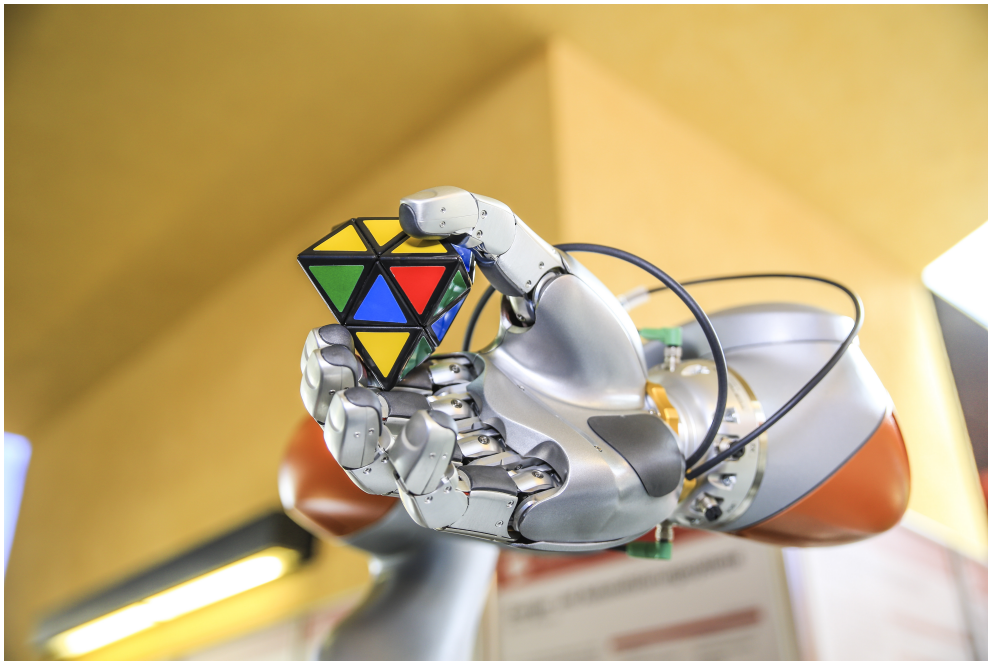
TECHNISCHE UNIVERSITÄT
CHEMNITZ

Fakultät für Mathematik

CMS-MMEI-2019



Program

Collection of abstracts

List of participants

Chemnitz, March 27 - 29, 2019

The focus is on computational management science with emphasis on risk management, valuation problems and measurement applications. This includes optimal risk control problems, stochastic optimization, robust and distributionally robust optimization methods as in the tradition of CMS conferences.

Applications (but not limited to):

- finance
- energy
- supply chain management
- logistic problems

Invited Speakers:

Michel De Lara, École des Ponts ParisTech

Tomas Kroupa, Czech Technical University in Prague

Georg Ch. Pflug, University of Vienna

David Wozabal, University of Munich

Huifu Xu, Southampton

Scientific Committee:

D. Kuhn (Lausanne) , R. Henrion (Berlin) , J. Outrata (Praha) , G. Pflug (Vienna) ,
R. Schultz (Duisburg-Essen) , P. Lachout (Praha) , I. Melicherčík (Bratislava) ,
O. Stein (KIT) , T. Harks (Augsburg) ,
R. Werner (Augsburg) , J. Žilinskas (Vilnius) , S-E. Fleten (NTNU) , A. Tomasgard (NTNU) , S. de Vries (Trier)

Organising Committee:

V. Shikhman, A. Pichler (chair), D. Uhlig,
R. Unger, R. Schlotter, O. Wilfer, D. Müller,
J. Hilber, K. Seidel

https://www.tu-chemnitz.de/mathematik/fima/cms-mmei/

Internet Access

Eduroam is available at the conference venue. For individual, free internet access you might want to check the welcome package.

Food

The conference fee includes

- Lunch in the students canteen
- Tea, coffee, soft drinks and snacks during breaks
- Concert in the church “St. Jakobi” on Wednesday

Social program

The concert on Wednesday starts at 7 pm in the church “St. Jakobi” which is located downtown, **Innere Klosterstraße 7A, 09111 Chemnitz**.

Conference Dinner

The conference dinner will start on Thursday at 7 pm in the restaurant “Chemnitzer Hof”.

The address of the restaurant is **Theaterplatz 4, 09111 Chemnitz**.

Chemnitz

With 245,000 inhabitants, Chemnitz is the third largest city of the Free State of Saxony after Dresden and Leipzig. It was first mentioned in 1143 in written as "locus Kameniz", when King Conrad III granted market rights to a Benedictine monastery. The name is taken from the river Chemnitz and means "stony brook". The river rises in the south of the city, where the rivers Würschnitz and Zwönitz join.

In the 19th century Chemnitz became one of the most important industrial cities in Germany and was the center for mechanical engineering. Steam engines and locomotives were produced here. Because of the number of chimneys, Chemnitz got the nickname "Saxon Manchester".

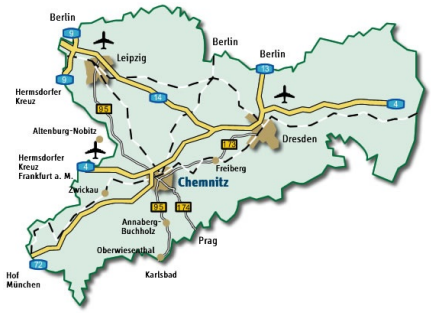
From 1953 to 1990 Chemnitz was called Karl Marx City and in 1971 the famous Karl Marx Monument, the "Nischel", was unveiled. In this time the city continued to be a center for machine construction and is still an important industrial location.

When the Royal Business School Chemnitz was founded on 2 May 1836, 14 students started their education there. Since then it grew, especially in the field of mechanical and electrical engineering, and received in 1986 the status of "Technical University".

Today, Chemnitz University of Technology hosts about 11,500 students from 91 countries.

Transport from airport to Chemnitz

The nearest airports are in Leipzig and Dresden, located 90 and 80 kilometers from Chemnitz, respectively. Trains run every hour to Chemnitz (1.5 - 2 hours), cost 17 - 24 EUR.



