Conference Program and Book of Abstracts

Conference on Computational Management Science

Pricing, Risk and Optimization in Management Science

University of Bergamo, Georgia Institute of Technology and CMS Journal

Bergamo, Italy

May 30- June 1, 2017
Organising Committee

- Giorgio Consigli
- Rosella Giacometti
- Adriana Gnudi
- Mohammad Mehdi Hosseinzadeh
- Davide Lauria
- Francesca Maggioni
- Vittorio Morriggia
- Sergio Ortoberi
- Roberto Pinto
- Gabriele Torri
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- Sebastiano Vitali

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- Sandra Paterlini (EBS, GE)
- George Pflug (Univ. Vienna, AUT)
- Berç Rustem (Imperial College, UK)
- Rüdiger Schultz (Univ. Duisburg, GE)
- Alex Weissensteiner (Univ. of Bolzano/Bozen, IT)
WELCOME FROM THE ORGANISING COMMITTEE

It is a pleasure and honour to welcome you all on behalf of the Organising Committee, to the CMS2017 conference, which this year promises to confirm previous years’ successes and attract to our community colleagues and scholars from neighbor scientific domains. Thanks to an ongoing Excellence Initiative project on Computational Management and Applications funded by the University of Bergamo in cooperation with the Institute of Systems Engineering (ISyE) at GeorgiaTech, this year the conference features a cooperation between University of Bergamo, GeorgiaTech and the Journal of Computational Management Science. We would like to thank the colleagues from GeorgiaTech for their precious cooperation. Relative to previous CMS conferences we are also happy to underline the unprecedented geographical span of this year conference with colleagues coming not only from European countries and quite many from the United States but also from the Middle and Far East. We welcome an important delegation from Iran, whose Islamic Azad University is one of the largest Universities in the World and with whom UniBG has recently signed a strategic agreement.

The CMS conference established itself as 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 in management science. This year CMS J Special Issue will be edited by Professor Berc Rustem from Imperial College and by Professor Rosella Giacometti from UniBG, thanks to both for taking up this important duty.

The CMS2017 conference will devote this year a special emphasis on computational aspects related to large-scale-optimization and statistical learning applied to risk management and control problems in any management domain. The conference title is Pricing, Risk and Optimization in Management Science.

As in past annual Conferences, a Best Paper prize will be awarded to a paper presented by a young researcher and we thank the Euro Working Group on Stochastic Optimization for sponsoring the prize, that will be decided by a Jury formed by the colleagues Milos Kopa, Ruediger Schultz and Francesca Maggioni.

At the very start of the CMS conference, which comes the day after the extremely interesting Workshop in memory of Marida, we would also like to thank the UniBG colleagues who have actively cooperated to this event, the administrative staff, but also with special emphasis the colleagues of the Scientific Committee who have collaborated to outline a program, which promises to be extremely relevant and interesting.

Our best regards,

The Organising Committee
SPONSORS

Academic sponsors

University of Bergamo

Georgia Institute of Technology

CMS Journal

Euro Working Group on Commodities and Financial Modelling

Euro Working Group on Stochastic Optimization

Committee on Stochastic Programming (COSP)
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OVERVIEW OF EVENTS

Workshop in memory of Marida
On May 29, 2017 at 8:55, we have organized a workshop in memory of Marida Bertocchi in Sala Galeotti, in via dei Caniana, 2 that will terminate at 17:00. In the same room at 17:15 we will recall Marida’s career and some dates with photos and individual memories. This will last until the CMS2017 welcome reception at 18:30.

Plenary Lectures
Every Plenary Lecture lasts 50 minutes plus discussion. Plenaries take place in Sala Galeotti on May 30, 31 and June 1, at 14:15. A closing plenary by Francesca Maggioni is scheduled in the same room on June 1 at 16:45.

Parallel Sessions
Between May 30 and June 1, the CMS2017 program includes four parallel sessions with 4 speakers in the morning and 3 speakers in the afternoon. They are located in the main conference room Sala Galeotti and lecture rooms 10, 11 and 12.

Award - CMS Student Paper Prize
A student paper prize will be awarded at CMS2017 on Tuesday, May 30 at 16:45. The prize is kindly sponsored by the Euro Working Group on Stochastic Optimization (EWGSO). The award has been decided by a three-member jury formed by Prof. Milos Kopa (Chair of the EWGSO, Charles University of Prague), Prof. Ruediger Schultz (Chair of the committee and Editor in Chief of Computational Management Science, University of Duisburg) and Prof. Francesca Maggioni (University of Bergamo).

Special Issue CMS
The international Journal Computational Management Science is editing a special issue on the occasion of the CMS2017 conference. We invite recent contributions with a strong focus on the computational aspects of management science. Submission is not restricted to participants of the conference. Topics include theoretical and empirical analysis of computational models; computational statistics; analysis and applications of constrained, unconstrained, robust, stochastic and combinatorial optimization algorithms; dynamic models, such as dynamic programming and decision trees; new search tools and algorithms for global optimization, modeling, learning and forecasting; models and tools of knowledge acquisition. Manuscripts should be submitted via the CMS submission system, choosing special issue: “S.I.: CMS 2017”. Deadline for the submission of full papers: September 30, 2017. Additional information can be obtained from the guest editors: Rosella Giacometti, University of Bergamo Berc Rustem, Imperial College London

SOCIAL PROGRAM

Monday, May 29, 18:30-20:00
The welcome reception will take place in the hall (next to room Galeotti) of the University of Bergamo in via dei Caniana, 2.

Tuesday, May 30, 20:45 – 22:45
A concert performed by the Estudiantina Ensemble Bergamo will take place in Sala Greppi which is 8 minutes walking distance from University of Bergamo in via dei Caniana, 2.

Wednesday, May 31, 17:45 – 19:30
A two hour city tour in the Upper Town is available for Wednesday May 31 starting from Colle Aperto at 17:45. Special pick up services departing from the University at 17:00.

Wednesday, May 31, 20:00 – 23:00
Wednesday May 31, at 20:00 at the restaurant “Il Pianone” in the Upper Town. Special pick up services departing from the University at 19:30 and 19:45. Special pick up services departing from the restaurant at 23:00 and 23:30.
REGISTRATION AND GENERAL INFO

Badges required for conference sessions
Conference participants will collect the badge onsite upon registration and are required to carry it during the conference and to access the conference site.

CMS2017 Registration
Late registration fee can be paid upon arrival at the conference at the registration desk only with credit card, on May 29, 2017 or May 30, 2017 until 12:30.

Conference dinner tickets
Conference dinner tickets will be included in the conference bag.

Question and information
All the people from the organization with light blue badge’s lanyard will be available for any type of information.

Internet access
Each participant will have his/her own Wi-Fi account in the conference bag.

Food
Food is available from 12:00 to 14:00 at the University cafeteria ("Mensa") or in nearby bars and restaurants:

- "La Fricca"
  Via Previtali, 18
  (Wednesday and Sunday closed)
- "Da Nasti"
  Via Zambonate, 25
  (Monday and Sunday closed)
- "Marechiaro"
  Via Borgo Palazzo, 2
- "Da Mimmo"
  Via Colleoni, 17 (Upper Town)
- "Da Franco"
  Via Colleoni, 8 (Upper Town)

SPEAKER AND CHAIR INFORMATION

Speaker guidelines
A laptop is available in each room and it is connected to a video beamer. White board is also available in each room.

The Chair session must have available the presentations before the starting of the session. They have to keep on time to allow people to move from one session to another. Time your presentation to fit within the designated time schedule leaving enough time for audience questions and change of speaker.

Chair guidelines
The role of the Chair is to coordinate the smooth running of the session and introduce each speaker.

The time available for each type of talk is the following:

- Plenary: 50 minute talks plus 10 minutes for questions
- Parallel: 25 minute talks including questions

Assistance during your session
A person from the organizing committee with light blue badge’s lanyard will be available in each conference room.
Workshop in memory of Marida Bertocchi

Facing risk ... sometimes with negative interest rates

University of Bergamo and EWGCFM

Bergamo, Italy

May 29, 2017 – Sala Galeotti
## WORKSHOP IN MEMORY OF MARIDA BERTOCCHI

Monday, May 29 - Room Galeotti

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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</table>
| 8:55-10:30 | Chair: Giorgio Consigli  
Marida and my research in finance  
Grazia Speranza  
It all started in Bergamo: stochastic debt sustainability analysis  
Stavros Zenios  
Pension and Retirement Models remembrances of my cooperation with Marida  
Bill Ziemba |
| 10:30-11:00 | Coffee break                                                                                      |
| 11:00-12:30 | Chair: Adriana Gnudi  
Systemic risk governance in a dynamical model of a banking system  
Francesco Zirilli  
Multiobjective Portfolio Optimization with Diversification in View  
Giovanni Zambruno  
Multiperiod optimization: from stochastic programming to discrete time optimal control  
Elio Canestrelli |
| 12:30-14:00 | Lunch break                                                                                     |
| 14:00-17:00 | Chair: Rita D'Ecclesia  
Sensitivity and distributional robustness in financial optimization  
Georg Pflug  
Dynamic Asset Pricing approach to behavioral finance  
Zari Rachev  
Market risk implied in option prices  
Giovanni Barone-Adesi  
A practical long term yield curve model  
Micheal Dempster  
Optimization Perspective  
Francesco Archetti |
| 17:15 | Marida's greetings: photos and friends' memories |
### SCIENTIFIC SCHEDULE

Tuesday, May 30, Morning

#### [Room Galeotti] Opening of CMS2017 and welcome by Giorgio

<table>
<thead>
<tr>
<th>Room</th>
<th>Session</th>
<th>Time</th>
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<tbody>
<tr>
<td>Galeotti</td>
<td>Stream</td>
<td>08:45</td>
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</tbody>
</table>

#### [Room Galeotti] New Trends in Optimization under Uncertainty
**Chair:** Wolfram Wiesemann

- Distributionally Robust Mechanism Design
  - Cagil Kocyigit
- From Data to Decisions: Distributionally Robust Optimization is Optional
  - Daniel Kuhn
- Regularization via Mass Transportation
  - Soroosh Shafieezadeh Abadeh
- Scenario Reduction Revisited: Fundamental Limits and Guarantees
  - Napat Rujeerapaiboon

#### [Room 10] Uncertainty and Energy
**Chair:** Stein-Erik Fleten

- Benders decomposition applied to a stochastic multi-horizon power system planning model
  - Christian Skar
- Regulatory Uncertainty and Real Options in Switching of Peaking Generators
  - Steiin Erik Fleten
- Techno-economic analysis of power dispatch in medium voltage networks
  - Paolo Piscella
- Multihorizon stochastic programming for energy system design
  - Asgeir Tomasgard

#### [Room 11] Data Envelopment Analysis
**Chair:** Farhad Lofti Hosseinzadeh

- Efficiency evaluation and benchmarking in multi-stage network: A DEA approach
  - Hamidreza Rezaei Kelidbari
- Efficiency evaluation of a Supply Chain with damaged products
  - Bijan Rahman Parchikolaei
- Global Efficiency evaluation: A Data envelopment analysis approach
  - Mohsen Vaez-Ghasemi
- Robust two-stage dynamic DEA models under discrete uncertain data: A case study
  - Mohammad Fallah

#### [Room 12] Financial Market Models and Portfolio Optimization
**Chair:** Aaron Young Shin Kim

- Assessing model risk in post-modern portfolio construction
  - Stoyan Stoyanov
- Dynamic orderings consistent with preferences
  - Sergio Ortobelli
- Option valuation for dynamic jump-diffusion models with cross-feedback effect
  - Fumin Zhu
- Portfolio Optimization in the Multivariate Mixed Tempered Stable framework
  - Edit Rroji

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### SCIENTIFIC SCHEDULE

Tuesday, May 30, Morning

#### [Room Galeotti] Advances in data-driven optimization
**Chair:** Daniel Kuhn

- Robust Dual-Response Optimization
  - Ihsan Yanikoglu
- A Coverage Theory for Least Squares
  - Algo Caré
- Efficient Algorithms for Robust MDPs with State Rectangularity
  - Clint Chin Pang Ho
- Risk and complexity in scenario optimization
  - Simone Garatti

#### [Room 10] Algorithms and SP computations advances
**Chair:** Sjur D. Flåm

- BFC methods with primal-dual methods for multistage mixed nonlinear convex stochastic problems
  - Eugenio Mijangos
- Block-Coordinate Methods and Stochastic Programming
  - Sjur Didrik Flåm
- Optimality Conditions and Algorithms for Nonlinear Chance Constrained Problems
  - Martin Branda
- Scenario-based Learning for Stochastic Combinatorial Optimisation
  - David Hemmi

#### [Room 11] Orderings and optimal choices
**Chair:** Sergio Ortobelli

- Long and Short Memory in the Risk-neutral Pricing Process
  - Aaron Young Shin Kim
- Multivariate dominance among financial sectors
  - Noureddine Kouaissah
- Parametric dominance rules for heavy tailed distributions
  - Tommaso Lando
- Using the Shapley Value of Optimal Portfolios for Systematic Risk
  - Haim Shalit

