roofing. The Count Pálffy had built the castle at his own expense according to design by the architect Jozef Hubert. During World War 1, the construction was interrupted; provisional adaptation of some rooms was made and archives of the Pálffy family was located there. The construction was not resumed before the end of World War 2. In 1945 the Castle became the property of the State; it was taken over by the Slovak National Council who decided to have their summer-house there. The castle was finished and furbished and handed over to the Slovak Academy of Sciences on 26 June 1953 to become a representative place for meetings of scientists from worldwide.

Congress Centre of the SAS

The village of Smolenice with the well-known Smolenice Castle is situated at the foot of Malé Karpaty (Lesser Carpathians) mountain range, 60 km northwest from Bratislava. The castle shelters the Congress Centre of the Slovak Academy of Sciences (CC SAS). Each year, numerous international congresses and symposiums with international attendance take place here, organised by scientific institutions of the SAS. In the CC SAS 82 beds are available (in single-, double- and three-bed rooms). The representation interior offers interesting views outside. In the restaurant premises, 120 seats for catering are available and the Congress Room has 90 seats. The adjacent English park, well included into mountain forest edge, offers numerous possibilities for walking to the visitors. The Driny Stalactite Cave, only at 3 km distance from the castle, will certainly please the visitors by its remarkable beauty.

Opposite to the castle - on adjacent edge of the mountain ridge, one can visit the fortified mansion from the 5th century B.C. via a marked path (rather difficult to walk). The district town of Trnava with its well-known Baroque sacral monuments can be reached at 20 km distance.

Upon request, the CC SAS staff are ready to ensure folk group and/or classical music performances, historical castle games program (historical sword-play, falconers), as well as to offer the products of well-known ceramics manufacture Majolica from Modra, castle wine degustation and other activities to enrich the events.

CC SAS is ready to provide for comfort and rest after scientific events to its guests. Within this sense, the Centre serves to all its guests, thus facilitating international integration.

Address:
Congress Centre of the SAS
Zamocká c. 18, 919 04 Smolenice

Source: http://www.smolenice.sav.sk/

SPECIAL ACKNOWLEDGEMENTS TO

Scientific Committee

Pavol Brunovský (Bratislava)

Katarína Cechlárová (Košice)

René Henrion (Berlin)

Petr Lachout (Praha)

Mikuláš Luptáčik (Wien)

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Pedro Pólvora

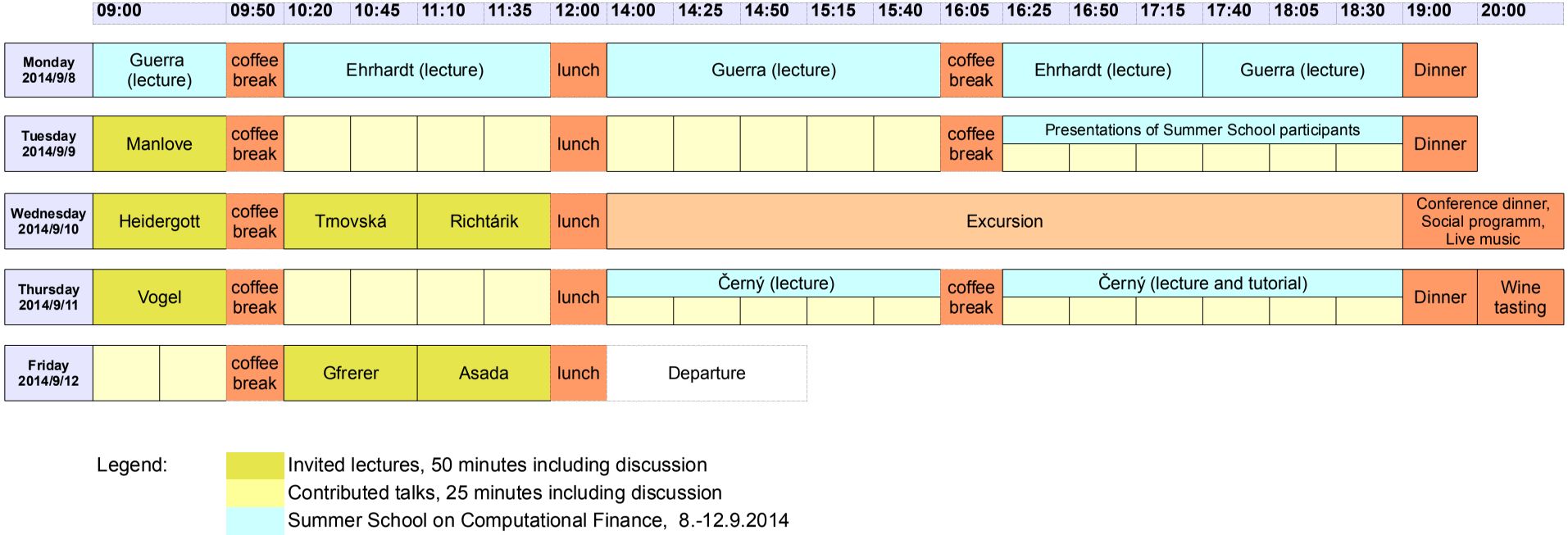
Daniel Ševčovič

Zuzana Bučková

CONFERENCE PROGRAMME

Mathematical Methods in Economy and Industry, 9-12.9.2014, Smolenice and Summer School on Computational Finance, 8-12.9.2014

Program structure



Legend:

- Invited lectures, 50 minutes including discussion
- Contributed talks, 25 minutes including discussion
- Summer School on Computational Finance, 8.-12.9.2014

Mathematical Methods in Economy and Industry
Summer School on Computational Finance
8-12.9.2014, Smolenice