Useful Links

TU Chemnitz: www.tu-chemnitz.de

Campus map: www.tu-chemnitz.de/tu/lageplan/rhstr.php.en

Chemnitz city information: www.chemnitz.de/chemnitz/en/index.itl

Local public transport: www.cvag.de/de/english_110.html

Taxi in Chemnitz: www.taxi-chemnitz.de or tel.: +49 371 369000

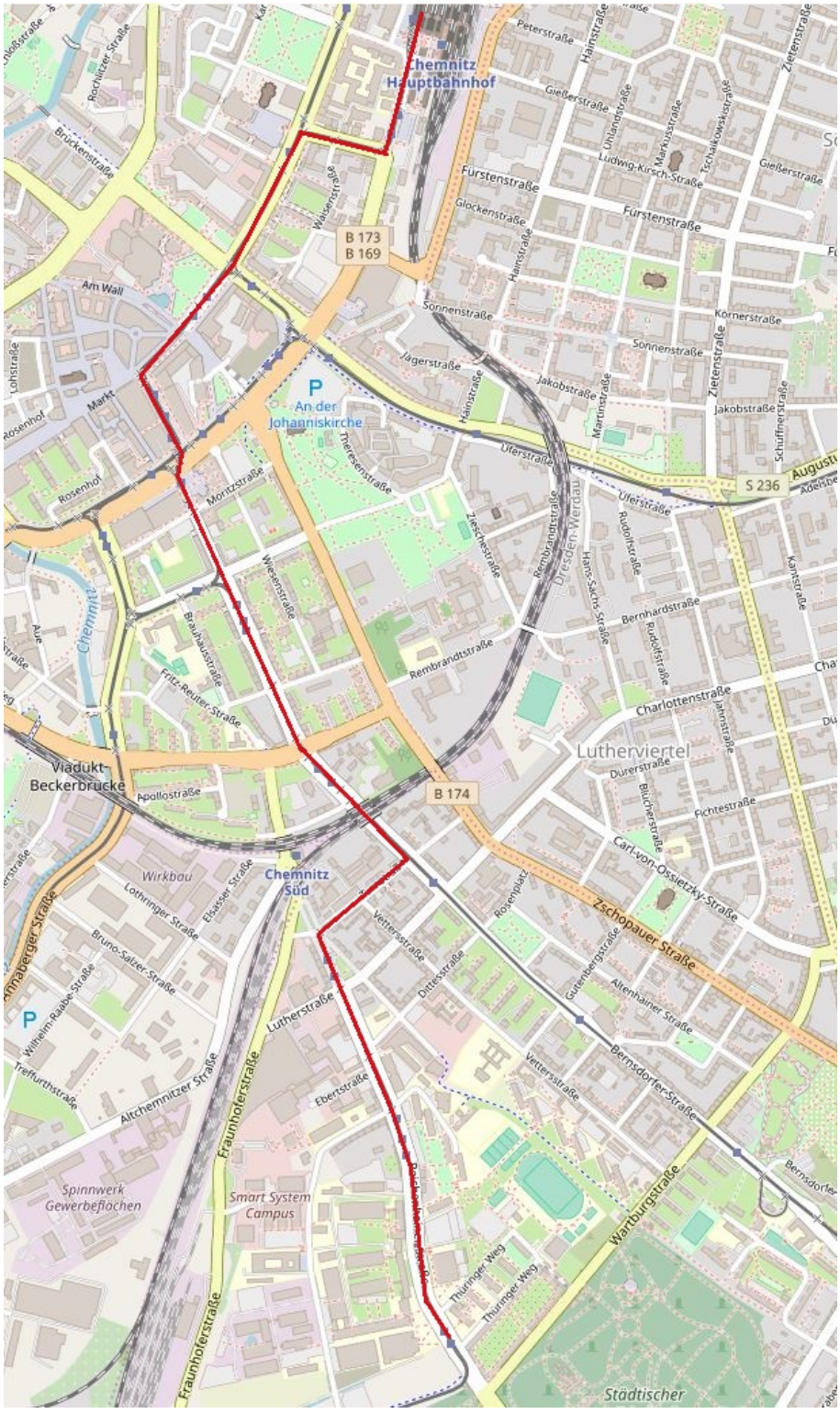
Train in Germany: www.deutschebahn.com/en

Local transport to University site Reichenhainer Straße

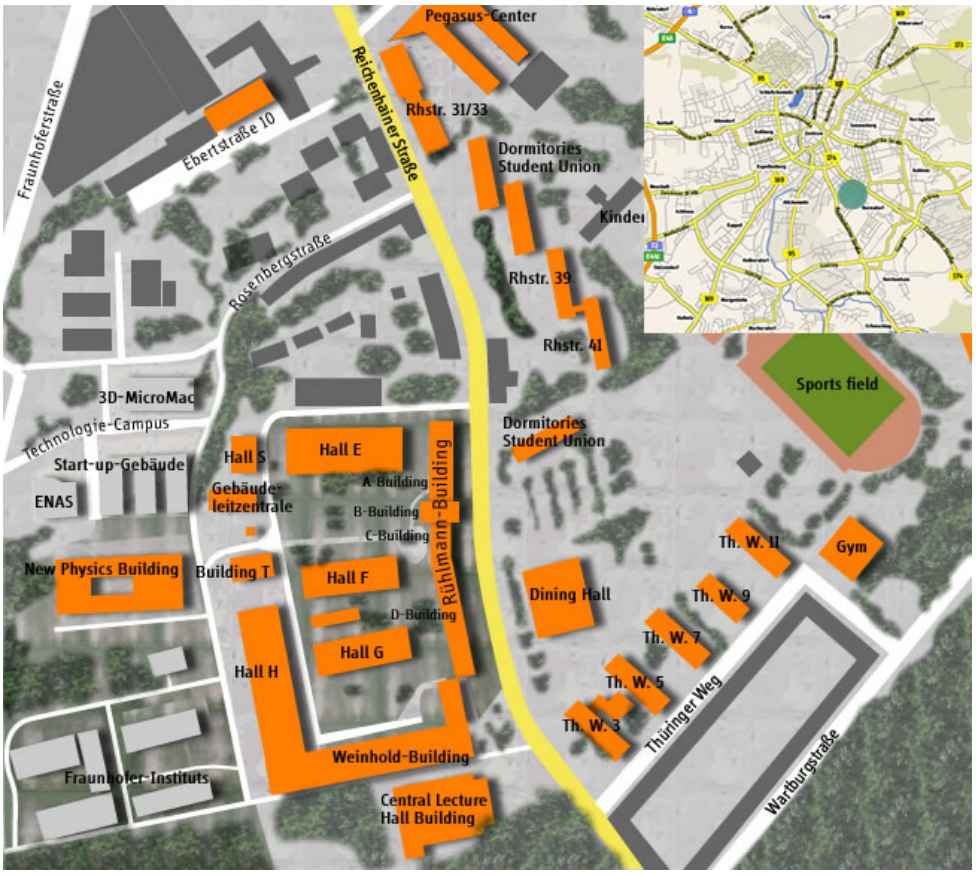
From downtown and the most hotels the tramlines 3, C13, C14 and C15 are easily accessible, they run to the conference site (**direction Technopark, tram stop: TU Campus**) every 10 minutes.
Tickets can be bought at ticket machines or in the tram (4.40 EUR for the whole day).
Alternative bus lines are 53 and 82, leaving from the hotels downtown.

Tram map

Tramlines **3**, **C13**, **C14** and **C15** from train station via city center to TU Campus with conference venue.



Campus map



Main conference venue location

Weinhold-Building
Reichenhainer Straße 70
09126 Chemnitz

Programme

Programme for Wednesday, March 27, 2019

08:00	*Registration*	
09:00	*Opening*	
	Invited talk Chair: Vladimir Shikhman	
09:10	**Tomáš Kroupa** . . . . . 36 Continuous games and their applications	
	Risk aversion Chair: Vladimir Shikhman	**Algorithmic approaches** Chair: Sebastian Maier
10:00	**Matthias Claus** . . . . . 21 Structure of risk-averse stochastic linear bilevel programs	**Vadim Omelcenko** . . . . . 47 Decomposition Algorithms in Mixed Integer Linear Programming
10:30	**Johanna Burtscheidt** . . . . . 20 Application of Risk-Averse Bilevel Problems under Uncertainty	**David Müller** . . . . . 44 Pricing in Markets with Differentiated Products
11:00	*Tea and Coffee Break*	
11:15	**Oliver Stein** . . . . . 58 On pessimistic bilevel optimization	**Martin Branda** . . . . . 19 New solution approaches to nonlinear chance constrained problems
11:45	**Martin Gugat** . . . . . 26 Optimal Control of a vibrating string with uncertain initial data and probabilistic terminal constraints	**Maria Trnovska** . . . . . 60 Nonlinear DEA models for technologies with undesirable outputs - an application of semidefinite programming
12:15	**Kai Arne Spürkel** . . . . . 57 Strong Convexity of Risk Functions in Linear Recourse Models	**Regan Baucke** . . . . . 18 A deterministic algorithm for stochastic multistage problems
12:45	*Lunch*	

	Invited talk Chair: Alois Pichler
13:55	**Georg Pflug** . . . . . 49 Stochastic optimization in Hilbert spaces with applications to shape optimization

	Mathematical methods Chair: Alois Pichler	**Dynamic programming** Chair: Stein-Erik Fleten
14:45	**Michal Cervinka** . . . . . . New verifiable sufficient conditions for metric subregularity of constraint systems with application to disjunctive programs	**Sona Kilianova** . . . . . 30 Dynamic portfolio optimization via Hamilton-Jacobi-Bellman equations and their transformation
15:15	**Natalia Gulko** . . . . . 46 Wave propagations in full absorption medium	**Vlasta Kaňková** . . . . . 29 Second Order Stochastic Dominance in Optimization Problems via Empirical Data
15:45	*Tea and Coffee Break*	