#### [Room 12] Dependence modelling in finance
**Chair:** Rosella Giacometti

- A metric for extreme value distributions
  - Corina Birghila
- Effects of Diversification and Capital Buffers on the EU Sovereign-Bank Network
  - Margherita Giuzio
- Modelling Multidimensional Extremal Dependence for Operational Risk
  - Sandra Paterlini
- Using Robust and Sparse Networks to capture Systemic Risk
  - Rosella Giacometti
### Optimization

**Room Galeotti**

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<tr>
<td>Robust and Data-Driven Optimization</td>
<td>Phebe Vayanos</td>
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<tr>
<td>Ambiguous Risk Constraints with Moment and Unimodality Information</td>
<td>Ruiwei Jiang</td>
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<tr>
<td>Optimization of tree ensembles</td>
<td>Velibor Misic</td>
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<tr>
<td>Robust Wait Time Estimation in Resource Allocation Systems with an Application to Kidney Allocation</td>
<td>Phebe Vayanos</td>
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### Computation

**Room 10**

<table>
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<tr>
<td>Computational Optimisation for Engineering Networks</td>
<td>Ruth Misener</td>
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<tr>
<td>A path-based ILP formulation for the Hydro Unit Commitment and Scheduling problem</td>
<td>Dimitri Thomopoulos</td>
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<tr>
<td>Chance-constrained formulation and solution of hydro scheduling</td>
<td>Enrico Malaguti</td>
</tr>
<tr>
<td>Piecewise Parametric Structure in the Pooling Problem: from Sparse Strongly-Polynomial Solutions to NP-Hardness</td>
<td>Radu Baltean-Logojan</td>
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### Management and Decision Theory

**Room 11**

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<tr>
<td>Business and economic innovation methods</td>
<td>David Anzola</td>
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<tr>
<td>Accelerating business innovation through emergent computation models and methods</td>
<td>David Anzola</td>
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<tr>
<td>Insurance literacy of Romanian citizens and the demand for life insurance: a spatial econometric analysis</td>
<td>Ingrid-Mihaela Dragota</td>
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<tr>
<td>System modeling of scientific research center as a base architecture of knowledge management and innovation</td>
<td>Dilmurod Azimov</td>
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### Finance

**Room 12**

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<tr>
<td>Stochastic dominance in portfolio optimization</td>
<td>Miloš Kopa</td>
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<tr>
<td>Multidimensional stochastic dominance in portfolio optimization</td>
<td>Barbora Petrová</td>
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<tr>
<td>Pension fund ALM with stochastic dominance constraints and hedging derivatives</td>
<td>Sebastiano Vitali</td>
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<tr>
<td>Portfolio optimization based on third-degree stochastic dominance</td>
<td>Miloš Kopa</td>
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The selected best 3 articles from young researchers are presented in this session.

### CMS2017 Best Paper Prize Presentations

**Room Galeotti**

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<tr>
<td>Computational Aspects of SP and Economics</td>
<td>Vladimir Shikhman</td>
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<tr>
<td>An Adaptive Model with Joint Chance Constraints for a Hybrid Wind-Conventional Generator System</td>
<td>Bismark Singh</td>
</tr>
<tr>
<td>Computation of Fisher-Gale equilibrium by auction</td>
<td>Vladimir Shikhman</td>
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### Management and Decision Theory

**Room 11**

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<tr>
<td>Risk models and applications</td>
<td>Loretta Mastroeni</td>
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<tr>
<td>A Study on the Run Length Distribution of the Group Runs Xbar Chart</td>
<td>Zhi Lin Chong</td>
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<td>On Quantile Risk Measures</td>
<td>Ruben Schlotter</td>
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### Finance

**Room 12**

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<td>Dynamic financial management</td>
<td>Sebastiano Vitali</td>
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<td>Pension fund selection model using multi-stage stochastic programming with Monte Carlo simulation</td>
<td>Audrius Kabasinskas</td>
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<tr>
<td>Optimal scenario-based financial planning under stochastic correlations</td>
<td>Mehdi Hosseinzadeh</td>
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<tr>
<td>Dividend Policy and Culture</td>
<td>Hanaan Yaseen</td>
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## Optimization

| Room Galeotti | Adaptive robust optimization  
Chair: Frans de Ruiter |
|---------------|--------------------------|
| Duality in two-stage linear and nonlinear adaptive robust optimization  
Chair: Frans de Ruiter |
| Piecewise Affine Policies for Two-Stage Adjustable Robust Optimization  
Chair: Omar El Housni |
| Robust Dual Dynamic Programming  
Chair: Angelos Tsoukalas |

| Room 10 | Network models and Risk management  
Chair: Paolo Giudici |
|---------|-----------------------------------|
| Bank distress in news and financial data  
Paola Cerchielo |
| Identifying Systemically Important Financial Institutions: A Network Approach  
Alessandro Spelta |
| Measuring contagion risk in international banking  
Paolo Giudici |
| Scoring Models for P2P Lending Platforms: A Network-Based Approach  
Branka Hadji-Misheva |

| Room 11 | Robust portfolio optimization  
Chair: Fraydoon R. Roodposhti |
|---------|--------------------------------|
| Developing a robust-fuzzy multi-objective optimization model for portfolio selection  
Mohammad Salehifar |
| Fuzzy cognitive maps Approach for Portfolio selection  
Tayebeh Zanganeh |
| Gold as a Safe Haven for Stock Markets: A Regime Switching Approach  
Soheila Naderi |

| Room 12 | Applications of Stochastic Optimization in Energy  
Chair: Shabbir Ahmed |
|---------|--------------------------------|
| A hybrid Stochastic dynamic programming - Tabu Search approach for long-term energy planning  
Yves Mbeutcha |
| The Cost of Time-Inconsistent Long-term Hydrothermal Operation Policies Induced by Short-Term Modeling Simplifications  
Alexandre Street |
| The Information Collecting Vehicle Routing Problem: Stochastic Optimization for Emergency Storm Response  
Lina Al-Kanj |
| Stochastic Dual Dynamic Integer Programming  
Shabbir Ahmed |

### Uncertainty in Logistics and Transportation

| Room Galeotti | Uncertainty in Logistics and Transportation  
Chair: Francesca Maggioni |
|---------------|-----------------------------------------------|
| A Branch-and-Cut Approach for the Vehicle Routing Problem with Stochastic Demands under an Optimal Restocking Re- 
course Policy  
Michel Gendreau |
| Risk-Averse Stochastic Path Detection  
Stephan Meisel |
| The Value of the Right Distribution, with application to Service Operations Management  
Luca Bertazzi |
| Stochastic Programming Models for bike-sharing problems  
Matteo Cagnolari |

| Room 10 | Financial Modelling  
Chair: Alex Weissensteiner |
|---------|------------------|
| A mathematical framework for testing individual long term asset allocation strategies  
Kourosh Marjani Rasmussen |
| Correlated noise: Why passive investments might improve market efficiency  
Alex Weissensteiner |
| Panel Vector Autoregression in R: The panellr Package  
Robert Fersl |
| Portfolio Optimization of Commodity Futures with Seasonal Components and Higher Moments  
Thomas Bjerring |

| Room 11 | Robust game theory and equilibrium  
Chair: Abdel Lisser |
|---------|------------------|
| Distributionally Robust Games with an Application to Supply Chain  
Shaoqian Qu |
| Distributionally Robust Games with Risk-Averse Players  
Nicolas Loizou |
| Dual decomposition approach for dynamic spatial equilibrium models  
Giorgia Oggioni |
| Variational inequality formulation of chance-constrained games  
Abdel Lisser |

| Room 12 | Power sector  
Chair: Paolo Falbo |
|---------|---------------|
| Analysis of long-term natural gas contracts with Vine copulas in optimization portfolio problems  
Maria Elena De Giuli |
| Energy-mix equilibrium in a two stage electricity market with risk averse producers  
Paolo Falbo |
| Optimal Energy Supply Shift with Battery Storages  
Cristian Pelizzari |
| Solving multi-stage renewable capacity expansion problems under uncertainty  
Ruth Domínguez |
### Financial market with no riskless (safe) asset

Svetlozar (Zari) T. Rachev

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<th>Energy</th>
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| [Room Galeotti] Transportation and logistics  
  Chair: Francesca Vocaturo  
  A Branch-and-Cut Algorithm for the Periodic Rural Postman Problem with Irregular Services  
  Francesca Vocaturo  
  Stochastic optimization models for a distribution network with transshipment  
  Rossana Cavagnini  
  Some ideas on integrating lift-and-project cuts into decomposition methods for solving two-stage stochastic programming problems with binary first-stage variables  
  Achim Koberstein | [Room 11] Scheduling and Location Problems  
  Chair: Pedro Godinho  
  Adaptive policies based on the starting times and project state for stochastic multi-mode project scheduling  
  Pedro Godinho  
  Vehicle scheduling based on the similarity of planning units  
  Balazs David | [Room 12] Applications in the energy sector  
  Chair: Maria Teresa Vespucci  
  Big Data Analytics: an aid to detection of non-technical losses in Power Utility  
  Giovanni Micheli  
  Fast Near-Optimal Heuristic for the Short-Term Hydro-Generation Planning Problem  
  Alexia Marchand  
  Forecasting Italian electricity market prices using a Neural Network and a Support Vector Regression  
  Federica Davò |

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### Bergamo Upper Town “Città Alta” tour

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### Conference dinner
Thursday, June 1, Morning

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<th>COMPUTATION</th>
<th>ENERGY – FINANCE</th>
<th>FINANCE</th>
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<tr>
<td>Distributionally Robust Newsvendor Problem with Variation Distance Guzin Bayraksan</td>
<td>(Open-Source) Multi-stage Scenario Generation Ronald Hochreiter</td>
<td>High-dimensional risk-constrained dynamic portfolio optimization with transactional costs and time-dependent returns Davi Valladao</td>
<td>Multi-period and Multiportfolio Credit Risk Factor Models Martin Smid</td>
</tr>
<tr>
<td>Variance reduction for restricted strong convexity Huan Xu</td>
<td>Stochastic Dynamic Programming Using Optimal Quantizers Anna Timonina-Farkas</td>
<td>Volatility vs. downside risk: performance protection in dynamic portfolio strategies Diana Barro</td>
<td>Simulation and Validation of Models for Interest Rate Risk Johan Hagenbörk</td>
</tr>
</tbody>
</table>

OPTIMIZATION

- Convex approximations for risk-averse stochastic integer programming Ward Romeijnders
- Expected Conditional Stochastic Dominance (ECSD). A new time-consistent risk averse measure in stochastic optimization Laureano Fernando Escudero
- Efficient methods for several classes of ambiguous stochastic programming problems under mean-mean absolute deviation information Krzysztof Postek
- Probability maximization by inner approximation Csaba Fabian

COMPUTATION

- Covariance Estimation in Minimum Variance Portfolios: Is There a Best Method? Gabriele Torri
- Working on portfolio weights: aggregation strategies versus regularized methods Giovanni Bonaccolto
- Sparse Portfolio Construction via the ordered L1 Norm Philipp Johannes Kremer
- Q-Learning and SARSA: Machine learning-based stochastic control approaches for financial trading Marco Corazza

ENERGY – FINANCE

- A Space-Time Random Field Model for Electricity Forward Prices Florentina Paraschiv
- On the Construction of Hourly Price Forward Curves for Electricity Prices Audun Sæther
- Risk premia measured by insurance prices and model uncertainty Debora Daniela Escobar
- Valuation of the flexibility of power-to-gas facilities Michael Schürle

FINANCE

- A stochastic programming model for optimal risk control with financial derivatives Vivek Varun
- European option pricing under cumulative prospect theory with alternative probability weighting functions Martina Nardon
- Hybrid tree-finite difference methods for the Heston, Bates and Heston Hull-White models Antonino Zanette
- Large scale evaluation of derivative pricing methods Pontus Söderbäck
"Dice"-sion Making under Uncertainty: When Can a Random Decision Reduce Risk?
Wolfram Wiesemann

Round table on "The future of Optimization under uncertainty": Giorgio Consigli and Sergio Ortobelli
interview proff Laureano Escudero, Zari Rachev, Berc Rustem and Bill Ziemba

Bounding Approaches for Multistage Stochastic and Robust Optimization Problems
Francesca Maggioni
**RELEVANT PLACES**

- **Social dinner**
  Ristorante Il Pianone
  Via al Pianone 21
  24121 Bergamo

- **Meeting Point**
  Colle Aperto
  24126 Bergamo

- **Railway station**
  Piazzale Marconi
  24100 Bergamo

- **Concert location**
  Sala Greppi
  Via Greppi, 6
  24126 Bergamo

- **Conference venue**
  University of Bergamo
  Dept. of Management, Economics and Quantitative Methods
  Via dei Caniana, 2
FLOOR PLANS