Alphabetical list of speakers

Surname, Name	Day	Time
Asada, Toichiro	Friday, Sept. 12	11:10
Bartl, David	Thursday, Sept. 11	14:50
Benko, Matus	Thursday, Sept. 11	15:15
Bordag, Ljudmila A.	Thursday, Sept. 11	17:15
Branda, Martin	Tuesday, Sept. 9	11:35
Bučková, Zuzana	Tuesday, Sept. 9	16:25
Cechlárová, Katarína	Tuesday, Sept. 9	14:00
Černý, Aleš	Thursday, Sept. 11	14:00, 16:25
Dupačová, Jitka	Tuesday, Sept. 9	10:20
Egorova, Vera	Tuesday, Sept. 9	16:50
Ehrhardt, Matthias	Monday, Sept. 8	10:20, 16:25
Eirinakis, Pavlos	Tuesday, Sept. 9	14:25
Gfrerer, Helmut	Friday, Sept. 12	10:20
Guerra, Manuel	Monday, Sept. 8	9:10, 14:00, 17:40
Gyulov , Tihomir	Thursday, Sept. 11	18:30
Heidergott, Bernd	Wednesday, Sept. 10	9:00
Hendricks, Christian	Tuesday, Sept. 9	18:05
Houda, Michal	Thursday, Sept. 11	14:25
Chladná, Zuzana	Thursday, Sept. 11	11:10
Kaňková, Vlasta	Tuesday, Sept. 9	10:45
Kilianová, Soňa	Thursday, Sept. 11	16:25
Kladivko, Kamil	Thursday, Sept. 11	17:40
Konečný, Jakub	Thursday, Sept. 11	14:00
Kopa, Miloš	Tuesday, Sept. 9	14:50
Krempaský, Július	Tuesday, Sept. 9	16:50
Kukumberg, Roman	Thursday, Sept. 11	15:40
Kvasničková, Eva	Tuesday, Sept. 9	16:25
Lachout, Petr	Tuesday, Sept. 9	11:10
Manlove, David F.	Tuesday, Sept. 9	9:00
Mashayekhi, Sima	Thursday, Sept. 11	16:50
Melicherčík, Igor	Friday, Sept. 12	9:00
Mudzimbabwe, Walter	Tuesday, Sept. 9	17:15
Pólvora, Pedro	Friday, Sept. 12	9:25
Remešíková, Mariana	Thursday, Sept. 11	10:20
Richtárik, Peter	Wednesday, Sept. 10	11:10
Santos, Filipe	Tuesday, Sept. 9	17:40
Ševčovič, Daniel	Thursday, Sept. 11	10:45
Šmíd, Martin	Tuesday, Sept. 9	17:40
Špitalský, Vladimír	Tuesday, Sept. 9	17:15
Teng, Long	Tuesday, Sept. 9	18:30
Trnovská, Mária	Wednesday, Sept. 10	10:20
Vogel, Silvia	Thursday, Sept. 11	9:00
Vulkov, Lubin	Thursday, Sept. 11	18:05
Wiszniewska – Matyszkiel, Agnieszka	Tuesday, Sept. 9	15:15
Zákopčan, Michal	Thursday, Sept. 11	11:35
Zimka, Rudolf	Tuesday, Sept. 9	15:40

Mathematical Methods in Economy and Industry
9-12.9.2014, Smolenice

Tuesday, September 9, 2014

8:50	9:00	Opening ceremony		
		Chairperson:	*Katarína Cechlárová*	
9:00	9:50	David F.	**Manlove**	Junior Doctor Allocation and Kidney Exchange in the UK: Theory and Practice
9:50	10:20	Coffee break		
		Chairperson:	*Miloš Kopa*	
		Section:	***Stochastic Programming, Probability Theory***	
10:20	10:45	Jitka	**Dupačová**	Stress testing for risk-averse stochastic programs
10:45	11:10	Vlasta	**Kaňková**	Empirical Estimates in Stochastic Programs with Probability and Second Order Stochastic Dominance Constrained
11:10	11:35	Petr	**Lachout**	Description of families of quasi-concave functions
11:35	12:00	Martin	**Branda**	Exact penalization in stochastic programming under calmness and constraint qualification conditions
12:00	14:00	Lunch		
		Chairperson:	*David Manlove*	
		Section:	***Mathematical Economy, Game theory, Portfolio Optimization***	
14:00	14:25	Katarína	**Cechlárová**	Modelling placement of teachers to schools
14:25	14:50	Pavlos	**Eirinakis**	Pareto optimal matchings
14:50	15:15	Miloš	**Kopa**	Representative utility functions in portfolio efficiency testing with respect to various stochastic dominance criteria
15:15	15:40	Agnieszka	**Wiszniewska - Matyszkiel**	Dynamic oligopoly with sticky prices --- off-steady-state analysis
15:40	16:05	Rudolf	**Zimka**	On the converse of Hartwick´s result in a multi-dimensional model of an economy with exhaustible resources
16:05	16:25	Coffee break		
		Chairperson:	*Pavol Brunovský*	
		Section:	***Mathematical Economy, Portfolio Optimization (Paralell session – Main lecture room)***	
16:25	16:50	Eva	**Kvasničková**	Impact of Luck on Performance Classification of Socially Responsible and Conventional Mutual Funds
16:50	17:15	Július	**Krempaský**	A quantitative approach to the theory of evolution of economic systems
17:15	17:40	Vladimír	**Špitalský**	Multinomial likelihood the recession cone view
17:40	18:05	Martin	**Šmíd**	A model of rational behaviour at limit order markets
		Chairperson:	*Ljudmila Bordag*	
		Section:	***Financial Mathematics, I. Part (Paralell session for Summer School participants – Hunting salon)***	
16:25	16:50	Zuzana	**Bučková**	Numerical Analysis of the Alternating Direction Explicit Method and its Application in Finance
16:50	17:15	Vera	**Egorova**	Constructing Positive Reliable Numerical Solution for American Options: A New Front-Fixing Approach
17:15	17:40	Walter	**Mudzimbabwe**	Numerical solution of a stochastic control problem of option pricing for a liquidity switching Market
17:40	18:05	Filipe	**Santos**	Convexity adjustments for the pricing of futures and forwards
18:05	18:30	Christian	**Hendricks**	High order Combination Technique for the efficient Pricing of Basket Options
18:30	18:55	Long	**Teng**	Option Price with dynamically correlated Stochastic Interest Rate
19:00	20:00	Dinner		

Mathematical Methods in Economy and Industry
9-12.9.2014, Smolenice

Wednesday, September 10, 2014

Chairperson: Silvia Vogel

9:00	9:50	Bernd	**Heidergott**	Towards a Statistical System Analysis
9:50	10:20	Coffee break		

Chairperson: Daniel Ševčovič

10:20	11:10	Mária	**Trnovská**	Conic relaxations and strong duality in quadratic programs
11:10	12:00	Peter	**Richtárik**	A Unified Theory of Randomized Block Coordinate Descent Methods for Big Data Optimisation
12:00	13:30	Lunch		
13:30	18:00	Excursion		
19:00	23:00	Conference dinner, Social programme, Live music		

Mathematical Methods in Economy and Industry
9-12.9.2014, Smolenice

Thursday, September 11, 2014

Chairperson: *Petr Lachout*

9:00	9:50	Silvia	**Vogel**	*Random Approximations and Confidence Sets in Multiobjective Optimization*
9:50	10:20	Coffee break		