	Mathematical methods Chair: Regan Baucke	**Stochastic programming** Chair: Oliver Stein
16:00	**Petr Lachout** . . . . . 37 Stochastic optimization shema with timers	**Sebastian Maier** . . . . . 40 Risk-averse pathwise dynamic programming: A simple simulation-and-regression approach
16:30	**Maximilian Emanuel Klein** . . 31 Almost Sure Convergence for Nested Monte-Carlo Simulations	**Francesca Maggioni** . . . . . 39 Sampling Methods for Multistage Robust Optimization
19:00	*Concert*	

Programme for Thursday, March 28, 2019

	Invited talk Chair: Stein-Erik Fleten	
09:10	**David Wozabal** . . . . . 62 Dampening the Curse of Dimensionality: Decomposition Methods for Stochastic Optimization Problems	
	Energy Chair: Martin Gugat	**Finance** Chair: Sona Kilianova
10:00	**Ruediger Schultz** . . . . . 53 Optimization in meshed gas networks	**Diana Barro** . . . . . 17 Derivatives-based portfolio management via multistage stochastic programming
10:30	**Stein-Erik Fleten** . . . . . 23 Dynamic Hedging of Electricity Storage Operations with Exchange Rate Risks	**Tomáš Rusý** . . . . . 51 Maximising Loan Value under Decision Dependent Randomness
11:00	*Tea and Coffee Break*	
11:15	**Andreas Klinkert** . . . . . 32 Workforce Planning in Airport Logistics: A Real-World Business Application	**Milos Kopa** . . . . . 33 Portfolio selection with DARA constraints
11:45	**Raimund M. Kovacevic** . . . . . 35 Fair distribution of random Revenues for joint projects in the electricity sector	**Rossella Agliardi** . . . . . 13 Optimal trading strategies with limit orders: a stochastic programming approach
12:15	**Sjur Didrik Flåm** . . . . . 22 Market Equilibrium and Parametric Optimization	**Alexander Fromm** . . . . . 25 Evaluation of equity-based debt obligations
12:45	*Lunch*	

	Invited talk Chair: Georg Pflug	
14:00	**Michel De Lara** . . . . . 38 Design of Lower Bound Convex Programs for Exact Sparse Optimization	
	Nonlinear programming Chair: Petr Lachout	**Statistics** Chair: Martin Smid
14:45	**Werner Römisch** . . . . . 50 Problem-based optimal scenario generation in two-stage stochastic programming	**Ruben Schlotter** . . . . . 52 Nested Risk Measures and Optimal Control
15:15	**Giovanni Micheli** . . . . . 42 Generation and Transmission Expansion Planning with high Shares of Renewables	**Sergio Ortobelli** . . . . . 48 Testing for paremetric orderings efficiency
15:45	*Tea and Coffee Break*	
16:00	**Sebastiano Vitali** . . . . . 61 Multistage stochastic dominance: an application to pension fund management	**Muazu Ramat Abujiya** . . . . . 12 Integrating Ranked Set Sampling in Memory Control Charts: A Study on Pepsi Cola
16:30	**Vladimir Shikhman** . . . . . 54 Dual subgradient method with averaging for optimal resource allocation	**Mo'tassem Al-arydah** . . . . . 16 Efficiency of Home Radon Mitigation Systems in some Canadian Provinces
19:00	*Conference Dinner*	

Programme for Friday, March 29, 2019

	Invited talk Chair: David Wozabal
09:10	**Huifu Xu** . . . . . 63 Utility Preference Robust Optimization: Piecewise Linear Approximation and Statistical Robustness

	Energy Chair: David Wozabal	**Finance** Chair: Milos Kopa
10:00	**Adrien Le Franc** . . . . . 24 Stochastic optimization problems from Energy Management Systems	**Karel Sladký** . . . . . 55 Separable Utility Functions in Discrete- and Continuous-time Markov Decision Chains
10:30	**Christopher Hofmann** . . . . . 27 Simultaneous Multi-Parameter Choice with Applications in Inverse Option Pricing	**Martin Smid** . . . . . 56 Application of Markov SDDP to Financial Modelling
11:00	*Tea and Coffee Break*	
11:15	**Thomas Martin** . . . . . 41 Stochastic Optimization for the Crude oil procurement problem	**Martina Nardon** . . . . . 45 Behavioral premium principles
11:45	**Thanh To** . . . . . 59 Stochastic Corrective Risk-Based Optimal Power Flow	**Mustafa Akan** . . . . . 15 Optimal Investment in Health Care for Patient Satisfaction.
12:15	**Noureddine Kouaissah** . . . . . 34 XOR-AHP Approach and Its Assessment in the Renewable Energy Sector	**Hua Jin** . . . . . 28 The impact of tax legislation on inventory and supplier selection models
12:45	*Lunch*	

Collection of Abstracts

Integrating Ranked Set Sampling in Memory Control Charts: A Study on Pepsi Cola

Muazu Ramat Abujiya[1]

The integration of ranked set sampling (RSS), and its variations in statistical process control cannot be over emphasized. The data collection technique has made ground breaking contributions in constructing memoryless control charts such as the Shewhart chart, for monitoring large changes in the process location and dispersion. With enhancements gained in integrating the RSS methodologies in Shewhart charts, the technique has recently found applications in the development of memory control charts namely, the Cumulative Sum (CUSUM) and Exponentially Weighted Moving Average (EWMA) charts. This article analyzes the practical performance of the CUSUM and EWMA charts under the RSS schemes to effectively monitor changes in a production process. The study is based on a real industrial data obtained from Pepsi Cole Production Company and will serve as a useful guide for quality control engineers on the implementation procedure of the scheme. The numerical results show that the application of RSS in CUSUM and EWMA control charts has accelerated the detectability of changes in a process over the traditional random sampling method. We present graphical comparisons of the RSS integrated memory charts for monitoring changes in a manufacturing process with the corresponding basic location and dispersion control charts.

[1]King Fahd University of Petroleum and Minearls

Optimal trading strategies with limit orders: a stochastic programming approach

Rossella Agliardi[1]

As computerized trading has been steadily growing and trades occur throughout electronic technologies, the problem of optimizing trading strategies has become a critical focus for trading firms. Orders to buy or sell are collected in "limit order books" (LOBs). Limit orders are buy/sell orders that are to be executed at their specified limit price or at a better one. A limit order sits in a LOB until it is either executed against a market order or it is canceled. Thus when dealing with limit orders the main question at hand is to model the risk of no (or partial) execution. Some models for optimal trade execution have been proposed in [5], [6], [7], [9], [10]. These models take the form of stochastic control problems which are rarely analytically tractable. A restriction in these models is that traders are allowed only to control for the posted price, but not for their order size. The model we proposed in [2] and [3] is able to capture the main features of the execution risk in a limit order book (i.e. the dependence of the execution rate of a limit order on the order price and on the trade size) and, at the same time, traders are allowed to optimally choose both the price quote and the trade size at each point in time, thus relaxing the above-mentioned model restriction. The problem is formulated as a stochastic programming one. The main setting is provided in [2] where an optimal strategy is obtained in explicit form and its effects are discussed. We explicitly construct path-dependent solutions and show how to adjust, at each trading time, the schedule of order sizes, depending on whether previous orders have been successfully executed. Then in [3] the framework has been applied to a hedging problem, which is new in the literature. Finally, [4] addresses the question of imperfect knowledge of the parameters.

[1] Agliardi, R., Gençay, R., 2014. Hedging through a limit order book with varying liquidity,Journal of Derivatives, 22, 2, 32-49
[2] Agliardi, R., Gençay, R., 2017. Optimal trading strategies with limit orders, International Journal of Theoretical and Applied Finance,20, 16 pages
[3] Agliardi, R., Gençay, R., 2017. Optimal trading strategies with limit orders, International Journal of Theoretical and Applied Finance,20, 16 pages
[4] Agliardi,R., 2016. Modelling uncertainty in limit order execution, Communications in Nonlinear Science and Numerical Simulation, 31, 143-150
[5] Bayraktar, E., Ludkovski, M., 2014. Liquidation in limit order books with controlled intensity, Mathematical Finance, 24, 4, 627-650
[6] Goettler, R., Parlour, C. A., Rajan, U., 2005, Equilibrium in a Dynamic Limit Order Market, Journal of Finance 60, 2149–2192.
[7] Guéant, O., Lehalle, C., 2012. General intensity shape in optimal liquidation, Mathematical Finance, doi: 10.1111/ mafi.12052
[8] Guéant, O., Lehalle, C., Fernandez-Tapia, J., 2012. Optimal portfolio liquidation with limit orders, SIAM Journal on Financial Mathematics 3,1, 740-746.
[9] Guilbaud, F., Pham, H., 2013. Optimal high frequency trading with limit and market orders, Quantitative Finance 13, 1, 79-94.
[10] Huitema, R., 2011. Optimal portfolio execution using market and limit orders, Swiss Finance Institute Research Paper Series 12/2011.