FIRST FLOOR

SECOND FLOOR

THIRD FLOOR

BASEMENT

Main entrance via dei Caniana, 2
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<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Event Description</th>
<th>Location</th>
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<tbody>
<tr>
<td><strong>Monday, May 29</strong></td>
<td><strong>08:55-17:00</strong></td>
<td>Workshop in memory of Marida</td>
<td>University of Bergamo</td>
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<td><strong>17:15-18:00</strong></td>
<td>Memories of Marida: photos and personal witnesses, her scientific career</td>
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<td><strong>18:30-20:00</strong></td>
<td>CMS2017 Welcome reception</td>
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<tr>
<td><strong>Tuesday, May 30</strong></td>
<td><strong>08:45-09:00</strong></td>
<td>CMS2017 Opening remarks</td>
<td>University of Bergamo</td>
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<td><strong>20:45-22:45</strong></td>
<td>CMS2017 Concert</td>
<td>Sala Greppi, Down Town</td>
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<td><strong>Wednesday, May 31</strong></td>
<td><strong>09:00-10:40</strong></td>
<td>Parallel</td>
<td>University of Bergamo</td>
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<td><strong>17:45-19:30</strong></td>
<td>Bergamo Upper Town &quot;Città Alta&quot; tour</td>
<td>Colle Aperto, Upper Town</td>
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<td><strong>20:00-23:00</strong></td>
<td>Social Dinner</td>
<td>Il Pianone, Upper Town</td>
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<td><strong>Thursday, June 1</strong></td>
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<td><strong>15:15-16:15</strong></td>
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<td><strong>16:45-17:45</strong></td>
<td>Closing Plenary</td>
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Tuesday, May 30, 14:15-15:15

Time and Dynamic Consistency of Risk Averse Stochastic Programs

Alois Pichler

Time consistency has been addressed by many authors, going back to original work by Richard Bellman. The basic idea of the dynamic principle is that a policy designed at the first stage, before observing realizations of the random data, should not be changed at later stages of the decision process. This is a rather vague principle since this leaves a choice of optimality criteria at every stage of the process conditional on an observed realization of the random data. We discuss this from the point of view of modern theory of risk averse stochastic programming. In particular we discuss time consistent decision making by addressing risk measures which are recursive, nested, dynamically or time consistent. It turns out that the paradigm of time consistency is in conflict with various desirable, classical properties of general risk measures.

Speaker Scientific Summary

Alois Pichler started his academic career at the University of Vienna. He then was working at NTNU (Norway) before accepting his current appointment at the University of Technology in Chemnitz, Germany. His interests are based on his experience in the financial industry. They include stochastic optimization, actuarial sciences and all aspects of risk. Further information here.

Wednesday, May 31, 14:15-15:15

Financial market with no riskless (safe) asset

Svetlozar T. Rachev

We study markets with no riskless (safe) asset. We derive the corresponding Black-Scholes-Merton option pricing equations for markets where there are only risky assets which have the following price dynamics: (i) continuous diffusions; (ii) jump-diffusions; (iii) diffusions with stochastic volatilities, and; (iv) geometric fractional Brownian and Rosenblatt motions. No arbitrage and market completeness conditions are derived in all four cases.

Speaker Scientific Summary

Prof. Svetlozar (Zari) T.Rachev was a co-founder and President of BRAVO Risk Management Group -originator of the Cognity methodology, which was acquired by FinAnalytica where he serves as Chief Scientist. Rachev holds Chair-Professorship in Statistics, Econometrics and Mathematical Finance at University of Karlsruhe, and Frey Family Foundation Professor at Department of Applied Mathematics & Statistics, Stony Brook University; He is the author of 12 books and over 300 published articles on finance, econometrics, statistics and actuarial science. At University of California at Santa Barbara, he founded the Ph.D. program in mathematical and empirical finance. Rachev holds PhD (1979) and Doctor of Science (1986) degrees from Moscow University and Russian Academy of Sciences. Rachev's scientific work lies at the core of Cognity's newer and more accurate methodologies in risk management and portfolio analysis.
Thursday, June 1, 14:15-15:15

"Dice"-sion Making under Uncertainty: When Can a Random Decision Reduce Risk?

Wolfram Wiesemann

Stochastic programming and distributionally robust optimization seek deterministic decisions that optimize a risk measure, possibly in view of the most adverse distribution in an ambiguity set. We investigate under which circumstances such deterministic decisions are strictly outperformed by random decisions which depend on a randomization device producing uniformly distributed samples that are independent of all uncertain factors affecting the decision problem. We find that in the absence of distributional ambiguity, deterministic decisions are optimal if both the risk measure and the feasible region are convex, or alternatively if the risk measure is mixture-quasiconcave. Several classes of risk measures, such as mean (semi-)deviation and mean (semi-)moment measures, fail to be mixture-quasiconcave and can therefore give rise to problems in which the decision maker benefits from randomization. Under distributional ambiguity, on the other hand, we show that for any ambiguity averse risk measure there always exists a decision problem (with a non-convex, e.g., mixed-integer, feasible region) in which a randomized decision strictly dominates all deterministic decisions.

Speaker Scientific Summary

Wolfram Wiesemann is Associate Professor of Management Science and Operations as well as Fellow of the KPMG Centre for Advanced Business Analytics at Imperial College Business School, London. Before joining the faculty of Imperial College Business School in 2013, he was a post-doctoral researcher at Imperial College London (2010-2011) and an Imperial College Research Fellow (2011-2012). He was a visiting researcher at the Institute of Statistics and Mathematics at Vienna University of Economics and Business, Austria, in 2010, the Computer-Aided Systems Laboratory at Princeton University, USA, in 2011, and the Industrial Engineering and Operations Research Department at Columbia University, USA, in 2012. Wolfram's research interests revolve around the methodological aspects of decision-making under uncertainty, as well as applications in operations management, energy and finance.

Thursday, June 1, 16:45-17:45

Bounding Approaches for Multistage Stochastic and Robust Optimization Problems

Francesca Maggioni

Real world decision problems are usually dynamics and affected by uncertainty. Stochastic Programming and Robust Optimization provide two important modeling frameworks able to manage uncertain data in a multi-period decision making process. However such a kind of problems, involving sequences of decisions over time, are usually hard to solve. For this reason approximation techniques which replace the original problem by a simpler one and provide lower and upper bounds to the optimal value are very useful in practice. In this talk bounding and sampling methods for multistage problems affected by uncertainty both in stochastic programming and robust optimization frameworks are discussed. In the context of multistage stochastic programs we consider bounds based on the assumption that a sufficiently large discretized scenario tree describing the problem uncertainty is given but is unsolvable. Monotonic bounds based on group subproblems will be discussed and compared in terms of computational complexity. In the context of multistage robust optimization, the dynamic nature of the problem is tackled via the so-called scenario-with-certificates approach and the uncertainty by constraint sampling. An explicit bound on the probability of violation of the randomized solution and a chain of inequalities among lower bounds to the original problem are provided. Numerical results show the efficacy of the proposed approaches.

Speaker Scientific Summary

Francesca Maggioni is an Assistant Professor of Operations Research at the Department of Management, Economics and Quantitative Methods at University of Bergamo (ITALY). She is habilitated as Associate Professor of Operations Research and Mathematical Methods in Economics and Finance. She was a visiting researcher at the Isaac Newton Institute for Mathematical Sciences in Cambridge, Lancaster University Management School, Molde University College in Norway, University of Newcastle, University of Maryland, University of Vienna and CIRRELIT in Montreal. Her research interests center on optimization of sequential decision problems under uncertainty using different methodologies like Stochastic Programming and Robust Optimization. The applications considered are mainly in logistics, energy and biology areas. Further information here.
### OPTIMISATION

**[Room Galeotti]** New Trends in Optimization under Uncertainty  
*Chair(s): Wolfram Wiesemann*

<table>
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<th>Title</th>
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<tr>
<td><strong>Distributionally Robust Mechanism Design</strong></td>
<td>Cagil Kocyigit</td>
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<td>We study a mechanism design problem in which a seller aims to sell an indivisible good to multiple buyers. We model the buyers’ values as random variables following a probability distribution in some ambiguity set. We assume that the seller is ambiguity averse and that the buyers have Knightian preferences. We investigate the optimal and the best efficient mechanisms for different classes of ambiguity sets, and we show that the optimal mechanism may exploit a randomized allocation rule to generate significantly higher worst-case expected revenues than the best second price auction.</td>
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<td><strong>From Data to Decisions: Distributionally Robust Optimization is Optimal</strong></td>
<td>Daniel Kuhn, Bart Van Parys, Peyman Mohajerin Esfahani</td>
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<td>Data-driven stochastic programming aims to find a procedure that transforms time series data to a near-optimal decision (a prescriptor) and to a prediction of this decision’s expected cost under the unknown data-generating distribution (a predictor). We propose a meta-optimization problem to find the least conservative predictors and prescriptors subject to constraints on their out-of-sample disappointment. Leveraging tools from large deviations theory, we prove that the best predictor-prescriptor pair is obtained by solving a distributionally robust optimization problem.</td>
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<td><strong>Regularization via Mass Transportation</strong></td>
<td>Soroosh Shafieezadeh Abadeh</td>
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<td>In this talk we introduce new regularization techniques using ideas from distributionally robust optimization, and we give new probabilistic interpretations to existing techniques. Specifically, we propose to minimize the worst-case expected loss, where the worst case is taken over the ball of all distributions that have a bounded transportation distance from the empirical distribution. By choosing the radius of this ball judiciously, we can guarantee that it contains the unknown data-generating distribution with high confidence, thus facilitating new out-of-sample performance guarantees.</td>
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<td><strong>Scenario Reduction Revisited: Fundamental Limits and Guarantees</strong></td>
<td>Napat Rujeerapaiboon, Kilian Schindler, Daniel Kuhn, Wolfram Wiesemann</td>
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<td>The goal of scenario reduction is to approximate a discrete distribution with another discrete distribution that has fewer atoms. We distinguish continuous scenario reduction, where the new atoms may be chosen freely, and discrete scenario reduction, where the new atoms are chosen from among the existing ones. Using Wasserstein distance to measure proximity between distributions, we analyze the added benefit of continuous over discrete scenario reduction. We also propose polynomial-time constant-factor approximations and exponential-time exact algorithms for both types of scenario reduction.</td>
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### COMPUTATION

**[Room 10]** Uncertainty and Energy  
*Chair(s): Stein-Erik Fleten*

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<tr>
<td><strong>Benders decomposition applied to a stochastic multi-horizon power system planning model</strong></td>
<td>Christian Skar, Pedro Crespo del Granado</td>
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<td>The European power system planning model EMPIRE applies multi-horizon stochastic programming to optimize investments in generation, transmission and storage capacities subject to operational uncertainty. System operation optimization is embedded. In this presentation we will discuss the relation between the multi-horizon formulation of EMPIRE and two-stage SPs, and how to apply Benders decomposition to allow for high temporal</td>
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detail in the operational modeling. Finally, we will present computational results from an implementation of the algorithm tested on a high performance computing cluster.

Stein-Erik Fleten, Marius Johansen, Alois Pichler, Carl Ullrich

Regulatory Uncertainty and Real Options in Switching of Peaking Generators

This paper examines empirically how regulatory uncertainty, strategic interactions and other factors affect managers decisions to switch between operating and stand-by states for peaking electric power generators. We use structural estimation, where the switching decisions are assumed to be governed by a real options model. We focus on the power markets in the Northeastern United States, where annual observations of such decisions are available. The results indicate that regulatory uncertainty significantly increases firms’ perception of switching costs.

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

Techno-economical analysis of power dispatch in medium voltage networks

We consider the problem of economic efficiency in Active and Reactive power redispatch in a medium voltage AC power network. The redispatch is particularly important when renewable power sources are installed in the network. The problem of optimal redispatching considers both economical and technical aspects through the minimization of total costs for the usage of the resources, constrained by nodal balance equations, power flow equations, upper and lower bound on line current, inter-temporal battery level constraints and local reactive power control by means of droop curves.

Asgeir Tomasgard

Multihorizon stochastic programming for energy system design

The paper presents multi horizon stochastic programming applied to energy system design. Different policies and applications are studied. For the analysis we use the EMPIRE model, a multi-horizon stochastic investment model for the European power system that combines long-term capacity expansion with operational modeling under different load and generation as well as a stochastic version of the energy system model TIMES.

MANAGEMENT AND DECISION THEORY
[Room 11] Data Envelopment Analysis
Chair(s): Farhad Lofti Hosseinzadeh

Hamidreza Rezaei Kelidbari, Zohreh Moghaddas

Efficiency evaluation and benchmarking in multi-stage network: A DEA approach

This paper investigated sugar plants’ efficiency in different stages as well as the whole process and determining some relations for benchmarking and reaching efficient status. In doing so, a multi-stage data envelopment analysis model is formulated. The obtained results from showed those units with good and weak performances. Also, the results for benchmarking showed to what extent each of the outputs should be changed in each of the stages for reaching the efficient conditions.