Chairperson: *Pavol Brunovský*

Section: **Differential equations and Optimization**

10:20	10:45	Mariana	**Remešíková**	Truss structure design using a length-oriented surface remeshing technique
10:45	11:10	Daniel	**Ševčovič**	Solution to the inverse Wulff problem by means of the enhanced semidefinite relaxation method
11:10	11:35	Zuzana	**Chladná**	Incentive to vaccinate: a synthesis of the two approaches
11:35	12:00	Michal	**Zákopčan**	Equilibria and stable paths in infinite horizon nonlinear control problems with discrete time the linear-quadratic approximation
12:00	14:00	Lunch		

Chairperson: *Peter Richtárik*

Section: **Optimization, Topological design, Mathematical Programming**

14:00	14:25	Jakub	**Konečný**	Semi-Stochastic Gradient Descent Methods
14:25	14:50	Michal	**Houda**	On the use of Archimedean copulas in chance-constrained programming
14:50	15:15	David	**Bartl**	A discrete version of Farkas' Lemma, homogeneous systems of linear inequalities, and a Duality Theorem for homogeneous linear programming
15:15	15:40	Matus	**Benko**	Active set method for mathematical programs with complementarity constraints
15:40	16:05	Roman	**Kukumberg**	Methods for solving nonsmooth convex problems
16:05	16:25	Coffee break		

Chairperson: *Maria do Rosario Grossinho*

Section: ***Financial Mathematics, II. Part (Paralell session – Main lecture room)***

16:25	16:50	Soňa	**Kilianová**	Dynamic Worst Case Portfolio Optimization via a Hamilton-Jacobi-Bellman Equation
16:50	17:15	Sima	**Mashayekhi**	Nonstandard Finite Difference Scheme for a Nonlinear Black-Scholes equation with Transaction Costs
17:15	17:40	Ljudmila A.	**Bordag**	Optimization problem for a portfolio with an illiquid asset: Lie group analysis
17:40	18:05	Kamil	**Kladivko**	An Incomplete Market Approach to Employee Stock Option Valuation
18:05	18:30	Lubin	**Vulkov**	On Fitted Finite Volume Splitting Operator Methods for the Valuation of Asian Options
18:30	18:55	Tihomir	**Gyulov**	Well-Posedness and Comparison Principle for Option Pricing with Liquidity Shocks
19:00	20:00	Dinner		
20:00	22:00	Wine tasting		

Mathematical Methods in Economy and Industry
9-12.9.2014, Smolenice

Friday, September 12, 2014

Chairperson: Soňa Kilianová

Section: ***Financial Mathematics, III. Part***

9:00	9:25	Igor	**Melicherčík**	Investment Strategies in the Funded Pillar of the Slovak Pension System
9:25	9:50	Pedro	**Pólvora**	Derivative pricing with transaction costs using a stochastic utility maximization model
9:50	10:20	Coffee break		

Chairperson: Rudolf Zimka

10:20	11:10	Helmut	**Gfrerer**	Handling mathematical programs with equilibrium constraints by generalized equations
11:10	12:00	Toichiro	**Asada**	Mathematical Modeling of Financial Instability and Macroeconomic Stabilization Policies
12:00	12:10	Closing of MMEI2014 Conference and the Summer School		
12:10	14:00	Lunch		
14:00	15:00	Departure		

Summer School on Computational Finance, 8-12.9.2014

Monday, September 8, 2014

Opening of the Summer School

Chairperson: Daniel Ševčovič

Lectures on Stochastic dynamic programming

9:10	9:50	Manuel	**Guerra**	Stochastic dynamic programming and control of Markov processes I. part
9:50	10:20	Coffee break		

Lectures on Project management

10:20	12:00	Matthias	**Ehrhardt**	Project management and soft skills tutorials I. part – Risk Assessment
12:00	14:00	Lunch		

Chairperson: Daniel Ševčovič

Lectures on Stochastic dynamic programming

14:00	16:05	Manuel	**Guerra**	Stochastic dynamic programming and control of Markov processes II. part
16:05	16:25	Coffee break		

Chairperson: Daniel Ševčovič

Lectures on Stochastic dynamic programming and project management

16:25	17:40	Matthias	**Ehrhardt**	Project management and soft skills tutorials, II. and III. parts - Grant writing in Horizon 2020 framework program and Time Management
17:40	18:55	Manuel	**Guerra**	Stochastic dynamic programming and control of Markov processes III. part and tutorials

Tuesday, September 9, 2014

9:00	12:00	Attendance of the Summer School participants at plenary and contributed section talks
14:00	16:05	Attendance of the Summer School participants at plenary and contributed section talks
16:25	18:55	Contributed talks of participants of the Summer School in the Section Financial Mathematics

Wednesday, September 10, 2014

9:00	12:00	Attendance of the Summer School participants at plenary talks

Thursday, September 11, 2014

9:00	12:00	Attendance of the Summer School participants at plenary and contributed section talks

Chairperson: Manuel Guerra

Lectures on Mean-Variance hedging (Paralell session for Summer School participants – Hunting salon)

14:00	16:05	Aleš	**Černý**	Mean-variance hedging of financial derivatives, I. part
16:25	18:55	Aleš	**Černý**	Mean-variance hedging of financial derivatives, II. part and tutorials

Friday, September 12, 2014

9:00	9:50	Contributed talks of participants of the Summer School in the Section Financial Mathematics, III. Part
10:20	12:00	Attendance of the Summer School participants at plenary and contributed section talks

SOCIAL EVENTS

Participation to all social events is free of charge and is included in the conference fee.