[1] University of Bologna, Department of Mathematics, Bologna (Italy)

[11] Lo, A. W. , MacKinlay, C., Zhang, J., 2002. Econometric models of limit-order executions, Journal of Financial Economics 65, 31-71.

Optimal Investment in Health Care for Patient Satisfaction.

Mustafa Akan[1]

Health care is ever more important with aging population. Assuming the number of doctors per patient is a good proxy for patient satisfaction, optimal investment in practitioner doctors,specialist doctors and foreign doctors are analyzed given the total number of doctors(domestic) are exegenously determined. The high cost of investment in specialist doctors are weighted against the high salaries of imported foreign doctors.
An optimal control theory methodology is employed to determine the optimal investment plans for the two alternative sources of doctors to maximize the net(of costs) patient satisfaction over a fixed time horizon.
It found that a nation with insufficient number of doctors at the beginning of the time horizon should increase the investment in local specialist doctors gradually while employing foreign doctors as to equate their salaries to the marginal satisfaction of the patients.
It is shown that an equililibrium point exists and it is stable if the population is constant.

[1] Halic University, Management

Efficiency of Home Radon Mitigation Systems in some Canadian Provinces

Mo'tassem Al-arydah[1]

Lung cancer (LC) is the leading cause of death of cancer in Canada in both men and women, and indoor radon is the second leading cause of LC after tobacco smoking. The Population Attributable Risk (PAR) is used to assess radon exposure risk. We use the PAR to identify the radon levels responsible for most LC cases. During the period 2006–2009, 6% of houses in Ontario, 9% of houses in Alberta, 19% of houses in Manitoba, 7% of houses in Quebec, and 5% of houses in British Columbia had radon levels higher than 200 Bq/m3 and was responsible about 913, 211, 260, 972, and 258 lives, respectively. Radon mitigation programs could have prevented these LC cases. We use the PAR function of the two variables, radon action, and target levels, to search for a possible optimal mitigation program. The PAR is a linear function in the target radon value with an estimated slope of 0.0001 for Ontario, Alberta, Quebec, and British Columbia, and 0.0004 for Manitoba. The PAR is an increasing function in the radon action level. The PAR is sensitive to changes in the radon mitigation program and as such, any improvement is a worthwhile investment.

[1] Al-arydah, M. (2018). Estimating the Burden of Lung Cancer and the Efficiency of Home Radon Mitigation Systems in some Canadian Provinces. Science of the Total Environment, 626, , 287-306.
[2] Al-arydah, M. (2017). Population attributable risk associated with lung cancer induced by residential radon in Canada. Sensitivity to relative risk model and radon. Science of the Total Environment. http://dx.doi.org/10.1016/j.scitotenv.2017.04.067.

[1] Khalifa University, math department, Abu Dhabi UAE

Derivatives-based portfolio management via multistage stochastic programming

Diana Barro[1] Giorgio Consigli[2] Vivek Varun[3]

We extend a canonical dynamic asset management model to allow for nonlinear financial payoffs such as those carried by European call and put options. We present a generic optimization model, which is then applied to the US market to derive optimal hedging and speculative strategies over different time periods characterizing recent financial history. From a modelling perspective we generalize previous efforts to allow for a comprehensive modelling approach based on a tree-based option pricing method and multistage stochastic optimization with recourse. The contribution is focused on a short term planning problem with 6 month horizon and monthly strategy revision, an objective function based on a shortfall minimization problem with respect to a return target and a set of constraints including options strategy constraints such as those induced by a covered call or a protective put strategy.

[1]Ca' Foscari University, Department of Economics

[2]Università degli Studi di Bergamo

[3]Università degli Studi di Bergamo

A deterministic algorithm for stochastic multistage problems

Regan Baucke[1] Anthony Downward[2] Golbon Zakeri[3]

Algorithms for stochastic multistage optimisation problems (such as SDDP) typically involve discretisation of a stochastic process, and then a construction of lower bounds by Monte Carlo simulation on the resulting tree. In this talk, I will outline an algorithm which converges on the optimal policy for the discrete tree *surely*. The key feature of this algorithm is a convex programming formulation for an *upper-bound* of the convex value functions. We will also discuss an extension of this algorithm, which bounds value functions which are saddle.

[1]CERMICS at Ecole des Ponts ParisTech

[2]University of Auckland

[3]University of Auckland

New solution approaches to nonlinear chance constrained problems

Martin Branda[1] Lukáš Adam[2] Holger Heitsch[3] René Henrion[4]

We focus on joint chance constrained problems (CCP) with differentiable nonlinear, possibly nonconvex nonconvex, functions with nonseparable random parts. We reformulate the problem using integer variables variables and by their relaxation we arrive at a nonlinear programming problem. Since the constraint constraint qualification conditions are often not fulfilled, we regularize the set of feasible solution solution. For all considered problems, we propose necessary optimality conditions based on the strong strong stationarity and discuss the relations between the stationary points and minima. Since the resulting resulting regularized problem is still highly demanding, we introduce a general approach based on the the Benders decomposition and discuss its performance on a gas network design problem. We compare the the approach with the algorithm based on the spheric-radial decomposition of Gaussian random demands demands.

[1]Institute of Information Theory and Automation, AS CR, Prague

[2]Southern University of Science and Technology

[3]Weierstrass Institute for Applied Analysis and Stochastics, Berlin

[4]Weierstrass Institute for Applied Analysis and Stochastics, Berlin

Application of Risk-Averse Bilevel Problems under Uncertainty

Johanna Burtscheidt[1] Matthias Claus[2]

A bilevel problem is a hierarchical programming problem which arises from the interplay between two decision makers on different hierarchical levels. In stochastic bilevel problems, the lower level problem is entered by the realization of some random vector whose distribution does not depend on the upper level decision as an additional parameter. It is assumed that the leader has to make his or her decision without knowing the realization of the randomness, while the follower decides under full information.
We examine linear bilevel problems, where the right-hand side of the lower level problem is subject to stochastic uncertainty, and present a risk averse formulation based on special risk measures. In particular, structural properties and qualitative stability of the optimal value function of this model will be investigated. Focussing on the case of an underlying random vector with a finite number of realizations, equivalences of the risk averse stochastic bilevel problems and single-level problems conclude the talk.

[1]University of Duisburg-Essen, Faculty of Mathematics

[2]University of Duisburg-Essen, Faculty of Mathematics

Structure of risk-averse stochastic linear bilevel programs

Matthias Claus[1]

Two-stage linear stochastic programs and linear bilevel problems under stochastic uncertainty bear significant conceptual similarities. However, the step from the first to the latter mirrors the step from optimal values to optimal solutions and entails a loss of convexity and desirable analytical properties.

Taking into account that the lower level problem may have more than one optimal solution, the talk focusses on properties of the optimistic formulation under stochastic uncertainty. Assuming that only the follower can observe the realization of the randomness, Lipschitz continuity and continuous differentiability of the objective function are established for the risk neutral and various risk averse models.

The second part of the talk examines stability of local optimal solution sets under perturbations of the underlying probability measure w.r.t. to the topology of weak convergence for models involving law-invariant convex risk measures.

[1] University of Duisburg-Essen, Mathematics

Market Equilibrium and Parametric Optimization

Sjur Didrik Flåm[1]

The Walrasian approach to market equilibrium hinges on three assumptions: First, the law of one price; second, price-taking behavior, and third, no trade happens out of equilibrium. For each assumption, posted prices serve as common parameters for agents who never get tired of full optimization. This optic is glaringly unrealistic. And it sheds no light on eventual emergence of equilibrium. Outlined here are two more constructive and computational avenues: Along one, agents repeatedly make direct deals; along the other they iteratively take part in double auctions.