Bijan Rahmani Parchikolaei

Efficiency evaluation of a Supply Chain with damaged products

Here a supply chain is assessed considering DEA technique. In this chain products which are damaged existed. For assessing this system a four-stage DEA model mooted in order to consider the situation in which there exist damaged products which should be returned to the previous stages to be fixed. These returned products are the inputs of previous sub-processes that need to be processed again due to existence of flaws. Here a supply chain with four stages as supplier, manufacture, distributor and retailer with intermediate and return products has been considered and a DEA model formulated.

Mohsen Vaez-Ghasemi

Global Efficiency evaluation: A Data envelopment analysis approach

In classical Data Envelopment Analysis model for efficiency measurement in various time periods technology variations have not been considered. Also, considering data envelopment analysis approach for deriving Malmquist productivity index a specific score for efficiency will not be resulted. Thus, in this study considering
DEA axioms, a quasi-concave frontier for deriving efficiency score in different periods while time value of money has also be accounted for is presented.

Mohammad Fallah, Amir Mohajeri, Farbod Estiri

Robust two-stage dynamic DEA models under discrete uncertain data: A case study

Dynamic Data envelopment analysis is a well-known non-parametric technique for evaluating the relative efficiency of decision-making units (DMUs) which consume multiple inputs to produce multiple outputs over a certain time period. One of the most important issues associated with DEA is the uncertainty related to input data. In this paper, two robust dynamic DEA models are proposed for the performance measurement of two-stage processes. The two proposed robust models are applied to a real world data-set related to 20 Hydro power plants in Iran.

FINANCE

[Room 12] Financial Market Models and Portfolio Optimization

Chair(s): Aaron Young Shin Kim

Stoyan Stoyanov

Assessing model risk in post-modern portfolio construction

Post-modern portfolio construction recognizes that financial asset return distributions are non-Gaussian through an explicit parametric hypothesis or by including higher order moments. If a parametric hypothesis is assumed, then the results may be sensitive to the model error; that is, the risk that the assumed model may be incorrect. In this paper, we assume that the dependence model is provided through an implicit factor model, which is standard, and we study the impact of marginal model risk through a new semi-parametric approximation to the quantile function.

Sergio Ortobelli

Dynamic orderings consistent with preferences

This paper studies the theory of stochastic orderings and risk measures consistent to investors’ preferences in a temporal framework. First, we introduce orderings and risk measures in a dynamic context defined among random variables and stochastic processes with and without considering the available market information. Secondly, we distinguish between dynamic functionals for random variables and static/dynamic functionals for stochastic processes. Finally, we study dynamic orderings and probability functionals and examine their main

Fumin Zhu

Option valuation for dynamic jump-diffusion models with cross-feedback effect

This paper presents a cross-feedback jump-diffusion model to capture the dynamic interactions between jumps and diffusions. Using local risk-neutral valuation relationship and sequential Bayesian learning approach, this paper shows an empirical research for the options on S&P 500 index. The research shows that, infinite activity jump-diffusion model (VG-JD) performs better than finite jump-diffusion model, cross-feedback model always has the lowest errors in option valuation, and jumps show a higher persistence, stronger leverage effect and a higher market price of risk than diffusions.

Edit Rroji, Asmerilda Hitaj, Lorenzo Mercuri

Portfolio Optimization in the Multivariate Mixed Tempered Stable framework

We study the behaviour of estimators for parameters in the Multivariate Mixed Tempered Stable distribution. We remove the bias introduced by two steps estimation procedures where some parameters are estimated marginally while the remainings by minimizing some distance between theoretical and sample variance-covariance matrix. The possibility of having a confidence interval for each estimator with asymptotically same length of the confidence interval for MLE estimators gives us the possibility to construct uncertainty parameter sets and to perform robust portfolio optimization.
Ihsan Yanikoglu
Robust Dual-Response Optimization

The dual-response approach fits separate models for the mean and the variance and analyzes these two models in a mathematical optimization setting. We use metamodels estimated from experiments with both controllable and environmental inputs. For the environmental inputs, classic approaches assume known means, variances, or covariances and sometimes even a known distribution. We, however, develop a method that uses only experimental data, so it does not need a known probability distribution. Our approach yields a solution that is robust against the ambiguity in the probability distribution.

Algo Carè, Simone Garatti, Marco Campi
A Coverage Theory for Least Squares

We refer to least-squares as a methodology to make decisions. Given a sample from a population, the least-squares decision minimises the sum of the quadratic costs paid by the individuals in the sample. We study the question whether the empirical proportion of members in the sample that pay a cost above a given value is a valid statistic for the part of the whole population that pays a cost above that given value. The answer is No. However, we show that, by introducing suitable margins, valid and tight statistics can be obtained which hold true distribution-free, that is, these statistics.

Clint Chin Pang Ho, Marek Petrik, Wolfram Wiesemann
Efficient Algorithms for Robust MDPs with State Rectangularity

Robust Markov decision processes (MDPs) seek for optimal policies in view of the worst transition kernel from within an ambiguity set that specifies the knowledge about the unknown true Markov process. Although robust MDPs have emerged as powerful modeling tools, robust MDPs have typically been considered to be intractable, except for special cases where the ambiguity sets are rectangular in both the states and the actions.

In this talk, we develop tractable solution techniques for robust MDPs whose ambiguity sets are only required to be rectangular in the states.

Simone Garatti, Marco Campi
Risk and complexity in scenario optimization

Scenario optimization is a well-recognized methodology to perform uncertain optimization based on empirical knowledge. One assumes that a sample of constraints is known from previous experience and makes an optimal decision that is feasible for the cases that have been observed. In this work, the risk of not satisfying a new, previously unseen, constraint is studied jointly with the complexity of the solution. It is shown that the joint probability of risk and complexity is concentrated in such a way that the complexity carries fundamental information to tightly judge the risk.

Eugenio Mijangos
BFC methods with primal-dual methods for multistage mixed nonlinear convex stochastic problems

Multistage mixed 0-1 stochastic problems with nonlinear convex objective function and convex constraints can be solved by Branch-and-Fix Coordination (BFC) methods with primal-dual methods. The non-anticipativity constraints are satisfied by means of the twin-node family strategy. We solve each nonlinear convex subproblem generated at each node of the trees of the BFC method by primal-dual methods. The nonlinear constraints are included in the objective function by using a Lagrangean function. Subgradient methods are used to maximize the dual function. Numerical experiments are contributed.
Sjur Didrik Flåm

Block-Coordinate Methods and Stochastic Programming

Considered here are extremal convolutions concerned with allocative efficiency or market equilibrium. Each additive term is concave and possibly extended-valued or non-smooth. At any stage two randomly selected agents/blocks implement a direct transfer. The amount and direction of transfer depends on the difference in their gradients. The resulting process - and the associated convergence analysis - fits the frames of stochastic programming. Motivation stems from modern order markets.

Martin Branda

Optimality Conditions and Algorithms for Nonlinear Chance Constrained Problems

We deal with chance constrained problems (CCP) with differentiable nonlinear, possibly nonconvex, random functions. We reformulate the problem using integer variables and by their relaxation we arrive at a nonlinear programming problem. We approach it as a mathematical program with complementarity constraints and regularize it by enlarging the set of feasible solutions. For all considered problems, we derive necessary optimality conditions corresponding to the strong stationarity. We discuss relations between the stationary points and minima. We provide a numerical experiment.

David Hemmi

Scenario-based Learning for Stochastic Combinatorial Optimisation

We propose an extension of a scenario decomposition algorithm for stochastic combinatorial optimisation problems. To strengthen the lower bound we introduce diving, a scheme to produce strong scenario independent nogood cuts. The runtime is further improved by utilising Lazy Clause Generation, a Constraint Programming technique. The algorithm can be implemented based on existing solving technology, is easy to parallelise, and is shown experimentally to scale well with the number of scenarios.

MANAGEMENT AND DECISION THEORY

[Room 11] Orderings and optimal choices

Chair(s): Sergio Ortobelli

Aaron Young Shin Kim

Long and Short Memory in the Risk-neutral Pricing Process

The paper proposes a semimartingale approximation to a fractional Levy processes that is capable of capturing long and short memory in the stochastic process together with fat tails. We use the semimartingale process in option pricing and empirically compare its performance to other option pricing models including a stochastic volatility Levy process.

We contribute to the empirical literature by being the first to report the implied Hurst index computed from observed option prices on the Levy process model. By this calibration of the implied Hurst index of S&P500 option prices in a period

Noureddine Kouaissah, Sergio Ortobelli, Tomas Tichy

Multivariate dominance among financial sectors

In this paper, we propose a multivariate stochastic dominance comparison among different sectors from the point of view of different non-satiable investors. In particular, we consider different distributional hypotheses for the multivariate distribution of financial sectors and we examine if there exist some dominance among them. In this framework, we also discuss the asymptotic dominance between financial sectors. Finally, we empirically examine the choices of some non-satiable investors taking into account the proposed studies.

Tommaso Lando

Parametric dominance rules for heavy tailed distributions

In the financial literature, distributions are frequently ranked by relying on stochastic dominance relations of the second degree, namely, the so-called increasing and concave order and the increasing and convex order. In this context, it is useful to fit the empirical distributions with theoretical models, so that such ranking criteria, that are based on functional comparisons, may be replaced by scalar comparisons between parametric values. In this
regard, it is well documented that empirical distributions of financial returns are often skewed and exhibit fat tails, so that they can be appr

Haim Shalit

Using the Shapley Value of Optimal Portfolios for Systematic Risk

Systematic risk as expressed by the relative covariance of stock returns to market returns is an essential measure in pricing risky securities. As an alternative I propose the Shapley value from game theory to quantify the relative risk of a security in an optimal portfolio. The idea is that portfolios can be viewed as cooperative games played by the assets for the purpose of minimizing risk. Thus, investors can calculate the exact and true contribution of each asset to the joint payoff. The Shapley value is computed for stocks and market indices for frontier portfolios using daily data.

FINANCE

[Room 12] Dependence modelling in finance
Chair(s): Rosella Giacometti

Corina Birghila

A metric for extreme value distributions

In this talk we consider the problem of quantifying the impact of model misspecification on the decision-making process. We propose a modified version of the Wasserstein distance (called mixed Wasserstein distance), which is more sensitive to the difference between the tails of distributions. In the one-dimensional setting, the proposed metric exhibits similar properties as the well-known Wasserstein distance. Numerical results illustrate the robustness of an insurance insurance premium when model misspecification is considered.

Margherita Giuzio, Ben Craig, Sandra Paterlini

Effects of Diversification and Capital Buffers on the EU Sovereign-Bank

During the European sovereign crisis, it became clear that government bonds are not risk-free investments. Thus, recent policy discussions suggested tighter capital and diversification requirements for EU government bond holdings. In this paper, we identify the common factors driving EU sovereign CDS spreads by using an independent component analysis, and capture the dependence structure of EU sovereign risk. Then, we analyze the risk and diversification in sovereign portfolios of European banks and evaluate the effect of capital and diversification requirements on their Value-at-Risk.

Sandra Paterlini

Modelling Multidimensional Extremal Dependence for Operational Risk

We introduce a new statistical model for operational losses based on extreme value distributions and bipartite graphs, which captures the event type and business line structure of operational risk data. Two estimation methods for the tailed risk-measures are proposed and tested on simulated data. Finally, by having access to real-world operational risk losses, we show that even by relying on a small number of observations, the proposed estimation methods produce reliable estimates.

Rosella Giacometti, Gabriele Torri, Sandra Paterlini

Using Robust and Sparse Networks to capture Systemic Risk

Network analysis is becoming a fundamental tool for the study of systemic risk and financial contagion. We introduce a lasso approach based on partial correlations to estimate sparse networks from CDS spreads of European banks, capturing only the relevant links and effectively dealing with estimation error due to outliers. Our analysis allows to point out the structural properties of the European banking system, finding a strongly interconnected network with a clear country clusterization and potential systemic spillover effects across banks.
Tuesday 15:15-16:30 Parallel Sessions

OPTIMISATION
[Room Galeotti] Robust and Data-Driven Optimization
Chair(s): Phebe Vayanos

Ruiwei Jiang

Ambiguous Risk Constraints with Moment and Unimodality Information

We study risk constraints based on probabilistic guarantee and conditional value-at-risk under distributional ambiguity. We find that these risk constraints can be recast as a set of second-order conic constraints if we characterize the ambiguity based on moment and unimodality information. We demonstrate the theoretical results via a computational case study on power system operations.