Wednesday afternoon (13:00-18:00)

We offer the following two alternatives:

1. **a guided trip to Jaskyňa Driny (Driny Cave)**
   Jaskyňa Driny (Driny Cave) only at 3 km distance from the castle. The Driny Cave is the only show cave in the western Slovakia and one of the main tourist attractions of the Lesser Carpathians. As compared with other show caves in Slovakia, where usually larger underground spaces prevail, it represents a system of narrow fissure passages, however with beautiful dripstone decoration. For more information see the website of the cave.
   http://www.ssj.sk/en/jaskyna/8-driny-cave
2. **a guided hiking tour to Smolenice Karst region**
   Departing from the Smolenice castle (elevation 232 m) we will take a hike tour to the top of hill Záruby (elevation 768 m). The hike will be through the forest, part of the a protected landscape area which houses a diverse wildlife and plants. The distance between Smolenice and Záruby is about 4.2 km. There are nice views to the Smolenice karst area. It is recommended to take appropriate shoes. The approximate distance of the hike is 12 km.
   http://smolenice.oma.sk/turisticky-atlas

Wednesday evening (19:00-22:00):

Conference Dinner - Raut

Accompanied by a music performance of Peter Adamov live band playing jazz standards, pop tunes, classics, bossanova, samba, swing and other styles.
https://www.facebook.com/peteradamovandfriends

Thursday evening (20:00-22:00):

Wine degustation and wine tasting at the Smolenice Castle Chapel guided by winemaker and taster Peter Križan. The tasting includes 10 wine samples including white, rose, red and berry wine.
www.vinoteka-galeria.sk

Invited Speakers

ABSTRACTS

Mathematical Modeling of Financial Instability and Macroeconomic Stabilization Policies

Toichiro Asada[1]

[1] *Faculty of Economics,*
Chuo University,
742-1 Higashinakano, Hachioji, Tokyo 192-0393, Japan

In this paper, we formulate a series of mathematical models that contribute to the theoretical analysis of financial instability and macroeconomic stabilization policies. Two-dimensional model of fixed prices without active macroeconomic stabilization policy, four-dimensional model of flexible prices with central bank's monetary stabilization policy, and six-dimensional model of flexible prices with monetary and fiscal policy mix are considered in order. In the final section, we provide an intuitive economic interpretation of the analytical results.

Key words : Financial instability, Minsky cycle, monetary stabilization policy, monetary and fiscal policy mix, inflation targeting, credibility

Mean-variance hedging of financial derivatives

Aleš Černý [1]

[1] *Cass Business School,*
106 Bunhill Row, London,
United Kingdom

The lectures aim to provide a brief and accessible introduction to the theory and applications of quadratic hedging. We will also discuss the implications of quadratic hedging theory for risk management and asset pricing in incomplete markets.

Project management and soft skills tutorials

Matthias Ehrhardt [1]

[1] *University of Wuppertal,*
Applied Mathematics and Numerical Analysis,
Gaussstrasse 20, 42119 Wuppertal,
Germany

The lectures on the project management are devoted to three talks on complimentary skills: Risk Assessment, Successful Grant writing in Horizon 2020 framework programme and Time Management.

Handling mathematical programs with equilibrium constraints by generalized equations

Helmut Gfrerer [1]

[1] *Johannes Kepler University,*
Altenbergerstrasse 69, 4040 Linz,
Austria

Usually, for mathematical programs with equilibrium constraints (MPECs) the equilibrium is modeled by means of complementarity constraints. This approach has the disadvantage that an additional variable, the multiplier, is introduced and we run into difficulties, both of theoretical and practical nature, when this multiplier is not unique.In this talk we consider the alternative formulation of the equilibrium by generalized equations involving the normal cone mapping. We show how some recent results on computing generalized derivatives of the normal cone mapping can be applied.

Stochastic dynamic programming and control of Markov processes

Manuel Guerra[1]

[1]*CEMAPRE and ISEG-University of Lisbon,*
Rua do Quelhas 6, 1200-781 Lisboa,
Portugal

This course provides a quick introduction to dynamic programming methods for optimal control of Markov processes. We will start with a brief overview of the main aspects of controlled Markov processes and formulate a general optimal control problem. For this class of problems we introduce the dynamic programming (Bellman) principle, and show how it leads to the so-called Hamilton-Jacobi-Bellman (HJB) equation. Some basic properties of the HJB equation are discussed. In particular, existence of classical solutions can be proved only under restrictive assumptions. We provide a short introduction to viscosity solutions and their connection to the solution of the optimal control problem. Some examples are presented and discussed.

Towards a Statistical System Analysis

Bernd Heidergott [1]

[1] VU University Amsterdam,
Department of Econometrics and Operations Research,
Faculty of Economics and Business Administration,
De Boelelaan 1105, 1081 HV Amsterdam,
Netherlands

This lecture is aimed at stimulating a discussion on the relation between statistics and applied probability/operations research. Academic applied probability/operations research is mainly focused on the mathematical analysis of models that find their motivation in the outside (read, non-academic) world. In preparing a real-life problem for mathematical analysis, a 'model' has to be distilled, and once this is done, reality is replaced by this model, which is subsequently analyzed with much energy and analytical rigor. However, hardly ever are the exact model specifications known, and defining parameters of the model under consideration, such as arrival rates in queuing networks, failure rates of servers in reliability models, or demand rates in inventory systems, are only revealed to the analyst by statistics. The classical approach for dealing with such parameter insecurity is to integrate out the system performance with respect to the assumed/estimated distribution of the unknown parameter. We believe that this frequentialistic interpretation of parameter insecurity falls short in addressing the needs of the analyst.

This lecture will advocate supporting the analyst by studying the risk incurred by parameter insecurity. Rather than taking an entirely statistical point of view by dismissing "model building" at all, we want to integrate the data-driven statistical nature of model building into the analytical analysis. We will discuss an analytical framework for doing so that allows for separating (i) the (analytical) analysis of the system from (ii) the statistical model for the parameter insecurity. For an inventory example, we will present numerical results illustrating our approach.

Junior Doctor Allocation and Kidney Exchange in the UK: Theory and Practice

David Manlove [1]

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Matching problems typically involve assigning agents to commodities, possibly on the basis of ordinal preferences or other metrics. These problems have large-scale applications to centralised clearinghouses in many countries and contexts. In this talk I will describe the matching problems featuring in two centralised clearinghouses in the UK that have involved collaborations between the National Health Service and the University of Glasgow. One of these dealt with the allocation of junior doctors to Scottish hospitals (1999-2012), and the other is concerned with finding kidney exchanges among incompatible donor-patient pairs across the UK (2007-date). In each case I will describe the applications, present the theoretical underlying problems, outline the mathematical methods for their solution and give an overview of results arising from real data connected with the matching schemes in recent years.

A Unified Theory of Randomized Block Coordinate Descent Methods for Big Data Optimisation

Peter Richtárik [1]

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Many big data applications can be cast as convex optimization problems and solved by a suitable optimization algorithm. Due to the size of such problems, simple methods able to progress while investigating only a small portion of the data are more desirable and efficient. I will outline a unified theory of a large class of randomized block coordinate descent methods. These methods have recently become extremely popular in areas such as machine learning, optimization and engineering due to their simplicity, versatility, scalability and ability to take advantage of sparsity in data. In the special case of trivial randomization, these methods become deterministic and include algorithms such as gradient descent, projected gradient descent, proximal gradient descent, iterative soft thresholding algorithm (ISTA), Nesterov's accelerated gradient method and fast ISTA (FISTA). In the general randomized setting, the methods specialize to serial, parallel, distributed, proximal and accelerated coordinate descent. I will conclude with presenting the results of some big data experiments involving problems of gigabyte and terabyte sizes.