[1] University of Bergen, Informatics Dep.

Dynamic Hedging of Electricity Storage Operations with Exchange Rate Risks

Stein-Erik Fleten[1] Joakim Dimoski[2] Sveinung Nersten[3] Nils Löhndorf[4]

We model the risk management problem of an operator of electricity storage who participates in a wholesale electricity market and hedges risk by trading currency forwards as well as power futures contracts. Our model considers three types of risks: operational risk due to future supply uncertainty, exchange rate risk when operations and trading takes places in different currencies, and profit risks due to power price variability. We model the problem as a multistage stochastic programming problem and propose a sequential solution approach to handle the high complexity of the optimization problem. Our contribution is three-fold: first, we show how currency risk and currency derivatives can be included in real option models of electricity storage; second, we introduce variables for accurate replication of the cash flow structure from a portfolio of financial contracts; and third, we compare optimization under a risk measure with simple hedging strategies often used in practice. For the case of a Norwegian hydropower producer, we quantify the reduction in risk through currency hedging when there is currency risk. We find that currency hedging leads to a moderate decrease of the profit risk, and that considering monthly power futures in the hedging strategy allows for precision hedging that can contribute to substantial reductions in risk.

[1]Norwegian University of Science and Technology

[2]Norwegian University of Science and Technology

[3]Norwegian University of Science and Technology

[4]University of Luxembourg

Stochastic optimization problems from Energy Management Systems

Adrien Le Franc[1] Michel De Lara[2]

Inserting renewable energy in electric microgrids is one of the key challenges of the energy transition. However, renewable energy sources are subject to high uncertainties and require developing suitable Energy Management Systems (EMS) to operate microgrids at least cost. We present stochastic optimization formalizations of industrial use cases of increasing complexity provided by Schneider Electric.
In the simplest case, the microgrid is connected to the global electric grid to import and export energy. First, we outline a physical model of a microgrid equipped with solar energy sources and batteries as storage devices. Second, we describe the daily management optimization problem and propose different stochastic optimization formulations. Third, we showcase numerical results and compare the performances of different resolution methods including Stochastic Dynamic Programming and Model Predictive Control.
In the more complex case, the microgrid can, in addition, provide stabilization services for the global electric grid, under the form of frequency containment reserve. Here the microgrid should provide energy reserves along the day to restore the balance on the global grid. We formulate a stochastic optimization problem and highlight the imbrication of both open loop and multi-stage decision structures.

[1] Carpentier, P., Chancelier, J. P., Cohen, G., & De Lara, M. (2015). Stochastic multi-stage optimization. In Probability Theory and Stochastic Modelling (Vol. 75). Springer.

[1] CERMICS ENPC

[2] CERMICS ENPC

Evaluation of equity-based debt obligations

Alexander Fromm[1]

We consider a class of participation rights, i.e. obligations issued by a company to investors who are interested in performance-based compensation. Albeit having desirable economic properties equity-based debt obligations (EbDO) pose challenges in accounting and contract pricing. We formulate and solve the associated mathematical problem in a discrete time, as well as a continuous time setting. In the latter case the problem is reduced to a forward-backward stochastic differential equation (FBSDE) and solved using the method of decoupling fields.

[1] https://arxiv.org/abs/1901.02254

[1] Institute for Mathematics, University of Jena

Optimal Control of a vibrating string with uncertain initial data and probabilistic terminal constraints

Martin Gugat[1]

The computation of optimal controls that solve a dynamic optimal control problem is more time-consuming than the solution of the corresponding static problem. Turnpike theory provides a relation between the solutions of the dynamic problems and the solution of the static problem that is valid for arbitrarily large time horizons. Recently progress in turnpike theory with pdes has been achieved. Here we present turnpike theorems for problems with probabilistic constraints that can be applied in the context of boundary control of gas pipeline operations.

[1] On the turnpike phenomenon for optimal boundary control problems with hyperbolic systems, M. Gugat, F. Hante

[1] Friedrich-Alexander Universität Erlangen-Nürnberg

Simultaneous Multi-Parameter Choice with Applications in Inverse Option Pricing

Christopher Hofmann[1]

The recovery of implied volatility and interest rate functions over a finite time interval from observed option prices is used as a benchmark problem with nonlinear forward operator to study the simultaneous recovery of multiple unknowns from given (noisy) data. We operate in the classical Black-Scholes model and recover a pair of unknowns (i.e. volatility and interest functions) from a pair of data functions, in this case the prices of the respective call- and put options. The injectivity of the forward operator in L^2-spaces is proven and therefore guarantees the identifiability of the unknowns. Tikhonov regularization using two separate penalty terms is employed to overcome the ill-posedness and existing heuristic parameter choice rules were adapted and generalized for this particular problem with two regularization parameters. Numerical examples are provided to demonstrate these findings.

[1] C. Hofmann, B. Hofmann and A. Pichler. Simultaneous identification of volatility and interest rate functions - a two parameter regularization approach, Paper submitted, 2018.
[2] T. Hein and B. Hofmann. On the nature of ill-posedness of an inverse problem arising in option pricing. Inverse Problems, 19(6):1319–1338, 2003.
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The impact of tax legislation on inventory and supplier selection models

Hua Jin[1] Patrick Beullens[2]

Operational Research (OR) provides the methods and techniques by which firms can maximise their profits by taking smart decisions. The OR literature in the area of logistics, however, pays scant attention to cash flows that arise in order for the firm to fulfil its legal obligations. This paper develops a methodology for constructing models that explicitly account for the impact of tax legislation on a series of classic inventory management problems. It does this by expressing the future profits of the firm after tax as the Net Present Value or Annuity Stream Value of the cash flow function associated with the activity for the firm, including these cash flows exchanged with relevant third parties and the government that are needed in the context of ensuring compliance with tax legislation. Using the legislation in the United Kingdom (before Brexit), the research e established how the explicit consideration of Value Added Tax (VAT) scheme, Corporate Tax (CT) and i impor i import duties and tariffs rules affect optimal decisions for a firm with respect to the optimal a associated product ordering policies. We examine the implications from European Union legislation o on acquisitions as well as international based import on inventory management. We find that tax r rates as well as tax schemes that apply to the firm are important in particular for products with l lower profit margins. Taxes not only affect the optimal inventory policy, but may also influence t the sourcing and supplier selection strategy.

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Second Order Stochastic Dominance in Optimization Problems via Empirical Data

Vlasta Kaňková[1] Vadim Omelčenko [2]

Stochastic dominance is generally used to compare distributions of two random variables. Simultaneously, the stochastic dominance guarantees a solution corresponding to partial order between utility functions in a given subsystem U of the utility functions. Especially, considering $U := U_1$ (where U_1 is a system of non decreasing concave non negative utility functions) we can often obtain an optimization problem with second order stochastic dominance constraints. Evidently this is reason why the second order stochastic dominance constraints are very often employed in stochastic optimization problems. However, second order stochastic dominance can be also useful for the mean-risk models. Both of these situations correspond to optimization problems going to semi-infinite optimization problems for which Slater's condition is not necessary fulfilled. Consequently, it is often necessary to modify these problems a little. The aim of the contribution is to deal with the case when a construction of modified problem has to be done on the data base. We try to present approximating model that tends to the "theoretical" one with an approximating error less than a given value. The rate of convergence will be also investigated. The case of heavy tails distribution (covering stable) will be mention separately. To obtain new results we recall the stability results based on the Wasserstein metric corresponding to L_1 norm.

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Dynamic portfolio optimization via Hamilton-Jacobi-Bellman equations and their transformation

Sona Kilianova[1] Daniel Sevcovic[2] Maria Trnovska[3]

We consider a problem of dynamic stochastic portfolio optimization modeled by a Hamilton-Jacobi-Bellman (HJB) equation. Using a Riccati transformation, the HJB equation is transformed to a simpler quasi-linear PDE. An auxiliar quadratic programming problem is obtained, which uses a vector of expected asset returns and a covariance matrix of returns as input parameters and reveals useful properties. The problem can be extended to worst-case optimization over convex or discrete uncertainty sets both for asset returns and covariance matrix.