Velibor Misic

Optimization of tree ensembles

Decision trees and tree ensemble models such as random forests are often used to predict the effect of a decision. While such models are widely used for predictions, little is known about how to use them for effective decisions. In this talk, we consider the problem of finding a decision that is optimal with respect to a tree ensemble model. We formulate this problem as a mixed-integer optimization model and present theoretical results on the structure of this model. We showcase the value of our model on real datasets and present a detailed application of the method to multiproduct pricing.

Phebe Vayanos, Chaitanya Bandi, Nikolaos Trichakis

Robust Wait Time Estimation in Resource Allocation Systems with an Application to Kidney Allocation

We consider the problem of estimating candidate wait times in systems that allocate scarce heterogeneous resources based on predetermined priority rules. Candidates have heterogeneous preferences and incomplete information. We model the system as a multiclass multiserver queuing system and propose a novel robust optimization solution approach. We apply our method to develop a wait time estimation tool for patients in the US kidney waitlist based on their preferences and characteristics. We calibrate our model using historical data and obtain out-of-sample errors averaging to less than 15%.

COMPUTATION
[Room 10] Computational Optimisation for Engineering Networks
Chair(s): Ruth Misener

Dimitri Thomopulos, Wim van Ackooij, Claudia D’Ambrosio, Leo Liberti, Raouia Taktak, Sonia Toubaline

A path-based ILP formulation for the Hydro Unit Commitment and Scheduling problem

We study a single-reservoir Hydro Unit Commitment Problem in a deterministic price-taker context, where production is assumed to be generated through discrete operational points. Under some hypotheses, we present a time expanded graph representation for the problem, where, at each time step, nodes correspond to the discrete operational points, and arcs refer to possible state changes. Based on the graph representation, we show that our problem reduces to a Constrained Shortest Path Problem, for which we propose a MILP formulation.

Enrico Malaguti, Andrea Lodi, Giacomo Nannicini, Dimitri Thomopulos

Chance-constrained formulation and solution of hydro scheduling

We present a Branch-and-Cut algorithm for a class of nonlinear chance-constrained mathematical optimization problems with a finite number of scenarios, based on an implicit Benders decomposition scheme, where we generate cutting planes as outer approximation cuts from the projection of the feasible region on suitable subspaces. We apply the Branch-and-Cut algorithm to the mid-term hydro scheduling problem, for which we propose a chance-constrained formulation. A computational study using data from ten hydroplants in Greece is presented, showing the effectiveness of the proposed methodology.
Radu Baltean-Lugojan, Ruth Misener

Piecewise Parametric Structure in the Pooling Problem - from Sparse Strongly-Polynomial Solutions to NP-Hardness

Standard pooling is a NP-hard non-convex quadratically-constrained optimization problem sub-class prevalent in large-scale process systems engineering, mired by significant optimality gaps and impractical convergence times. Via a parametric approach and sparse dominating network topologies, we formally validate the late Prof. Floudas’ intuition that pooling problems are rooted in piecewise functions and justify linear approximations via sparsity from Beale et al. [1965]. A P/NP boundary linked to sparsity- vanishing conditions is delineated as a result, inspiring new approximation algorithms.

MANAGEMENT AND DECISION THEORY

[Room 11] Business and economic innovation methods
Chair(s): David Anzola

David Anzola, Nelson Gómez-Cruz

Accelerating business innovation through emergent computation models and methods

Although several models of the innovation process have been proposed, those inspired by biological evolution have been shown to better capture the most distinctive features of business innovation. We claim that non-conventional methods developed in bio-inspired engineering and computing provide robust and effective mechanisms to understand, foster and evaluate business innovations within organizational environments. These methods, we argue, act as innovation accelerators. Adaptive business intelligence is introduced as a methodological framework to study the innovation process.

Ingrid-Mihaela Dragota, CODRUTA MARE, SIMONA LAURA DRAGOS

Insurance literacy of Romanian citizens and the demand for life insurance: a spatial econometric analysis

One of the main goals of the paper is to reflect our survey results, based on representative data collected through a self-designed questionnaire from 1500 people, which evaluates the extent to which the Romanian citizens are aware of different issues related to the insurance market, all combined into an Insurance Literacy Index. To create this index we apply structural equation modeling. Secondly, we prove that the newly created index positively influence life insurance density by using a sample of 42 counties. Also, spatial effects indicate significant influences among neighbors.

Dilmurod Azimov

System modeling of scientific research center as a base architecture of knowledge management and innovation

Transition economy on an innovative path of development associated with the qualitative growth of human capital. Human capital is a combination of acquired knowledge and natural human qualities, which bring income to the individual. By innate qualities include biophysical state of health at birth, and to the formation of acquired knowledge, skills, intellectual capital, and the motivation to work. This paper discusses the purpose of system simulation and to determine the architecture of knowledge management and innovation as one of the conceptual aspects of management research center.

FINANCE

[Room 12] Stochastic dominance in portfolio optimization
Chair(s): Miloš Kopa

Barbora Petrová, Milos Kopa

Multidimensional stochastic dominance in portfolio optimization

Stochastic dominance is widely used in portfolio optimization as a tool which controls investor’s risk exposure. There exist plenty of multiperiod or multistage models which are designed to seek for the optimal investment strategy which outperforms a benchmark strategy in the sense of stochastic dominance. One dimensional stochastic dominance constraints do not consider correlations between random variables representing returns or wealth. We employ the concept of multidimensional stochastic dominance and reformulate stochastic dominance constraints in portfolio optimization problems.
Sebastiano Vitali, Milos Kopa, Vittorio Moriggia

Pension fund ALM with stochastic dominance constraints and hedging derivatives

The main goal of a pension fund manager is sustainability. We propose an Asset and Liability Management (ALM) model structured as a multi-stage stochastic programming problem adopting a discrete scenario tree and a multi-objective function. Among other constraints, we consider the second order stochastic dominance with respect to a market portfolio. To protect the pension fund from shocks we test the inclusion of hedge financial contracts in the form of put options and we introduce stressed scenarios using contamination techniques. Numerical results show that we can efficiently manage the pension fund satisfying liquidity, return, sponsors extraordinary contribution and funding gap targets. We test sensitivity to put option strikes and to stochastic dominance constraints inclusion.

Miloš Kopa, Thierry Post

Portfolio optimization based on third-degree stochastic dominance

We develop an optimization method for constructing investment portfolios that dominate a given benchmark portfolio in terms of third-degree stochastic dominance. Our approach relies on the properties of the semivariance function, a refinement of an existing 'superconvex' dominance condition, and quadratic constrained programming. We apply our method to historical stock market data using an industry momentum strategy. Our enhanced portfolio generates important performance improvements compared with alternatives based on mean-variance dominance and second-degree stochastic dominance.

Tuesday 16:45-18:00 Parallel Sessions

COMPUTATION

[Room 10] Computational Aspects of SP and Economics
Chair(s): Vladimir Shikhman

Bismark Singh, David Morton, Surya Santoso

An Adaptive Model with Joint Chance Constraints for a Hybrid Wind- Conventional Generator System

We model a two-stage stochastic integer program with joint chance constraints, motivated by a hybrid wind-conventional generator system. We develop an iterative regularization scheme in which we solve a sequence of sample average approximations under a growing sample size. This reduces computational effort dramatically, and our empirical results suggest that it heuristically achieves high-quality solutions.

Vladimir Shikhman

Computation of Fisher-Gale equilibrium by auction

We study the Fisher model of a competitive market from the algorithmic perspective. For that, the related convex optimization problem due to Gale and Eisenberg is used. We develop a subgradient-type algorithm from Convex Analysis to compute equilibrium prices. In order to decentralize prices, we additionally implement the auction design. Our price adjustment is based on a tatonnement procedure, i.e. the prices change proportionally to consumers' individual excess supplies. Historical averages of consumption clear the market of goods. The optimal convergence rate of our method is derived.

Cesar Beltran-Royo

Two-Stage Stochastic Linear Programming: From scenarios to conditional scenarios

In this talk we consider the Two-stage Stochastic Linear Programming (TSLP) problem with continuous random parameters. A common way to approximate the TSLP problem, generally intractable, is to discretize the random parameters into scenarios. Another common approximation only considers the expectation of the parameters, that is, the expected scenario. A new approximation corresponds to conditional scenarios which represent a midpoint between the scenario and the expected scenario concepts. We solve the Capacitated Facility Location problem in order to compare the previous three approaches.
A Study on the Run Length Distribution of the Group Runs Xbar Chart

For a product to have a superior quality, the underlying process manufacturing the product should be in statistical control. The Group Runs (GR) chart is proposed as an improvement over the synthetic chart for the detection of process mean shifts. The GR chart integrates the Shewhart Xbar sub-chart and an extended version of the conforming run length (CRL) sub-chart. To have a better understanding of the behaviour of the GR chart, in this paper, we study the percentiles of the run length distribution of the GR chart, instead of depending entirely on the average run length (ARL) criterion.

On Quantile Risk Measures

Risk measures and the properties that they should satisfy have recently received considerable attention in the financial mathematics literature. Several different classes have been introduced, such as distortion, spectral or coherent risk measures. We introduce the class of quantile risk measures and show that they are equal to the class of distortion risk measures. We show that the subclass of convex distortion risk measures is equal to the class of spectral risk measures and that the domain of a spectral risk measure forms a convex cone.

Collective influence in decisions in personal finance: an agent-based model

The progressive deployment of cloud storage has been so far accompanied by a continuous downward trend of prices. However the trend observed so far is not guaranteed to last forever. Market concentration phenomena may take place, reducing the panorama of cloud provider choices for the customer. We propose an insurance scheme by formulating the insurance policy as a multiperiod call option. We provide an expression for the fair price of such an insurance policy, exploring its dependence on the insurance policy duration and on the dispersion of current cloud service prices.

Pension fund selection model using multistage stochastic programming with Monte Carlo simulation

In this research, we consider the problem of choosing the optimal pension fund in 1lnp pillar of Lithuanian pension system. We present a multistage risk averse stochastic optimization model with Monte Carlo simulation. CVaR is the risk measure defined by a nested formulation that guarantees the time consistency in the multistage model. Model includes stochastic parameters, such as pension funds returns (simulated as alpha-stable correlated r.v.), inflation (forecasted by discrete-time Markov-Switching Auto Regressive model) and increment of salary (simulated as normal r.v.).

Optimal scenario-based financial planning under stochastic correlations

We present an extension of a scenario tree generation procedure to include stochastic correlations and test whether, as claimed by several authors, such extension is effective during crises periods, when correlation clustering is commonly claimed as affecting the markets and significantly reduce the effectiveness of portfolio diversification. Relying on a multistage stochastic asset-liability management (ALM) model and an asset universe we test the sensitivity of the first-stage implementable decision to alternative assumptions on the returns’ correlation structure during a recent crisis.
Hanaan Yaseen, Victor Dragota

Dividend Policy and Culture

This study investigates the impact of the local culture on dividend policy for 12,312 companies in the period of 2009-2014 from 73 countries. The percentage of each of the 8 religions of each country was taken as a proxy for the local culture. Also, the origin of the law systems and factors considered classics in literature have been tested. We pointed out that there is a relation between religion and dividend payout decision. This paper aims to accentuate the conclusions of the literature of the last years that socio-cultural factors have a significant impact on corporate decisions.

Wednesday 09:00-10:40 Parallel Sessions

OPTIMISATION
[Room Galeotti] Adaptive robust optimization
Chair(s): Frans de Ruiter

Jianzhe Zhen, Dick den Hertog, Melvyn Sim
Adjustable Robust Optimization via Fourier-Motzkin Elimination
We demonstrate how adjustable robust optimization (ARO) problems with fixed recourse can be casted as static robust optimization problems via Fourier-Motzkin elimination (FME). This generic reformulation technique enhances the classical approximation scheme via decision rules, and enables us to solve adjustable optimization problems to optimality. Through the lens of FME, we characterize the structures of the optimal decision rules for a broad class of ARO problems.

Frans de Ruiter, Dick den Hertog, Dimitris Bertsimas
Duality in two-stage linear and nonlinear adaptive robust optimization
We derive and exploit duality in general two-stage adaptive linear optimization models. The new dual differs from the primal in its structure and dimensions. We show that by using affine policies we obtain the same solutions for the primal and dual model, but the dual can be solved an order of magnitude faster than the primal formulation. For the nonlinear case we show that problems that were seemingly intractable before, do have a tractable dual formulation. Finally, we show how the dual model can be used to provide lower bounds for the optimal value of the adaptive optimization problem.

Omar El Housni, Aharon Ben-Tal, Vineet Goyal
Piecewise Affine Policies for Two-Stage Adjustable Robust Optimization
We consider the problem of designing good piecewise affine policies for two-stage adjustable robust optimization problems. We introduce a new framework where we approximate the uncertainty set by a simplex and construct a piecewise affine policy based on the map from the uncertainty set to the simplex. Our policy is a threshold policy with exponentially many pieces but can be computed efficiently and in many cases, faster than the optimal affine policy. Furthermore, the performance of our policy is significantly better than the affine policy for many important uncertainty sets.