Conic relaxations and strong duality in quadratic programs

Mária Trnovská [1]

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Nonconvex quadratic optimization problems (QOPs) find applications in many areas, they include binary quadratic problems as a special case and are known to be NP-hard in general. The usual approach is to relax the QOP via some conic problem for which efficient algorithms are known, to obtain a bound on the optimal solution. However, a lot of research focuses around the question - when is the relaxation exact? This question is closely related to strong duality of QOPs. In this talk we discuss sufficient conditions that guarantee the exact bound.

Random Approximations and Confidence Sets in Multiobjective Optimization

Silvia Vogel [1]

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Often decision makers have to consider several objective functions and, moreover, face the problem that not all quantities are completely known. Then they usually estimate the unknown parameters or probability distributions and determine the sets of efficient points and the corresponding decisions of the random approximate problem. Hence there is a need for stability results, i.e. assertions that guarantee that the sets obtained in that way come close to the sets for the true problem. Qualitative stability results can be derived making use of suitable convergence notions for sequences of random sets. Confidence sets for the sets of efficient points etc. yield useful quantitative information. The talk will provide convergence results and confidence sets for the sets of efficient points, weakly efficient points and the decisions. The results will be applied to the Markowitz model of portfolio optimization.

Contributed Talks

ABSTRACTS

A discrete version of Farkas' Lemma, homogeneous systems of linear inequalities, and a Duality Theorem for homogeneous linear programming

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We report a discrete version of Farkas' Lemma. It is formulated in the setting of a module over a linearly ordered commutative ring (e.g. the ring of the integer numbers). Then, we consider Gale's Theorem of the alternative and its simple proof; it uses the trick of the homogenization. Consequently, we consider homogenized systems of linear inequalities in modules over a linearly ordered ring. Introducing the concept of the primal and dual problem of homogeneous linear programming, we present an optimality condition for the primal and dual problem, respectively. We also show that the Strong Duality Theorem holds for the problems. In conclusion, we mention a very simple application of the discrete version of Farkas' Lemma in pure integer linear programming to estimate an upper bound of a maximization problem.

Active set method for mathematical programs with complementarity constraints

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In this talk, we consider mathematical programs with equilibrium constraints (MPEC for short) which have their origin in bilevel programming and arise in many applications in economic, engineering and natural sciences. While many other algorithms are only able to secure (weaker) C-stationarity, we present the algorithm that guarantees (stronger) M-stationarity of a limit point. Our approach was inspired by an active set method from nonlinear programming. Moreover, this algorithm can be modified to obtain even stronger stationarity.

Optimization problem for a portfolio with an illiquid asset: Lie group analysis

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Management of a portfolio that includes an illiquid asset is an important problem of modern mathematical finance. One of the ways to model illiquidity among others is to build an optimization problem and assume that one of the assets in a portfolio can not be sold until a certain finite, infinite or random moment of time. This framework usually leads to a three-dimensional PDE on the value function. The nonlinear PDE is then studied with different analytical and numeric methods. This approach arises a certain amount of models that are actively studied at the moment. To reduce the three-dimensional problem to a two-dimensional one or even to an ODE one use similar substitutions. The types of possible substitutions are used commonly yet were never profoundly studied before to our knowledge. We carry out a complete Lie group analysis of the PDE that arises for a portfolio optimization problem. We find the inner algebraic structure behind some studied PDEs and use it to reductions. Several of these reductions were used in other papers before and other ones are new. Further, we study the influence of choice different reductions on the way to solve the problem.

Exact penalization in stochastic programming under calmness and constraint qualification conditions

Martin Branda[1]

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We deal with the conditions which ensure exact penalization in stochastic programming problems. We give several sufficient conditions for problem calmness including graph calmness, existence of an error bound and generalized Mangasarian-Fromowitz constraint qualification. We propose a new version of the theorem on asymptotic equivalence of local minimizers of chance constrained problems and problems with exact penalty objective. We apply the theory to a problem with a stochastic vanishing constraint.

Numerical Analysis of the Alternating Direction Explicit Method and its Application in Finance

Zuzana Bučková[1]

(**co-authors:** Matthias Ehrhardt, Michael Günther)

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We are dealing with numerical methods for linear and nonlinear Black-Scholes model. We apply finite difference method, especially Alternating direction explicit methods (ADE), which were suggested in 1957 by Saul'ev. Our work includes detailed numerical analysis consisting of stability and consistency proofs. Numerical results of the ADE method for nonlinear Black-Scholes models, where the nonlinearity is caused by transaction costs or illiquid markets, such as Barles and Soner model, Frey and Patie model, Risk adjusted pricing methodology (RAPM), are provided. We compare our method to alternative numerical approaches for solving the nonlinear Black-Scholes equation from the literature.

Modelling placement of teachers to schools

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Several countries successfully use centralized matching schemes for assigning students to study places or fresh graduates to their first positions. We explore the computational aspects of a possible similar scheme for assigning teachers to schools. Our model is motivated by the situation characteristic for Slovak and Czech education system where each teacher specializes in two subjects. We show that the requirement to perform both subjects at the same school leads to intractable problems even under several strict restrictions concerning the total number of subjects, partial capacities of schools and the number of acceptable schools each teacher is allowed to list. Finally, we report on an integer programming model and the results of its application to real data.

Incentive to vaccinate: a synthesis of the two approaches

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Slovakia is one of the few European countries, where the obligatory vaccination is enacted by legislation. However, recent frequent mass media discussions of the adverse effects of the vaccination have gradually decreased compliance of parents: a shift from obligatory scheme to a voluntary has become an issue to response. In this paper we estimate the epidemiological situation after an abolition of compulsory vaccination. We introduce two approaches how to formally describe an incentive to vaccinate. In the first approach an equilibrium vaccination coverage is determined by a game theory concept, while in the second one the resulting equilibrium coverage is determined as the steady-state solution of the system of the differential equations. Both approaches are motivated by results of Bauch (2004, 2005). We make a synthesis of both approaches and discuss the results.