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Almost Sure Convergence for Nested Monte-Carlo Simulations

Maximilian Emanuel Klein[1] Ralf Werner[2]

The Solvency II framework provides a standard formula for the calculation of the risk capital (SCR=Solvency Capital Requirement) in one year, but also gives life insurance companies the freedom to develop an own internal model. By using such an internal model, insurance companies aim to reduce their risk capital, as specific business strategies and internal diversification effects can be better taken into account by an internal model instead of the predefined standard formula. One way of determining future risk capital on the basis of an internal model is to use a nested Monte Carlo simulation.

From a theoretical point of view, in nested stochastics we analyze the asymptotic behavior and optimal convergence rates of Monte Carlo estimators for

$$\mathbb{E}\left[G\left(\mathbb{E}\left[V|Z\right]\right)\right],$$

whereby $G(\cdot)$ represents a non-linear function and V and Z are elements of $L^2(\Omega, \mathcal{F}, \mathbb{P})$. Thereby outer scenarios are used for modelling Z (e.g. for an insurance framework this represents risk factor modelling) and (conditional) inner scenarios for V, for the approximation of the previously introduced conditional expected value.

Essentially, we will show almost sure (a.s.) convergence results for nested Monte-Carlo estimators. For specific setups we will discuss almost sure asymptotic rates of convergence based on the law of iterated logarithm. Finally, these results will be compared with the existing results for the L^2-convergence and for the convergence in distribution. We particularly compare to the work of Gordy & Juneja (2010) and Andradóttir & Glynn (2016), who laid the foundation for the L^2- and central limit theory of nested simulation.

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Workforce Planning in Airport Logistics: A Real-World Business Application

Andreas Klinkert[1]

Staff scheduling and rostering involves a number of hierarchical subproblems including demand modeling, task generation, shift design, days-off scheduling, shift assignment and real-time dispatching. When solving highly constrained large-scale workforce planning problems it is usually not computationally practical to deal simultaneously with all these tasks. Real-world software solutions typically decompose the overall planning task into heuristically designed subproblems which then are tackled by a variety of suitable exact and heuristic methods.

We present results from a major research and business project with Swissport International Ltd., the largest ground handling company worldwide, which provides services for 850 client companies and 265 million passengers a year, with a workforce of 68 000 personnel at 315 airports. During a long-term strategic cooperation, a high-performance software for automated staff scheduling in airport logistics has been developed, which is able to solve the complex large-scale rostering problems in Swissports airport operations. The solution methodology comprises a broad range of optimization techniques including preprocessing, decomposition and relaxation approaches, mixed-integer programming models, and various heuristic procedures.

We start with an introduction to the business environment of the project and show its actual planning context which comprises other software tools and human planning activities related to the workforce scheduling process. We provide insight into several aspects of the solution process, including the analysis and preprocessing phase which turned out to be crucial for the entire planning system. We provide further insight into decomposition strategies, mathematical problem structure, and algorithmic approaches. Finally, we present computational experience with real world instances and discuss operational impacts of the developed planning tool. Bottom line benefits include faster and more robust planning processes, improved roster quality, better fairness, reduced planning capacity requirements, and as a result, substantial financial savings.

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Portfolio selection with DARA constraints

Miloš Kopa[1] Thierry Post[2]

Portfolio optimization based on Stochastic Dominance (SD) is theoretically appealing, for investment strategies with asymmetric risk profiles such as equity price reversal and momentum plays. Most studies in this area are based on the second-order stochastic dominance (SSD) criterion. Unfortunately, SSD has limited discriminatory power, because it requires unanimity among all global risk averters, including those with implausible attitudes towards higher-order risk. SSD optimization therefore often produces solutions which are suboptimal for all standard utility functions. To improve the power of the analysis, the paper develops a portfolio optimization method based on Decreasing Absolute Risk Aversion Stochastic Dominance (DSD). DSD is known to be more powerful than alternative dominance criteria in several related financial applications and it is generated by the most restrictive class of utility functions acceptable to most economists. The proposed optimization method improves upon the performance of Mean-Variance optimization by tens to hundreds of basis points per annum, for low to medium risk levels. The improvements critically depend on imposing Decreasing Absolute Risk Aversion instead of Global Risk Aversion or Decreasing Risk Aversion.

[1] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3063141

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XOR-AHP Approach and Its Assessment in the Renewable Energy Sector

Noureddine Kouaissah[1] Amine Hocine[2]

Uncertainty is an inherent and intrinsic feature of various decision-making processes. This paper proposes a new method called XOR-AHP that integrates classic AHP techniques and the logic of the "exclusive-or" (XOR) function. Specifically, the method uses a novel mathematic programming model to derive a priority vector from an XOR comparison matrix; it uses an XOR weighting (XOR-W) technique that allows decision makers (DMs) to set multiple judgments for a particular evaluation using XOR logic. Methodologically, to integrate DMs' preferences into this method, three types of XOR matrices are proposed: positive, negative, and neutral. The model's utility is validated by applying it to a real-world scenario: ranking and selecting North African countries for renewable energy investments for the Desertec project. The results show that the proposed methodology can assist DMs and offer an alternative way to support decision-making processes under uncertain conditions and in imprecise environments.

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Fair distribution of random Revenues for joint projects in the electricity sector

Raimund Kovacevic[1] Walter Gutjahr[2] David Wozabal[3]

When there is a joint project undertaken by several parties, an important question is how to distribute the costs and the random income streams created from the project in a fair way. Examples for such projects in the electricity sector are e.g. jointly operated solar panels and batteries or virtual power plants. We analyze the application of the (generalized) Nash-bargaining setup to such projects. The participants bargain their shares, together with the optimal usage of the implemented equipment. Moreover we analyze the cases of equal versus diverse bargaining power.

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Continuous games and their applications

Tomáš Kroupa[1]

A continuous game is a multi-player strategic game in which strategy spaces are compact metric spaces and all the utility functions are continuous. According to Glicksberg's theorem, which is a vast generalization of the Nash theorem, equilibria always exist for any continuous game. This level of generality brings about a number of caveats, since Glicksberg's theorem is an existential statement providing no information about the equilibrium strategies. On top of that, such strategies can be arbitrarily complicated Borel probability measures. Solving continuous games thus requires a good combination of theoretical results with algorithmic insight gained from application domains. The main focus is on games for which finitely-supported equilibria exist and there are efficient solution methods for their computation. For example, it is known that an equilibrium of a two-player zero-sum polynomial game can be obtained by solving a single semidefinite programming problem (Parillo, 2006). Any continuous zero-sum game on the square can be approximated by piecewise affine functions. It is an open question if a resulting continuous game allows for at least one finitely-supported equilibrium. In the talk I will present partial results related to this problem and I will mention applications in adversarial machine learning.

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Stochastic optimization shema with timers

Petr Lachout[1]

We introduce a stochastic optimization schema with random times of changes. The task is to optimize gain from a random process arising in the scheme. The process is controlled by decisions made in random times. We intent to give a description of the schema and present a procedure finding a solution.

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Design of Lower Bound Convex Programs for Exact Sparse Optimization

Michel De Lara[1] Jean-Philippe Chancelier[2]

In exact sparse optimization problems, one looks for solution that have few non-zero components. We consider problems where sparsity is exactly measured by the non convex l0 pseudo norm (and not by substitute penalizing terms).
First, we display a suitable conjugacy for which we show that the l0 pseudo norm is "convex" in the sense of generalized convexity (equal to its biconjugate). As a corollary, we also show that the l_0 pseudo norm coincides, on the sphere, with a convex lsc function.
Second, thus equipped, we display a lower bound for the original exact sparse optimization problem. Under mild additional assumptions, this bound is a convex minimization program over the unit ball of a so-called support norm.
Third, we introduce generalized sparse optimization, where the solution is searched among a union of subspaces. We provide a systematic way to design norms and lower bound convex minimization programs over their unit ball. Thus, we yield an interpretation for most of the sparsity-inducing norms used in machine learning.