Angelos Tsoukalas, Angelos Georghiou, Wolfram Wiesemann
Robust Dual Dynamic Programming
We propose a robust dual dynamic programming (RDDP) scheme for multi-stage robust optimization problems. The RDDP scheme takes advantage of the decomposable nature of these problems by bounding the costs arising in the future stages through inner and outer approximations. In contrast to Stochastic Dual Dynamic Programming, we refine the approximations deterministically, using as a devise to determine the points of refinement our inner approximations. RDDP converges deterministically in finite time. Numerical results illustrate the good practical performance of the algorithm.
Paola Cerchiello

**Bank distress in news and financial data**

In this paper we focus our attention on the exploitation of the information contained in financial news to enhance the performance of a classifier of bank distress. Among the different models proposed for such purpose, we investigate the so called deep learning approach, based on a doc2vec representation of the textual data, a kind of neural network able to map onto a reduced latent semantic space the initial bag of words structure. Then, a second supervised neural network is trained combining news data with standard financial figures to classify banks whether in distressed or tranquil state.

Alessandro Spelta

**Identifying Systemically Important Financial Institutions: A Network Approach**

The Basel Committee on Banking Supervision has proposed a methodology to identify SIFIs. We argue that methodology chosen by Basel III maintains the micro-prudential focus of Basel I and II. We show how the PageRank algorithm that operates behind the Google search engine can be modified and applied to identify SIFIs. Being a feedback measure of systemic importance, the algorithm is able to capture the risks that individual institutions into the system, while at the same time, taking into account how the exposures at the system-wide level affect the ranking of individual institutions.

Paolo Giudici, Stefan Avdjiev, Alessandro Spelta

**Measuring contagion risk in international banking**

The financial distress of a banking system can be measured by risk premia implied by the corresponding set of CDS spreads which, in efficient markets, can incorporate information relevant to correctly measure solvency risk and. We claim that a good predictor should take contagion between banking systems into account. To achieve this aim, we propose a distress measure for banking systems that incorporates not only their CDS spreads, but also how they interact with the rest of the global financial system via multiple linkage types.

Branka Hadji-Misheva, Paolo Giudici

**Scoring Models for P2P Lending Platforms: A Network-Based Approach**

Peer-to-Peer platforms have allowed significant cost reduction in lending. However, this improved allocation comes at the price of a higher credit risk. This paper investigates the effectiveness of credit scoring models employed by P2P platforms with respect to loan default prediction. It is the belief of the authors that, because of asymmetric information and disintermediation of risk-owners, the grades obtained from P2P scoring models may not be the best predictor of loan default. With the aim of improving default forecasting accuracy, a network scoring model for P2P lenders is proposed.

Fraydoon R. Roodposhti

**Developing a robust-fuzzy multi-objective optimization model for portfolio selection**

In this paper, we consider a multi-objective portfolio selection model taking into account uncertainty data. This modeling approach considers the uncertainty of data through fuzzy logic within the framework of the model. In particular, the purpose of this study is to present a robust fuzzy multi-objective optimization model for portfolio selection. We analyze the performance of the model for a data set from Tehran Stock Exchange. Findings show that the model considers more effective the trade-offs between risk and return, taking into account the budget and investment constraints as well.
Tayebeh Zanganeh, Fraydoon Rahnamay Roodposhti, Amir Hosein Zanganeh

Fuzzy cognitive maps Approach for Portfolio selection

We propose a portfolio construction method in the present study which incorporates the hybrid model of improved Adaptive Resonance Theory (ART), and Fuzzy Grey Cognitive Maps (FGCM). Despite having become firmly established as one of the major cornerstone principles of modern finance, traditional Markowitz mean-variance analysis has, nevertheless, failed to gain widespread acceptance as a practical tool for equity management. The results show significant superiority of both Resonance Theory and Fuzzy Grey Cognitive Maps models compared to traditional Markowitz mean-variance analysis.

Soheila Naderi, Fraydoon Rahnamay Roodposhti, Jalal Seifoddini

Gold as a Safe Haven for Stock Markets: A Regime Switching Approach

In this paper, we investigate the role of gold as a hedge or safe haven for stock markets. We consider this relationship in U.S.’s stock market as a developed market and in Iran’s stock market as an emerging market, to discover the differences between the roles of gold in developed and emerging markets. By providing a different methodology in which the existence of different regimes in the relationship between gold and stock market is discovered based on data characteristics, we improved the methodologies of earlier studies in this area.

ENERGY

[Room 12] Applications of Stochastic Optimization in Energy
Chair(s): Shabbir Ahmed

Yves Mbeutcha, Michel Gendreau, Grégory Emiel

A hybrid Stochastic dynamic programming - Tabu Search approach for long-term energy planning.

Hydro-Quebec long-term energy planning aims at evaluating the impact of additional firm load contracts on the energy reliability of the system and the future revenues for the next fifteen years. Future inflows uncertainty is threatening those criteria, and should be managed by Energy surplus exchange policies. As classical Stochastic dynamic programming failed to represent adequately the risk brought by some inflows hypothesis on the system reliability, we propose a Tabu-Search approach to improve SDP policies performance with different hypothesis regarding the underlying stochastic process.

Alexandre Street, Arthur Brigatto, Davi Valladão

The Cost of Time-Inconsistent Long-term Hydrothermal Operation Policies Induced by Short-Term Modeling Simplifications

In this presentation, we use the concept of time inconsistency to measure the impact of modeling simplifications in the SDDP framework applied to long-term hydrothermal operation planning. Case studies involving simplifications in transmission modeling and security criteria indicate a relevant impact in the operation cost and market prices. Thus, a new multi-stage stochastic, in the long-term uncertainty of inflows, and two-stage-robust, in the short-term uncertainty of contingencies, model is proposed to ensure a general n - K security criterion in the hydrothermal dispatch problem.

Lina Al-Kanj

The Information Collecting Vehicle Routing Problem: Stochastic Optimization for Emergency Storm Response

This talk presents a new policy that routes a utility truck to restore outages in the power grid using trouble calls and the truck’s route as a mechanism for collecting information to create beliefs about outages. This means that routing decisions change our belief about the network, creating the first stochastic vehicle routing problem that explicitly models information collection. The problem is formulated as a sequential stochastic optimization program. Then, a stochastic lookahead policy is presented that uses Monte Carlo tree search to produce a policy that is asymptotically optimal.

Shabbir Ahmed

Stochastic Dual Dynamic Integer Programming

Stochastic dual dynamic programming (SDDP) has been established as an effective method for multistage stochastic optimization problems in power systems. The standard SDDP approach is restricted to the linear setting. However many power system applications involve integer variables arising from scheduling constraints. In this
talk we propose an extension to SDDP to handle integer variables - called Stochastic Dual Dynamic Integer Programming (SDDiP) - and prove its convergence. We demonstrate the effectiveness of SDDiP with several power systems case studies.

**Wednesday 11:00-12:40 Parallel Sessions**

**OPTIMISATION**

[Room Galeotti] Uncertainty in Logistics and Transportation
*Chair(s): Francesca Maggioni*

*Michel Gendreau, Majid Khoshghalb, Ola Jabali, Walter Rei*

**A Branch-and-Cut Approach for the Vehicle Routing Problem with Stochastic Demands under an Optimal Restocking Recourse Policy**

The Vehicle Routing Problem with Stochastic Demands is an extension of the classical VRP in which customer demands are specified through probability distributions. It may thus happen that the total demand of the customers assigned to a route could exceed the capacity of the vehicle serving the route (failure). When this happens, a corrective recourse action must be undertaken by the vehicle. In this talk, we consider an optimal restocking recourse policy in which preventive returns to the depot are inserted into routes to prevent failures, and we propose an exact solution approach to solve it.

*Stephan Meisel, Ricardo Collado, Laura Priekule*

**Risk-Averse Stochastic Path Detection**

We present a risk-averse solution approach to the stochastic path detection problem. In this problem an invader and a protector operate on a network with a set of possible source-destination paths. The protector aims at allocating security resources on the network such that the invader's path is detected with high probability. Errors in the protector's beliefs about the chosen path induce the risk of a low detection probability. We use coherent risk measures to mitigate this risk, and show that the resulting allocation policy is particularly effective in case of large errors in the beliefs.

*Luca Bertazzi, Matteo Cagnolari, Francesca Maggioni*

**The Value of the Right Distribution, with application to Service Operations Management**

We study the problem in which a provider has to face the stochastic demand of a service, minimizing the expected total cost. This problem has application whenever the aim is to find the best balance between the service level and the cost of the service, instead of profit maximization, like in bike sharing. We formulate a two-stage stochastic programming model and introduce the new concept of the Value of the Right Distribution that measures the cost of assuming a wrong probability distribution. We evaluate the cost increase in the worst case and on average. Managerial insights are provided.

*Matteo Cagnolari, Luca Bertazzi, Francesca Maggioni*

**Stochastic Programming Models for bike-sharing problems**

We investigate the problem of bike-sharing systems in which demands are stochastic and the factor of success is to meet the user demands for both bicycles and vacant locks at each bike-station. The provider aims at minimizing the expected total cost. We propose two-stage and multi-stage stochastic programming models in which are considered at the same time both the problem of determining the optimal number of bicycles to place in each bike-station and the rebalancing problem. We study the real case of the bike-sharing service in Bergamo LaBiGi. Numerical results are provided.
Kourosh Marjani Rasmussen

A mathematical framework for testing individual long term asset allocation strategies

Investment is, in a nutshell, the art and science of picking up a few assets from a universe of assets with several hundreds or thousands of assets. In this paper we present a framework for systematically testing different asset selection strategies against a given a benchmark. The process of asset selection is divided in three steps of due diligence, performance analysis and optimization. An open access platform is introduced as part of this work for students and researchers alike to test and compare their work on strategic asset allocation.

Alex Weissensteiner

Correlated noise: Why passive investments might improve market efficiency

We analyze a market in which agents process noisy signals and trade a single asset, and we derive a closed-form expression for their expected payoffs. Dependent on the behavior of the market maker, we investigate efficient and inefficient markets. For a market maker interested in a level playing field, we provide a unique pricing expression. On the contrary, profit-maximizing market makers induce inefficiencies. Agents with highly correlated noise improve their expected payoffs by reducing the information processing activity, and by doing so they even increase market efficiency.

Robert Ferstl, Michael Sigmund, Daniel Unterkofler

Panel Vector Autoregression in R: The panelvar Package

This paper considers two types of generalized method of moments (GMM) estimators for panel vector autoregression models (PVAR) with fixed individual effects. Both are extensions of the single equation dynamic panel model. Our code is available in R and extends the widely used STATA package xtabond2. We contribute to the literature by adapting various specification tests to the multiple equation framework. In addition, many classical structural analysis methods from VAR models are adapted for the panel context.

Thomas Bjerring

Portfolio Optimization of Commodity Futures with Seasonal Components and Higher Moments

We investigate the diversification benefits of combining commodities with a traditional equity portfolio, while considering higher order statistical moments and seasonality. The literature suggests that the in-sample diversification benefits of commodities in portfolio optimization are not preserved out-of-sample. We provide an extensive in-sample and out-of-sample analysis with ten commodities and a stock index using two prominent portfolio rules and show that seasonality in commodity returns should be considered, and leads to significant excess returns and increase in Sharpe ratio.

Shaojian Qu

Distributionally Robust Games with an Application to Supply Chain

In this paper, we propose a distributionally robust optimization approach for $N$-player, nonzero sum finite state/action games with incomplete information where the payoff matrix is stochastic with an imprecise distribution which is assumed to be attached to an a-priori known set. We show that the existence of the equilibria for the distributionally robust games. The computation method for equilibrium point, with the first- and second information about the uncertain payoff matrix, can be reformulated as semidefinite programming problems which can be tractably realized.
Nicolas Loizou

Distributionally Robust Games with Risk-Averse Players

We present a new model of incomplete information games without private information in which the players use a distributionally robust optimization approach to cope with the payoff uncertainty. With some specific restrictions, we show that our 'Distributionally Robust Game' constitutes a true generalization of popular finite games. Subsequently, we prove that the set of equilibria of an arbitrary distributionally robust game with specified ambiguity set can be computed as the component-wise projection of the solution set of a multi-linear system of equations and inequalities.

Giorgia Oggioni, Elisabetta Allevi, Adriana Gnudi, Igor Konnov

Dual decomposition approach for dynamic spatial equilibrium models

We consider the problem of managing a dynamic system of spatially distributed auction markets of a homogeneous commodity that are joined by transmission lines in a network. At each market, traders and buyers are represented by their offer/bid price functions and volume bounds. We propose a set of equilibrium type conditions for this system of markets and show that it is equivalent to a single-level variational inequality problem. In order to find its solution, which yields an equilibrium trajectory, we propose to apply a combined proximal point and dual type methods.