Stress testing for risk-averse stochastic programs

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Possible use of contamination technique in stress testing of risk measures Value at Risk (VaR) and Conditional Value at Risk (CVaR) was initiated in [D-P]. In this presentation we discuss several extensions of the approach, namely to stress testing for multistage risk-averse stochastic programs with CVaR related objectives, cf. [D-K], for static problems with polyhedral risk measures, cf. [D], and with spectral risk measures objectives.

References:

[D-P] J. Dupačová and J. Polívka: Stress testing VaR and CVaR, Quant. Financ. 7 (2007), 411–421.

[D-K] J. Dupačová and V. Kozmík: Structure of risk-averse multistage stochastic programs, to appear in OR Spectrum.

[D] J. Dupačová: Risk objectives in two-stage stochastic programming models, Kybernetika 44 (2004), 227–242.

Constructing Positive Reliable Numerical Solution for American Options: A New Front-Fixing Approach

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A new front-fixing transformation is applied to the Black-Scholes equation for the American option pricing problem. A new non-linear partial differential equation appears under this transformation. The transformed boundary conditions become homogeneous. This fact simplifies the construction of the numerical solution and analysis of the scheme. The numerical solution obtained by an explicit finite-difference method is positive and monotone. Stability and consistency of the scheme are studied. The explicit method is compared with implicit one based on the Newton method. The comparison with other methods shows that the proposed scheme is competitive because of its accuracy and efficiency.

Pareto optimal matchings

Pavlos Eirinakis[1]

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Consider a many-to-many matching market that involves two finite disjoint sets, a set of applicants A and a set of courses C. Each applicant has preferences on the different sets of courses she can attend, while each course has a quota of applicants that it can admit. In this paper, we examine Pareto optimal matchings (briefly POM) in the context of such markets, that can also incorporate additional constraints, e.g., each course bearing some cost and each applicant having an available budget. We provide necessary and sufficient conditions for a many-to-many matching to be Pareto optimal and show that checking whether a given matching is Pareto optimal can be accomplished in $O(|A|^2 \cdot |C|^2)$ time. Moreover, we provide a generalized version of serial dictatorship, which can be used to obtain any many-to-many POM. We also study some structural questions connected with POM. We show that, unlike in the one-to-one case, finding a maximum cardinality POM is NP-hard for many-to-many markets.

Well-Posedness and Comparison Principle for Option Pricing with Liquidity Shocks

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We consider a coupled system of a parabolic PDE and an ODE suggested by M. Ludkovski and Q. Shen (Int. J. Theor. Appl. Finan., 16(7), 2013) in European option pricing with liquidity shocks. We study the well-posedness and prove comparison principle for the corresponding initial value problem.

High order Combination Technique for the efficient Pricing of Basket Options

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In computational finance high dimensional problems arise, such as basket options, foreign-exchange (FX) options etc. Since the number of grid points grows exponentially with the dimension, the curse of dimensionality shows its effect very quickly, e.g. when pricing basket options. Sparse grids and the Combination Technique have proven their great ability to reduce the computational effort. In this article we introduce a fourth order scheme for the combination technique to efficiently solve high dimensional partial differential equations. In order to linearly combine the sub-solutions, we propose a tensor-based interpolation method. We show that our approach can preserve the error splitting structure of the sub-solutions and lead to a highly accurate sparse grid solution.

On the use of Archimedean copulas in chance-constrained programming

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We investigate the problem of linear joint probabilistic constraints with normally distributed constraints. We assume that the rows of the constraint matrix are dependent, the dependence is driven by a convenient Archimedean copula. We describe main properties of the problem and show how dependence modeled through copulas translates to the model formulation. We also develop an approximation scheme for this class of stochastic programming problems based on second-order cone programming.

Empirical Estimates in Stochastic Programs with Probabiity and Second Order Stochastic Dominance Constrained

Vlasta Kaňková[1]

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Stochastic programming problems with probability and stochastic dominance constraints belong to 'deterministic' problems depending on a probability measure. Moreover, the problems with stochastic dominance of second order can be written as a stochastic semi infinite programming problems (with a parameter belonging to all one-dimensional Euclidean space). According to Slater's constraints qualification a parameter set is usually restricted to a compact set. While to choose this compact set is not problem in the case of thin tailed distributions, it must be done very carefully in the case of heavy tailed distributions (especially stable distributions). The aim of the talk will be to discuss just this second case. Moreover, we focus on a situation when the 'underlying' distribution is replaced by empirical one. Theoretical results will be completed by a simulation investigation.

Dynamic Worst Case Portfolio Optimization via a Hamilton-Jacobi-Bellman Equation

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We consider a problem of dynamic stochastic portfolio optimization modeled by a Hamilton-Jacobi-Bellman (HJB) equation. Using the Riccati transformation the HJB equation is transformed to a simpler quasi-linear PDE. An auxiliary quadratic programming problem is obtained, which uses a vector of expected asset returns and a covariance matrix of returns as input parameters. Since this problem can be sensitive to the input data, we modify the problem from fixed input parameters to worst-case optimization over convex or discrete uncertainty sets both for asset returns and covariance matrix. Qualitative properties of the value function are analyzed along with providing illustrative numerical examples.

An Incomplete Market Approach to Employee Stock Option Valuation

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We relax the pervasive assumption of market completeness made in Employee Stock Option (ESO) valuation models, which use the first jump of an exogenous Poisson process to capture an exercise or a forfeiture of the ESO. The first jump comes as a sudden surprise, and the ESO payoff cannot be replicated exactly by trading in the underlying stock and risk-free account. The market is incomplete, but existing ESO valuation models assume that the risk connected to the Poisson jump is diversified away, and the ESO is valued on risk-neutral complete market principles. We do not ignore the market incompleteness and use dynamic programming to study ESO valuation, in which the ESO granting firm minimizes quadratic hedging errors with respect to the Poisson jump. We demonstrate that the risk of the sudden ESO payoff or forfeiture is not negligible, and the market completeness assumption should be considered carefully. Furthermore, we show that if the expected return of the underlying stock differs from the risk-free return, then an ESO is, in average, less costly than predicted by the complete market risk-neutral valuation, although the possible extra costs or gains might be substantial. On the other hand, if the stock expected return and risk-free return are the same, then the complete market risk-neutral approach provides the optimal value and hedge, at least, in the mean squared sense.