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Sampling Methods for Multistage Robust Optimization

Francesca Maggioni[1] Georg Ch. Pflug[2] Fabrizio Dabbene[3]

In this talk, probabilistic guarantees for constraint sampling of multistage robust convex optimization problems are derived. The dynamic nature of these problems is tackled avoiding the conservative use of explicit parametrizations through decision rules. An explicit bound on the probability of violation of the randomized solution is provided and a proof of convergence of the randomized approach presented. Exact and sampled-based lower bound to the original multistage robust optimization program are discussed. Numerical results dealing with a multistage inventory management problem show the efficacy of the proposed approach.

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Risk-averse pathwise dynamic programming: A simple simulation-and-regression approach

Sebastian Maier[1] Georg Pflug[2]

Pathwise dynamic programming is a powerful algorithmic strategy to solve sequential stochastic decision problems such as valuing — real and financial -– options; however, existing valuation approaches generally neglect decision-makers' attitude towards risk and only consider risk-neutral expectations. In this paper we present a simple yet powerful new approach to approximately solve risk-averse pathwise dynamic programs by simulation-and-regression. Applying the — time consistent and convex -– dynamic entropic risk measure, we use simulation in combination with parametric regression to approximate the conditional risk measure that represents the dynamic entropic risk to the decision maker from continuation. The approach is therefore readily applicable in a wide range of realistic and practical real-world problems such as those involving real option portfolios and multiple sources of uncertainty. We illustrate the intuition behind our approach considering the simple examples of valuing American-style put and call options, as well as demonstrate its applicability to more complex problems by evaluating a natural resource investment under several portfolio configurations (deferment, mothballing, and abandonment) and under conditions of three underlying uncertainties (copper price, production cost, and convenience yield). We investigate the way in which the value of these investment problems is affected by the decision makers' attitude to risk, and by the degree(s) of uncertainty. In addition, we illustrate the impact of risk aversion on both optimal decisions and the probability of investment.

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Stochastic Optimization for the Crude oil procurement problem

Thomas Martin[1] Michel DeLara[2]

Crude oil procurement is subject to variations in shipping delays and random costs. The optimal procurement problem aims at buying oil for refineries so as to minimize costs. The plants owned by a company have different specifications, and so have the crude oils available on the market. In our setting for the problem, we focus on the stochasticity of the costs of oil, shipping and of the products prices. The dynamic of the system over time, the shipping delays, and the running of a refinery are supposed to be deterministic. In this presentation, we will first focus on the identification of controls and states variables for the crude oil procurement problem. The resulting problem is a multistage stochastic optimization problem, which, due to its huge size, is impossible to solve as such. We discuss possible numerical resolution techniques.

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Generation and Transmission Expansion Planning with high Shares of Renewables

Giovanni Micheli[1] Maria Teresa Vespucci[2] Marco Stabile[3] Cinzia Puglisi[4]

This paper is concerned with generation and transmission expansion planning of energy systems with high penetration of intermittent renewable energy sources. Given forecasts of future values of load, fossil fuel prices and investment costs, investments are defined by means of a mixed integer linear model that determines how the capacity mix should evolve in order to meet the demand for electricity and fulfill policy targets while minimizing the sum of operational, investment and decommissioning costs. An investment schedule is determined for the decommissioning of existing thermal plants and the construction of new generation capacity as well as of electrical regional interconnections that results in the minimum cost. Policy goals and environmental targets, such as fossil fuels and CO2 emissions reduction, are explicitly considered in the expansion plan. In order to accurately study the integration of large shares of renewable energy sources, a high level of temporal detail is required in this analysis. Due to the long time horizon expansion planning problems may become computationally intractable. Most generation and transmission expansion planning models reduce computational cost by employing a rather low level of temporal and technical detail. In order to obtain high accuracy without dramatically increasing computational cost, we select a set of representative days by performing a clustering analysis on input data. By selecting representative days, the proposed approach allows maintaining a high level of temporal detail, resulting ideally suited to analyze scenarios with high penetrations of intermittent renewable energy sources. Numerical results show how the proposed model can offer a professional guidance and support in strategic decision to the different actors involved in electricity transmission and generation.

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Pricing in Markets with Differentiated Products

David Müller[1] Vladimir Shikhman[2]

We present a price adjustment towards a market equlibrium for markets of similar products. In our approach we describe the demand of consumers by a nested logit model. Our objective function is then given by the total excessive revenue of the market's participants.
We derive optimality conditions with a meaningful economic interpretation. Using convex analysis we derive analytical properties of the total excessive revenue function, in particular the Lipschitz constant of the gradient. Hence the pricing problem is solvable by gradient-based methods and the dynamics of the market can be analyzed.

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Behavioral premium principles

Martina Nardon[1] Paolo Pianca[2]

We define a premium principle under the continuous cumulative prospect theory which extends the equivalent utility, or zero utility, principle; furthermore, we apply alternative framing of the outcomes. In prospect theory risk attitude and loss aversion are shaped via a value function, whereas a transformation of objective probabilities, which is commonly referred as probability weighting, models probabilistic risk perception. In cumulative prospect theory, probabilities of individual outcomes are replaced by decision weights, which are differences in transformed, through the weighting function, of counter-cumulative probabilities of gains and cumulative probabilities of losses, with outcomes ordered from worst to best. Empirical evidence suggests a typical inverse-S shaped function: decision makers tend to overweight small probabilities, and underweight medium and high probabilities; moreover, the probability weighting function is initially concave and then convex. We study some properties of the behavioral premium principle. Then we discuss several applications to the pricing of insurance contracts, considering alternative value functions and probability weighting functions proposed in the literature, and different mental accounting. Finally, we focus on the shape of the probability weighting function.

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Wave propagations in full absorption medium

Gulko Natalia[1] Slezov I.[2] Volinski R.[3]

We consider the initial-boundary value (IBV) problem based on a new generalized model. The Laplace transform and the numerical inversion are used in the case of arbitrary coefficients. The results of calculations for certain values of the coefficients characterizing real tissues are presented. Earlier, an approximate analytical solution of the problem for the generalized hyperbolic equation modeling the spread of a medical preparation injected into a biotissue was constructed.

Key words: generalized hyperbolic equation, Laplace transform, initial-boundary value (IBV) problem, numerical inversion

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Decomposition Algorithms in Mixed Integer Linear Programming

Vadim Omelcenko[1] Mohammadreza Saeedmanesh[2]

We present algorithms for decomposition of large-scale optimization problems where we manage a pool of connected hydro-power plant. The directions of the decomposition are asset-wise and stage-wise. In the asset-wise decomposition we test the capabilities of the Dantzig-Wolfe method and present our approach. In the stage-wise decomposition, we test capability of SDDiP methodology and compare the results with our recursive methods. These decomposition methods enable us to achieve substantial acceleration of the calculations sometimes in three orders of magnitude.

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Testing for paremetric orderings efficiency

Sergio Ortobelli[1] Matteo Malavasi[2] Nikolas Topaloglou[3]

In this paper, we develop and empirically compare semi-parametric tests to evaluate the efficiency of a benchmark portfolio with respect to different stochastic orderings. Firstly, we classify investors choices when returns depend on a finite number of parameters: a reward measure, a risk measure and other parameters. We extend Stochastic Dominance theory under minimal assumptions on reward and risk measures. We prove that, when choices depend on a finite number of parameters and, reward measure is isotonic with investors preference, agents behave as non satiable and risk averse when the reward measure is lower than the mean. While agents behave as non satiable and risk seeker when the reward measure is higher than the mean. Then, we introduce a new stochastic ordering, consistent with choices of a non satiable, nor risk averse nor risk seeker investors. Secondly, we propose a methodology to semi-parametric tests for the efficiency of a portfolio, when the return distribution is uniquely identified by four parameters, using estimation function theory. Finally, we empirically test whether the Fama and French market portfolio, as well as the NYSE and the Nasdaq indexes are efficient with respect to alternative stochastic orderings.