Abdel Lisser, Vikas Singh

Variational inequality formulation of chance-constrained games

In this talk, we consider an n-player non-cooperative game with random payoffs and continuous strategy set for each player. The random payoffs of each player are defined using a finite dimensional random vector. We formulate this problem as a chance-constrained game (CCG) by defining the payoff of each player using a chance constraint. We show that there exists a Nash equilibrium of a CCG when the payoff of each player follows a multivariate elliptically symmetric distribution. Numerical results are given on an example from electricity market.

ENERGY
[Room 12] Power sector
Chair(s): Paolo Falbo

Maria Elena De Giuli, Elisabetta Allevi, Luigi Boffino, Giorgia Oggioni

Analysis of long-term natural gas contracts with Vine copulas in optimization portfolio problems

This paper investigates, via Pair Copula Constructions, the portfolio's dependence risk structure across the constituents of long-term natural gas contracts. This analysis takes inspiration from the current situation of the European gas market. Oil-indexed long-term gas contracts failed to promptly adjust their positions implying significant losses for European gas mid-streamers that asked for a re-negotiation of their existing contracts and obtained new contracts linked to hub spot prices. Finally, we evaluate the optimized portfolio using different performance measures.

Paolo Falbo, Carlos Ruiz

Energy-mix equilibrium in a two stage electricity market with risk averse producers

Risk averse electricity producers interact on the generation market seeking to maximize a linear combination of expected profits and expected shortfall. They can decide the (technological) energy-mix of their plants and the selling channel of their generation (bilateral contracts or spot market). Demand and renewable generation are two sources of uncertainty, that can have different correlations. The model is applied to the cases of Spanish and German markets.

Cristian Pelizzari, Paolo Falbo, Juri Hinz

Optimal Energy Supply Shift with Battery Storages

Storing electricity through batteries is a sophisticated technological and mathematical problem. Costs, dependency of life expectancy on deep discharge, and high uncertainty in electricity markets are factors affecting the optimal deployment of battery technology. This work responds to the increasing demand for technological and algorithmic solutions in the dispatch optimization of power supply. In particular, we apply a novel approach to
solve discrete-time control problems of a battery storage system and assess the quality of numerical solutions through duality-based techniques.

Ruth Dominguez, Miguel Carrión

Solving multi-stage renewable capacity expansion problems under uncertainty

To achieve a decarbonized energy system by 2050, large renewable generating capacity must be introduced in power systems. In this work, we present a multi-stage investment model in renewable generating capacity regarding the uncertainty related to the demand growth and the investment costs and the variability of the renewable power production. Different approaches are used to solve the proposed model, such as stochastic programming and decision rules. Additionally, numerical and computational results are provided. The results are compared with the equivalent deterministic model.

**Wednesday 15:15-16:30 Parallel Sessions**

**OPTIMISATION**

[Room Galeotti] Transportation and logistics

Chair(s): Francesca Vocaturo

Francesca Vocaturo, Enrique Benavent, Angel Corberan, Demetrio Laganà

**A Branch-and-Cut Algorithm for the Periodic Rural Postman Problem with Irregular Services**

We present an extension of the rural postman problem in which some links of a mixed graph must be serviced once (or more times) in sub-periods of a given time horizon. The aim is to design a set of least-cost tours that satisfy the service requirements. We refer to this problem as the periodic rural postman problem with irregular services (PRPP-IS).

Some applications of the problem can be found in road maintenance operations and road network surveillance. We propose a branch-and-cut algorithm for the PRPP-IS and show its effectiveness through the results of an extensive experimental phase.

Rossana Cavagnini, Luca Bertazzi, Francesca Maggioni, Mike Hewitt

**Stochastic optimization models for a distribution network with transshipment**

We study a distribution system with one supplier and multiple retailers with stochastic demands. The supplier decides the quantities to ship to retailers before demand realization. Then, lateral transshipment is allowed and, at the end, retailers may incur in a positive inventory level or stock-outs. The objective is the overall cost minimization. We propose a two-stage and a multistage stochastic optimization model and we study a real U.S. bike sharing system. We analyze the stochastic solution, the influence of different scenario-tree structures and we provide managerial insights.

Achim Koberstein, Pavlo Glushko, Csaba Fabian

**Some ideas on integrating lift-and-project cuts into decomposition methods for solving two-stage stochastic programming problems with binary first-stage variables**

In this talk, we discuss ways to use lift-and-project cuts in Benders’ type decomposition algorithms for solving two-stage stochastic programming problems with binary first-stage variables. In particular, we show how L&P cuts derived for the mixed-binary first-stage master problem can be integrated into the SP decomposition scheme exploiting second stage information. As a first step of this ongoing research project, we present an adapted L-shaped algorithm, the envisaged implementation based on the existing solver system PNBSolver and an illustrative example.
Pedro Godinho

Adaptive policies based on the starting times and project state for stochastic multi-mode project scheduling

I present a model for multi-mode stochastic project scheduling. The mode used for undertaking each activity is chosen based on an adaptive policy which defines the execution mode according to the way the project is developing. I use the starting times of the activities and an indicator related to the global project state to define the rules that determine the execution mode. I use an electromagnetism-like heuristic for choosing a scheduling policy. I apply the model to a set of projects and compare the results with and without including the project state in the policy definition.

Balazs David, Miklos Kresz

Vehicle scheduling based on the similarity of planning units

The vehicle scheduling problem assigns the set of timetabled trips in a planning unit (usually a single day) to a fleet of available vehicles. In practice, schedules are created for a planning period of several weeks or months. Such a period contains planning units, for which the intersection of the sets of timetabled trips is large. In our talk we examine similar days of the planning period, and create the corresponding schedules simultaneously, also taking similarity into account besides the usual costs of the problem. Results are presented on real-life and randomly generated instances.

Niaz Wassan, Lina Simeonova, Said Salhi

The Heterogeneous Fleet Vehicle Routing Problem with Demand-Dependent Service Times and Light Loads: Population Variable Neighbourhood Search with Adaptive Memory

This paper considers a real-life VRP, characterized by heterogeneous fleet, demand-dependent service times, maximum allowable overtime and a special light load requirement. A new learning-based Population VNS algorithm is designed. The computational experience suggests that savings up to 8% can be achieved when overtime and light load requirements are considered in advance. Moreover, accommodating for allowable overtime has shown to yield 12% better average utilization of the driver's working hours and 12.5% better average utilization of the vehicle load, without incurring extra running costs.

ENERGY

[Room 12] Applications in the energy sector
Chair(s): Maria Teresa Vespucci

Giovanni Micheli

Big Data Analytics: an aid to detection of non-technical losses in Power Utility

The great amount of data collected by the Advanced Metering Infrastructure can help electric utilities to detect energy theft, a phenomenon that globally costs billions of dollars per year. This paper describes a new approach to nontechnical loss analysis in power utilities using a variant of the P2P computing allowing to identify fraud in absence of the total reachability of smart meters. Using real utility data, the algorithm has been compared with other data mining techniques such as SVM, neural networks, logistic regression in order to validate the approach proposed.

Alexia Marchand, Michel Gendreau, Marko Blais, Grégory Emiel

Fast Near-Optimal Heuristic for the Short-Term Hydro-Generation Planning Problem

Short-term hydro-generation planning can be efficiently modeled as a mixed integer linear program (MILP). However, for Hydro-Quebec's production system, the resulting MILP is too large to be solved in reasonable time with commercial solvers. We developed a three-phase approach based on price decomposition that yields quickly near-optimal solutions to large-scale real-world instances. We will present this approach and give numerical illustrations on real instances.
Federica Davò, Maria Teresa Vespucci, Alberto Gelmini

Forecasting Italian electricity market prices using a Neural Network and a Support Vector Regression

This work explores two different techniques for the prediction of the Italian day-ahead electricity market prices, the zonal prices and the uniform purchase price (Prezzo Unico Nazionale or PUN). The study is conducted over a 2-year period, with hourly data of the prices to be predicted and a large set of variables used as predictors. A Neural Network (NN) and a Support Vector Regression (SVR) are applied on the different predictors to obtain the final forecasts. Different predictors’ combinations are analyzed in order to find the best forecast.

Thursday 09:00-10:40 Parallel Sessions

OPTIMISATION
[Room Galeotti] Distributionally Robust Stochastic Optimization
Chair(s): Anton Kleywegt

Guzin Bayraksan, Hamed Rahimian, Tito Homem-de-Mello
Distributionally Robust Newsvendor Problem with Variation Distance

We investigate a distributionally robust newsvendor problem, where the demand distribution is unknown but is assumed to be within a given variation distance to a nominal distribution. We derive explicit formulas of the optimal solution and determine the regions of demand that are critical (in a precise sense) to optimal cost. We establish relationships between the distributionally robust model and its stochastic and robust counterparts. Our analyses can help to better understand the underlying uncertainties and decide on a level of robustness. We illustrate these ideas with numerical results.

Rui Gao, Anton Kleywegt
Distributionally Robust Stochastic Optimization with Fixed Marginals

In decision-making under high-dimensional uncertainty, hardly ever can the joint distribution be determined exactly, even when accurate estimates of one-dimensional marginals are available. Classical approaches sometimes leads to over-conservative decisions. We propose a robust, nonparametric approach that hedges against a family of distributions with fixed marginals and similar dependence structure, which is captured by the Wasserstein distance to a nominal distribution. Our choice of distance can be viewed as a new measure of dependence, and is useful for high-dimensional data.

Antonio Alonso-Ayuso, Laureano Fernando Escudero
Risk management: time consistent and inconsistent policies

For preventing negative impacts of the risk neutral measure in multistage stochastic mixed-integer problems, due to the potential variability of the function value for non-wanted scenarios, a variety of risk averse measures have appeared in the literature, such as CVaR and first- and second-order Stochastic Dominance (SD). We propose to consider a mixture of time-consistent and time-inconsistent versions for any of those two risk averse measures with the goal of reducing the risk of a negative impact of the solution in the objective function of those non-wanted (so-named black swan) scenarios.

Huan Xu
Variance reduction for restricted strong convexity

Several variants of stochastic first order methods based on variance reduction (SVRG, SDCA and SAGA) enjoy light computation load for each iteration, and fast convergence speed for strongly convex problems. Yet, many powerful statistical models (e.g., Lasso, SCAD) are not strongly convex. In this talk, I will argue that a nice statistical property of those problems, namely restricted strong convexity, ensures that linear convergence of variance reduced stochastic first order methods for those statistical models. This indicates a fundamental relationships between statistics and optimization.
Computational Advances in Optimization under Uncertainty

Chair(s): Daniel Kuhn

Ronald Hochreiter

(Open-Source) Multi-stage Scenario Generation

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 with different approaches to building the trees.

Julien Keutchayan, Michel Gendreau, Antoine Saucier

A quality evaluation framework for scenario-tree generation methods for solving stochastic programming problems (SPP)

We address two questions that arise when using a scenario-tree discretization for solving a SPP: (i) How to choose a suitable discretization method? (ii) How to implement the scenario-tree optimal decisions, which are given for a finite set of scenarios only? To answer both questions, we introduce a quality evaluation framework based on the idea of extending the optimal decisions of the scenario tree outside the set of scenarios. It includes several quality parameters and selection criteria allowing to find the discretization method and extension procedure most suitable for the problem.

Kilian Schindler, Napat Rujeerapaiboon, Daniel Kuhn, Wolfram Wiesemann

A Semidefinite Programming Approach for Unsupervised Capacitated Binary Classification

Given a set of data points, we develop an unsupervised binary classifier, where the cardinalities of the two clusters are fixed and the sum of intra-cluster squared distances is minimized. We first show that this problem is NP-hard and that it can be cast as a quadratic assignment problem. We then present an exact reformulation of this problem as a mixed-integer linear program and relax it to a semidefinite program, which can be solved in polynomial time. The solution of the latter is finally used to construct near-optimal clusters by means of a randomized rounding scheme.

Anna Timonina-Farkas, Georg Pflug

Stochastic Dynamic Programming Using Optimal Quantizers

Multi-stage stochastic optimization is a well-known quantitative tool for decision-making under uncertainty. However, theoretical solution of multi-stage stochastic programs can be found explicitly only in very exceptional cases due to the complexity of the functional form of the problems. Therefore, the necessity of numerical solution arises. In this work, we deal with numerical approximation methods for the solution of multi-stage decision-making problems under uncertainty, which allow to enhance both accuracy and efficiency of the solution.