Semi-Stochastic Gradient Descent Methods

Jakub Konečný[1]

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In this work we study the problem of minimizing the average of a large number (n) of smooth convex loss functions. We propose a new method, S2GD (Semi-StochasticGradient Descent), which runs for one or several epochs in each of which a single full gradient and a random number of stochastic gradients is computed, following a geometric law. The total work needed for the method to output an ε-accurate solution in expectation, measured in the number of passes over data, or equivalently, in units equivalent to the computation of a single gradient of the loss, is $O(\log(1/\varepsilon))$. This is achieved by running the method for $O(\log(1/\varepsilon))$ epochs, with a single gradient evaluation and $O(\kappa)$ stochastic gradient evaluations in each, where κ is condition number of the problem. The SVRG method of Johnson and Zhang (SVRG) arises as a special case. To illustrate our theoretical results, S2GD only needs the workload equivalent to about 2.1 full gradient evaluations to find an 10^{-6}-accurate solution for a problem with $n = 10^9$ and $\kappa = 10^3$.

Representative utility functions in portfolio efficiency testing with respect to various stochastic dominance criteria

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We present linear formulations of stochastic dominance relations for testing whether a given portfolio is efficient with respect to all portfolios which can be created from the considered set of assets. The formulations are derived for several different types of stochastic dominance (N-th order stochastic dominance, decreasing absolute risk aversion stochastic dominance, increasing relative risk aversion stochastic dominance). Our approach is based on the theory of representative utility functions. Application to US historical stock market data is presented.

A quantitative approach to the theory of evolution of economic systems

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The new approach to the economic system modeling is presented. Such systems are assumed to be an unimodal systems determined by two factors: the autocatalytic growth and external limitations. Both factors and stability systems theory are incorporated into basic evolution equations. Their solutions are able to produce interesting prognosis of the evolution, the influence of the management, changes of the external environment (fluctuations, overheated economics). The correlation with the reality is excellent and shows practical solutions.

Methods for solving nonsmooth convex problems

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Many real-world problems may lead to minimization of a non-differentiable convex function of large number of variables. We study different approaches for solving these problems. We apply and compare two competing methods of convex optimization, namely proximal gradient method and interior-point method. In proximal gradient method we use three different versions known from literature. Approaches are compared, analyzed and a discussion on the performance is provided.

Impact of Luck on Performance Classification of Socially Responsible and Conventional Mutual Funds

Eva Kvasničková [1]

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In this paper we analyse performance of socially responsible (SR) equity mutual funds over the last two decades (1990-2013), comparing them to their conventional (non-SR) peers. We significantly enlarge the investigated sample of previous literature by including all mutual funds reported by Morningstar and extending the time span until 2013. Our performance study covers not only region-adjusted alpha evaluation on both portfolio and individual level, but also view on how funds performed with vintage (rolling window estimation), how they learn with time (expanding window), and survivorship analysis, showing how the proportions of died fund evolved in time. The second part of the paper, we estimate proportion of false-discoveries and zeroalphas for SR and conventional funds, together with estimates for lucky and unlucky proportions showing its evolvement during time and across the regions. In five of six regions we evaluated the false-discovery proportions higher for conventional funds than SR, confirmed by simulations. While identifying a "good" or "bad" manager, the false-discovery rate was almost twice as big in most regions for conventional funds, while SR funds appear to be more robust in performance classification.

Description of families of quasi-concave functions

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Concave and quasi-concave functions are widely used in deterministic and stochastic optimization. Unfortunately, their application is limited due to the fact that supremum, sum, product of quasi-concave functions are typically not quasi-concave. This difficulty is overcome by establishing of uniformly quasi-concave functions, due to Prékopa, Yoda and Subasi (2011). We generalize the definition to an arbitrary large family of functions and contribute with a new characterization of uniformly quasi-concave functions.

Nonstandard Finite Difference Scheme for a Nonlinear Black-Scholes equation with Transaction Costs

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We apply a nonstandard finite difference scheme to solve a nonlinear Black-Scholes equation with transaction cost arisen from the Barles and Soner volatility model. Furthermore, we compare results with other numerical methods that have been used for this nonlinear Black-Scholes model.

Investment Strategies in the Funded Pillar of the Slovak Pension System

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We present a dynamic model for optimal investment decisions in privately managed defined contribution pension plans. Stock prices are assumed to be driven by the geometric Brownian motion. Interest rates are modeled by means of the Cox-Ingersoll-Ross model. The model determines an optimal fraction of pensioner's savings to be invested in an equity fund, with the rest invested in a bond fund. Next, we present sensitivity analysis with respect to various relevant parameters. We also perform stress-testing of optimal investment decisions under different equity return scenarios. The entire analysis is carried out on the actual Slovak DC scheme and all model parameters are calibrated by the latest available data.

Numerical solution of a stochastic control problem of option pricing for a liquidity switching Market

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We consider the problem of European option pricing in a market which experiences instances of liquidity and illiquidity. Our model of market liquidity takes the form of a regime-switching continuous Markov process. We study the investor's problem of maximizing both terminal wealth and option payoff whose solution can be found as a solution of a semilinear coupled HJB equation. We present several numerical studies based on our model.

Derivative pricing with transaction costs using a stochastic utility maximization model

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The pricing of financial derivatives with transaction costs is one of the most important extensions of the traditional Black-Scholes model. Stochastic utility maximization models can be used for the pricing of derivatives under these conditions, in this type of models the price is found by computing the certainty equivalent of the portfolio with the option and compare it with the certainty equivalent of the portfolio without the option. One of the most well-known models of this kind was developed by Barles and Soner in 1998, it includes proportional transactions costs and considers an exponential utility function, they use it to price an European Call option. In this paper we present a study on the extension of the model developed by Barles and Soner in terms of a broader type of utility functions (such as HARA-type utility functions) and derivatives payoffs. We make use (as in the original model) of the stochastic dynamic programming principle to find the set of HJB equations whose solution will represent the certainty equivalent of both portfolios. The price of the derivative will be given by the difference of those two functions. We compare the solutions with the original model in particular in terms of the asymptotic analysis of these equations.

Truss structure design using a length-oriented surface remeshing technique

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We present a method that can be used for designing truss structures representing either minimal surface shapes or general free-form shapes. The structures are designed so that they meet some specific criteria concerning their aesthetic properties and especially the lengths of the truss elements. We explain a technique for tangential redistribution of points on evolving surfaces that allows to obtain equally sized truss elements in selected subsets of the structure. This technique is applied to surfaces evolving by their mean curvature yielding constructions that approximate minimal surface shapes. Afterwards, we show how to remesh static free-form surfaces.