Finance

[Room 12] Risky Portfolio Optimization

Chair(s): Marco Nicolosi

Martin Smid

Multiperiod and Multiportfolio Credit Risk Factor Models

We present two ways of generalization of structural PD-LGD credit risk models. First we discuss a possible extension of a single-portfolio model to a single-portfolio one. Then we show how the portfolios lasting more than one period may be handled without neglecting their intrinsic dynamics. Finally, we present a case study of two nation-wide US mortgage portfolios in which multiple generations of debts are accumulated.
Jaroslav Dufek, Martin Šmíd

**Joint Estimation of Parameters of Mortgage Portfolio and the Factor Process**

In [1] a factor model for LGD and PD of mortgage portfolio based on KVM approach is proposed. The authors further fit an evolution of factors by a VECM model; however, they take the parameters of a portfolio as fixed instead of estimation. The present paper proposes a technique of a joint estimation of VECM and portfolio parameters. In particular MLE function is defined; asymptotic properties are discussed. Finally, our technique is applied to US market data. [1] Gapko and Šmíd: Dynamic Multi-Factor Credit Risk Model with Fat-Tailed Factors. Czech Journal of Economics and Finance, 62(2), 2012

Marco Nicolosi

**Optimal Strategy for a Fund Manager with Option Compensation**

I consider the problem of portfolio optimization for a manager whose compensation is given by the sum of a constant and a variable term. The variable term is a premium that is proportional to the profit earned by the manager over a benchmark at a certain evaluation date. I find the optimal strategy and the optimal wealth in the Black-Scholes setting when the benchmark is a linear combination of the risky asset and the money market account. I also provide an approximated strategy, based on a univariate Fourier inversion, that can be applied to more general dynamics.

Johan Hagenbörk, Jörgen Blomvall

**Simulation and Validation of Models for Interest Rate Risk**

The systematic interest rate risk factors are often estimated through PCA of yield curves. Unlike our method for estimating yield curves, traditional methods are sensitive to measurement noise, making the risk factors unrealistic and unsuitable for scenario generation over longer horizons. By using different models for the univariate distribution of these risk factors and their dependence we generate long term interest rate scenarios which we use to price a swap portfolio and compare to ex-post realizations. Through a statistical test we compare different methods to find a best practice.

ENERGY-FINANCE

[Room 11] Financial optimization

*Chair(s): Diana Barro*

Davi Valladão, Thuener Silva, Marcus Poggi

**High-dimensional risk-constrained dynamic portfolio optimization with transactional costs and time-dependent returns**

Dynamic portfolio optimization literature explores simplifying assumptions or heuristic solution approaches due to the computational tractability of the problem. We propose a high-dimensional risk-constrained dynamic portfolio optimization model with transactional costs and Markovian time-dependence. The proposed model is efficiently solved using a Markov chained stochastic dual dynamic programming algorithm. We empirically show that our approximate solution is near-optimal for the continuously distributed problem and outperforms selected benchmarks.

Junkee Jeon, Hyeng-Keun Koo, Yong Hyun Shin

**Horizon Effect on Optimal Portfolio with Consumption Ratcheting**

In this paper we study the portfolio selection problem of a finitely-lived agent who does not tolerate a decline in standard of living. We show that the coefficient of relative risk aversion implied by the optimal portfolio (implied coefficient of relative risk aversion, ICRA) decreases as time gets closer to the final time and approaches 0 near the final time, i.e., the agent becomes almost risk-neutral when time approaches the final day. As the horizon is sufficiently large, the agent's ICRA is weakly increasing but almost constant and approaches a constant value smaller than 1. B

Cristinca Fulga

**Risk preference modeling for portfolio selection**

In this talk, we present an integrated methodological approach for selecting portfolios which is focused on incorporation of investor's preferences in the Mean-Risk framework.
Our goal is to propose an alternative methodology for defining, measuring and optimizing risk that addresses some of the conceptual shortcomings of the Mean-Risk framework such as the disregard of investor's attitude towards risk and implicit assumption of neutrality to loss aversion.

Diana Barro, Elio Canestrelli, Giorgio Consigli

Volatility vs. downside risk: performance protection in dynamic portfolio strategies

We consider an optimization-based approach to portfolio management jointly focusing on volatility and tail risk controls and able to accommodate effectively the return payoffs associated with option strategies. The model is multi-period and based on a mean absolute deviation formulation. Results from different historical datasets confirm that optimal volatility controls produce better risk-adjusted returns if compared with rule-based approaches. Moreover the portfolio return distribution is dynamically shaped depending on the adopted risk management approach.

Thursday 11:00-12:40 Parallel Sessions

OPTIMISATION
[Room Galeotti] Advances in distributionally robust, risk-averse, and bilevel stochastic programming
Chair(s): Ward Romeijnders

Ward Romeijnders, Maarten H. van der Vlerk

Convex approximations for risk-averse stochastic integer programming

We consider risk-averse stochastic integer programming problems. In particular, mean-risk models with integer decision variables and CVaR as risk measure. For these models we construct convex approximations and derive corresponding performance guarantees using ideas from the risk-neutral case. We illustrate these results on models with a simple recourse structure, and we show that the convex approximations are better at a high level of risk-averseness if the so-called hazard rates of the distributions of the random variables in the model are decreasing.

Laureano Fernando Escudero, Juan Francisco Monge

Expected Conditional Stochastic Dominance (ECSD). A new time-consistent risk averse measure in stochastic optimization

A time-consistent SD risk averse measure is introduced for multistage stochastic optimization. It consists of a mixture of the first- and second-order SD functionals related to a set of modeler-driven profiles in the nodes of a given subset of periods. Each profile is included by a cost threshold, a bound on the expected cost excess over the threshold in the scenario group with a one-to-one correspondence with the nodes of the selected periods, and a bound on the failure prob

Krzysztof Postek, Ward Romeijnders, Dick den Hertog, Maarten H. van der Vlerk

Efficient methods for several classes of ambiguous stochastic programming problems under mean-mean absolute deviation information

We consider problems under distributional uncertainty, which are challenging, since the worst-case distribution needs to be determined while the underlying problem is a multistage recourse problem. Moreover, the model may contain integer variables. Applying a well-known result by Ben-Tal and Hochman (1972), we are able to solve such problems without integer variables, assuming only distributional information on means and mean-absolute deviations. Moreover, we extend the result to the non-convex integer setting by means of convex approximations, proving corresponding performance bounds.

Csaba Fabian

Probability maximization by inner approximation

The proposed approximation is based on a variant of p-efficient points. It is easy to implement and is immune to noise in gradient computation. Our simple implementation proved quite reliable and robust. This talk is based on a joint project with Edit Csizmas, Rajmund Drenyovszki, Wim van Ackooij, Tibor Vajnai, Lorant Kovacs and Tamas Szantai.
**[Room 10] Computational methods for optimal portfolio selection**  
*Chair(s): Sandra Paterlini*

Gabriele Torri, Rosella Giacometti, Sandra Paterlini

**Covariance Estimation in Minimum Variance Portfolios: Is There a Best**

High dimensionality and multicollinearity can badly affect the covariance estimation and results in unstable and extreme asset allocation weights within a minimum variance framework. Here, we compare state-of-art methods, such as Ledoit and Wolf shrinkage estimator with other recently introduced, such as random matrix theory and glasso, an innovative technique based on markovian graphs. Theoretical insights are discussed as well as empirical properties are extensively tested both on simulated and real-world data.

Giovanni Bonaccolto, Sandra Paterlini

**Working on portfolio weights: aggregation strategies versus regularized methods**

Despite criticized, the Markowitz’s model is still the cornerstone of modern asset allocation. However, the inability to deal with multicollinearity and high estimation errors have prompt to look for alternative solutions. In this work, we focus on two recent approaches, that share the common feature of working, either by aggregating or by imposing a constraint, on the vectors of the portfolio weights. Theoretical insights as well as empirical results will be presented.

Philipp Johannes Kremer, Sangkyun Lee, Malgorzata Bogdan, Sandra Paterlini

**Sparse Portfolio Construction via the ordered L1 Norm**

We study the properties of the recently developed Sorted L1-Penalized Estimation, called SLOPE, within the framework of correlated data. SLOPE relies on the idea of penalizing coefficients with a stronger signal more heavily and clumping equally correlated assets together. We show that SLOPE is able to identify and to cluster assets with the same underlying risk factor exposures. This enables the investor to improve his ex-ante portfolio risk management. Our empirical analysis on the SP100 and SP500 from 2004-2016 confirms the validity of SLOPE in developing effective investment strategies.

Marco Corazza

**Q-Learning and SARSA: Machine learning-based stochastic control approaches for financial trading**

We design machine learning-based stochastic control approaches for optimizing financial trading systems. Two algorithms are compared: Q-Learning and SARSA. Both optimize their behaviors in real time. The idea to use such tools is based on an emerging theory about financial markets: the Adaptive Market Hypothesis. The models use simple state variables and operate selecting one among three possible actions: buy, sell, and stay out. We perform applications based on different settings which are tested on different daily stock price series. Performances are both gross and net of transaction costs.

**FINANCE**

[Room 12] Derivatives portfolio management and pricing  
*Chair(s): Martina Nardon*

Vivek Varun, Diana Barro, Giorgio Consigli

**A stochastic programming model for optimal risk control with financial derivatives**

The modelling of options in multistage stochastic programming framework is a multi-utilitarian approach, a put option can be used for portfolio insurance against any unfavourable outcome, a call option if exercised at maturity can be used to buy an underlying at a lower price, therefore bringing down the average buying cost of the holding asset and finally, an option, if sold before maturity would transfer the risk to the buyer. We present here a multistage model to include call and put options in a portfolio along with the other asset classes. A case study presented summarizes the approach.
Martina Nardon, Pianca Paolo

European option pricing under cumulative prospect theory with alternative probability weighting functions

We evaluate European options under continuous cumulative prospect theory. We focus on investors’ probability risk attitudes and consider alternative probability weighting functions. In particular, the constant relative sensitivity weighting function allows to control separately curvature and elevation. Curvature models optimism and pessimism when one moves from extreme probabilities, whereas elevation can be interpreted as a measure of relative optimism. We performed a variety of numerical experiments and studied the effects of both these features on options prices and implied volatilities.

Zanette Antonino

Hybrid tree-finite difference methods for the Heston, Bates and Heston Hull-White models

We propose a mixed tree-finite difference method in order to approximate the Heston model. We prove the convergence by embedding the procedure in a bivariate Markov chain. Moreover, as a by-product, we provide a new simulation scheme to be used for Monte Carlo evaluations. Numerical results show reliability and the efficiency of the algorithms. We show how to generalize the procedure to the Bates model, the Heston-Hull-White model and the Heston-Hull-White2D model.

Pontus Söderbäck, Jörgen Blomvall

Large scale evaluation of derivative pricing methods

Derivative prices carry important information about both risks and markets beliefs. The information can be inferred through measurements that require calibration to market prices through non-convex inverse problems. Market prices contain noise, and this aggravates the consequence of multiple local optima. The measurement accuracy is commonly studied through out-of-sample pricing, but other alternatives are also explored. Extensive testing that requires determining the global optimum as well as large scale numerical tests are required to determine the most accurate measurement method.

ENERGY-FINANCE
[Room 11] Advances in Energy Finance
Chair(s): Michael Schürle

Florentina Paraschiv, Fred Espen Benth

A Space-Time Random Field Model for Electricity Forward Prices

We derive a spatio-temporal dynamical model based on the Heath-Jarrow-Morton (HJM) approach under the Musiela parametrization, which ensures an arbitrage-free model for electricity forward prices. We disentangle the temporal from spatial (maturity) effects on the dynamics of forward prices, show the statistical properties of risk premia, of the noise volatility term structure and of the spatio-temporal noise correlation structures. Furthermore we find evidence for coloured noise and correlated residuals, which we model by a Hilbert space-valued normal inverse Gaussian Levy process.

Audun Sætherø, Florentina Paraschiv, Rudiger Kiesel

On the Construction of Hourly Price Forward Curves for Electricity Prices

There are several approaches in the literature for the derivation of PFCs which distinguish among each other by the procedure employed for the derivation of seasonality shapes, smoothing technique and by the design of the optimization procedure. We will present some of these methods, as well as present a novel method for the construction of the PFC, where the level of futures as well as historical spot prices are simultaneously taken into account in a joint optimization approach. We discuss comparatively the features and advantages of these methods for the construction of PFCs.

Debora Daniela Escobar

Risk premia measured by insurance prices and model uncertainty

Unlike financial markets, future prices in energy markets do not have a well established pricing principle and therefore neither do the risk premia. We propose to price future contracts in energy markets using insurance premium principles. We extend the definitions of these principles in order to explain risk-averse and risk-seeking
preferences. We will justify the choice of the distortion premium principle. Using this premium principle we formulate the risk premia in terms of Wasserstein distances. Finally, we incorporate uncertainty in the model using Wasserstein balls as ambiguity sets.

Michael Schürle

Valuation of the flexibility of power-to-gas facilities

Power-to-gas (P2G) is a technology that converts electrical power to gas fuels like methane for storage in the natural gas grid. Due to the low efficiency, the production of synthetic methane is only profitable if electricity is sufficiently cheap. However, P2G facilities are flexible consumers and can benefit from short-term price fluctuations on the electricity spot market. We use a real option approach to assess the profitability of an investment in a P2G facility, taking into account the uncertainty of power prices, gas prices and future investment costs.
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