Convexity adjustments for the pricing of futures and forwards

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The most common use of the term convexity adjustment is linked with the correction needed to more accurately capture the effect that changes in the interest rates have on the bond prices. However, convexity adjustments are used in a more general setting, to describe corrections used to price non-standard products by means of plain vanilla ones. It is therefore of extreme importance to the financial world because the correct computation of these adjustments allows corporations and investors to better evaluate exotic instruments. Futures and forwards differ on many levels such as structure, formality and demand. With our approach to the pricing of these kind of instruments we are interested in more technical differences, more specifically those regarding measures. Our main goal is to obtain a system partial differential equation that will return as solution the convexity adjustment $CA(t,T)$, having as starting point a term structure of the ATS type. Finally we present examples for some multidimensional stochastic models.

Solution to the inverse Wulff problem by means of the enhanced semidefinite relaxation method

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We propose a method for resolving the optimal anisotropy function. The method is based on resolving the optimal anisotropy function as a minimizer of the anisoperimetric ratio for a given Jordan curve in the plane. It can be viewed as a solution to the inverse Wulff problem. It leads to a nonconvex quadratic optimization problem with linear matrix inequalities. We solve this nonlinear programming problem by means of the so-called enhanced semidefinite relaxation method. It is based on solving a convex semidefinite problem obtained by a semidefinite relaxation of the original problem. We show that the sequence of finite dimensional approximations of the optimal anisoperimetric ratio converges to the optimal anisoperimetric ratio which is a solution of the inverse Wulff problem. Several computational examples, including those corresponding to real snowflakes boundaries and discussion on the rate of convergence of numerical method will be also presented in this talk.

A model of rational behaviour at limit order markets

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We consider an agent trading at a continuous-time limit order market, maximizing discounted consumption over an infinite time horizon while keeping the probability of bankruptcy (in a traded asset or in money) at a prescribed level. Possible strategy of the agent (and also of the other traders) is putting market order and/or a set of limit orders. The agent is, however, uncertain about what strategies the other agents take and which agent manages to apply his action first. We show that, given this setting, the optimal strategy of the agent depends only on the current shape of the order book, the agent's inventory of the traded asset and his uncertainty. We also present an empirical study supporting our findings given a simpler setting, in which the agent may post only single limit order.

Multinomial likelihood: the recession cone view

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The primal problem of finding maximum of the multinomial likelihood under convex constraints appear naturally in several statistical models, such as the marginal homogeneity models, isotonic cone models, the mean response models, multinomial-Poisson homogeneous models, among many others. Its Fenchel dual problem, as well as the relation between the solution sets of these problems, are considered. A crucial role is played by the notion of the recession cone. In addition, a perturbed primal problem is studied. Convergence (epi and pointwise) of the perturbed problems to the multinomial primal is established.

Option Price with dynamically correlated Stochastic Interest Rate

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In this work, we study the option pricing model with stochastic interest rate given by Vasicek stochastic differential equation and extend this model by incorporating local time dependent correlation between the underlying and the interest rate. Further, we compare the difference between using a constant and a dynamic correlation by analyzing some numerical results. Besides, we conduct an experiment on fitting the pricing model in either case of using constant and dynamic correlation to the real market option price. We find, in both case, the option pricing model could not be much appropriately fitted to the market option price, nevertheless, the case of using dynamic correlation is better. As a consequence, the option pricing can not really improved by incorporating stochastic interest rate even applying dynamic correlation.

On Fitted Finite Volume Splitting Operator Methods for the Valuation of Asian Options

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Asian options are exotic financial derivative products whose price must be calculated by numerical evaluation. The valuation of Asian options can often be reduced to the study of initial boundary value problems for ultraparabolic equations. First we derive fitted finite volume difference approximations for ultra-parabolic problems of fixed strike Asian options. Also, splitting methods are used to transform the whole time-dependent problem into two unsteady subproblems of small complexity. The positivity property of the numerical methods is established. Numerical experiments are discussed.

Dynamic oligopoly with sticky prices — off-steady-state analysis

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In this paper we present an extensive analysis of a dynamic model of oligopoly with sticky prices, both with open loop (strategies dependent on time) and feedback information structure (strategies dependent on price). We calculate both symmetric feedback Nash equilibria and all symmetric open loop Nash equilibria and compare resulting trajectories of price and production. Although our paper appears in a sequence of papers by various authors on a model of oligopoly with sticky prices (among others Ferthmann and Kamien [F-K], Cellini and Lambertini [C-L-2004], it appears to be the first paper in which the open loop Nash equilibrium was calculated for initial value of price which is not the steady state. Therefore, unlike in previous literature, our analysis allows us to study and compare closed loop and open loop Nash equilibria which are not constant over time. We prove that feedback equilibrium production is always greater or equal to the open loop equilibrium production, and strictly greater from some time instant on, with reverse inequality for prices. Moreover, equilibria are only piecewise differentiable. We also analyse behaviour of equilibrium price, production and aggregate production as functions of parameters of the model and we obtain, among others, monotone convergence of steady states of open loop Nash equilibrium price and production to analogous levels of the static Cournot-Nash equilibrium as the speed of adjustment tends to infinity, while for feedback convergence is to some nontrivial convex combination of the static Cournot-Nash equilibrium and the competitive equilibrium. For the paper see [W-B-M].

Keywords: Cournot oligopoly, dynamic model of oligopoly, differential game, sticky prices, Nash equilibrium, open loop, feedback.

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Equilibria and stable paths in infinite horizon nonlinear control problems with discrete time: the linear-quadratic approximation

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Nonlinear discrete time infinite horizon problems with discount are discussed. It is assumed that the problem without discount admits a nondegenerate steady state 'extremal' solution. Under this and certain additional hypotheses it is proved that for sufficiently mild discounts the steady state solution exists, for initial conditions sufficiently close to it the problem has a solution of the stable path type and that the solution can be approximated by the linear-quadratic truncation of the problem.

On the Converse of Hartwick's Result in a Multi-dimensional Model of an Economy with Exhaustible Resources

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An important role in finding conditions which would guarantee intergenerational equity in the sense that the consumption level is constant over time in an economy with exhaustible resources plays Hartwick's result: If along a competitive path the investments of renewable capital goods are provided only by the rents from exhaustible resources, then the consumption remains constant over time. The premise of this result, known as Hartwick's rule, gives sufficient condition for receiving constant consumption. Scientists are trying to make clear, under which conditions the converse of Hartwick's result is possible. In the contribution this question is discussed with respect to the price Hartwick's rule. There will be presented results, giving sufficient conditions, under which a price equitable path satisfies the price Hartwick's rule.

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