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Stochastic optimization in Hilbert spaces with applications to shape optimization

Georg Pflug[1] Caroline Geiersbach[2]

First, we give an overview of stochastic (projected) gradient techniques. These methods are quite old, but see some important revival in deep machine learning, image reconstruction and pattern recognition.
Our application of the stochastic quasi-gradient technique deals with stochastic optimization in Hilbert spaces, with applications in optimal control and stochastic shape optimization. In these high dimensional applications, constraints are typically coming from PDE-equations. We compare the results in infinite dimensional Hilbert spaces with known results in finite dimensional situations. In particular, we study the strictly convex case, the non-strict convex case and the nonconvex case separately. The weak convergence to a critical point can be shown under regularity assumptions. A case of a shape optimization for a structure under random stress is demonstrated leading to a concrete, touchable solution.

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Problem-based optimal scenario generation in two-stage stochastic programming

Werner Römisch[1] René Henrion[2]

Scenarios are indispensable ingredients for the numerical solution of stochastic programs. Earlier approaches to optimal scenario generation are based on stability arguments involving distances of probability measures. We review those ideas and suggest to make use of stability estimates based only on problem specific data. For linear two-stage stochastic programs we show that the problem-based approach can be reformulated as best approximation problem for the expected recourse function which in turn can be rewritten as a generalized semi-infinite program. We show that the latter is convex if either right-hand sides or costs are random and can be transformed into a semi-infinite program in a number of cases.

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Maximising Loan Value under Decision Dependent Randomness

Tomáš Rusý[1] Miloš Kopa[2]

We present a stochastic programming asset-liability management model which deals with decision dependent randomness. The model is designed to answer questions frequently asked by many (multinational) companies. That is, what is the "best" interest rate that a company should offer to a client for a loan and how to finance it. In determining the answers, we must consider numerous factors. Between these, the possibility that client rejects the loan, the possibility of clients default on the loan and also the possibility of a prepayment need to be included. Moreover, these random effects have certain relationship to the offered interest rate of the loan, which induces decision dependent randomness into our program. Another important factor which now plays major role for the liabilities is the price of money at the market. That is determined by corresponding market interest rate and we capture its evolution in the form of a scenario tree. We will formulate a non- linear, multi-stage, decision dependent randomness stochastic program which will span over the lifetime of a typical consumer loan. Its solution will give us the optimal decisions the company should make. In addition, we will also show a sensibility analysis, that is present results of the model for various parameter settings describing different types of clients. Finally, we will discuss the losses caused in the case that companies would not act in the optimal way.

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Nested Risk Measures and Optimal Control

Ruben Schlotter[1]

We introduce nested risk measures for stochastic processes and extend the infinitesimal generator to the risk averse case. Nested risk measures are built on static risk measures, which originate by conditioning on the history of a stochastic process. These nested risk measures appear naturally in the context of multistage optimization, as they allow beneficial reformulations for algorithmic treatments. We extend the notion of a nested risk measure to continuous time and derive a risk-averse analogue to the infinitesimal generator, a nonlinear partial differential operator. Using the concept of a risk-averse generator we obtain a risk-averse Hamilton-Jacobi-Bellman equation. Finally we relate our results with risk measures defined via g -expectation and characterize their drivers in relation to nested risk measures and give an example of a risk-averse control problem which can be explicitly solved.

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Optimization in meshed gas networks

Rüdiger Schultz[1]

In the talk, systems of nonlinear equations describing pressure and flow in stationary gas networks will be addressed. It will be illustrated that, primarily, it neither is the number of nodes nor the number of edges that drive the computational effort. Rather it is the number of fundamental circles and their mutual penetration in terms of common edges that has the essential impact. Both analytical and algebraic approaches leading to useful insights for structural analysis, stability considerations, and problem solution will be presented.

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Dual subgradient method with averaging for optimal resource allocation

Vladimir Shikhman[1] Yurii Nesterov[2]

A dual subgradient method is proposed for solving convex optimization problems with linear constraints. As novelty, the recovering of primal solutions can be avoided. Instead, the optimal convergence rate for the whole sequence of primal-dual iterates is obtained. This is due to the primal-dual averaging strategies which are incorporated into the iterative scheme. We apply our dual subgradient method with averaging to optimal resource allocation within a multi-agent environment. The proposed dual subgradient method naturally corresponds to a distributed process of production/price adjustments and effectively leads to a market equilibrium.

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Separable Utility Functions in Discrete- and Continuous-time Markov Decision Chains

Karel Sladký[1]

The usual optimization criteria examined in the literature on stochastic dynamic programming, such as total discounted or mean (average) reward structures, may be quite insufficient to characterize robustness of the problem from the point of a decision maker. To this end it may be preferable if not necessary to select more sophisticated criteria that also reflect stability and variability-risk features of the problem. Hence robustness and risk control are also important issues in practical applications. As well known one of the common and popular risk measure is the variance and the best known approaches stem from the classical work of Markowitz on mean variance selection rules. In this article we consider discrete- and continuous-time Markov decision processes with finite state spaces where the stream of rewards generated by the Markov processes is evaluated by an exponential utility function with a given risk sensitivity coefficient. If the risk sensitivity coefficient equals zero (risk-neutral case) we arrive at a standard Markov decision process. For the risk-sensitive case, i.e. if the risk-sensitivity coefficient is non-zero, for a given value of the risk-sensitivity coefficient we establish necessary and sufficient optimality conditions for maximal (or minimal) growth rate of expectation of the exponential utility function. Recall that in this case along with the total reward also its higher moments are taken into account. Using Taylor expansion of the utility function we present explicit formulae for calculating variance and higher (central) moments of the total reward generated by the Markov reward process along with its asymptotic behavior. Policy iteration methods can be used for finding optimal policy for various types of utility functions.

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Application of Markov SDDP to Financial Modelling

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Many real-life decision problems are in fact problems of asset-liability management (ALM): an uncertain amount some asset has to be delivered and the goal is to satisfy this obligation in an optimal way. The asset to be delivered may be money (in pension fund management), stocks (when writing an option), carbon allowances (in emission trading), or anything else. Usually, the ALM problems lead to (linear or convex) multistage stochastic programming problems.
Unfortunately, the exact solution of these problems of reasonable size is virtually impossible. There exists an efficient method for their solution – Stochastic Dual Decomposition (SDDP); however, this method requires the underlying random processes to be time-independent, which is not the case of price time series, underlying the ALM models. Recently, a generalized version of SDDP relaxing the independence assumption to conditional independence given some Markov Chain has been introduced. The idea of our paper is to approximate the time-dependent random parameters of an ALM model by a Hidden Markov chain (HMC) process satisfying this assumption and use the Markov SDDP for the solution.
In particular, we define a general ALM model allowing some of its random parameters to be Markov. Next, we propose an HMC approximation of the Markov parameters and state its upper bound, measured by the Multistage distance. Then we prove the convergence of the approximation when increasing the granularity of the underlying Markov Chain, implying the convergence of the exact and the approximate optimal values. Finally, we numerically demonstrate that our solution method is efficient and reasonably exact.

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Strong Convexity of Risk Functions in Linear Recourse Models

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We generalize results concerning strong convexity of expectation-based risk functions arising in linear recourse models to a risk-averse setting. The analysis includes comonotonic risk measures, distorted expectations and risk measures based on higher moments. We will also point out implications on the stability of minimization models.

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On pessimistic bilevel optimization

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Pessimistic bilevel optimization problems, as optimistic ones, possess a structure involving three interrelated optimization problems. Moreover, their finite infima are only attained under strong conditions. We address these difficulties within a framework of moderate assumptions and a perturbation approach which allow us to approximate such finite infima arbitrarily well by minimal values of a sequence of solvable single-level problems. To this end, we introduce the standard version of the pessimistic bilevel problem.
For its algorithmic treatment we reformulate it as a standard optimistic bilevel program with a two follower Nash game in the lower level. The latter lower level game, in turn, is replaced by its Karush-Kuhn-Tucker conditions, resulting in a single-level mathematical program with complementarity constraints.
The perturbed pessimistic bilevel problem, its standard version, the two follower game as well as the mathematical program with complementarity constraints are equivalent with respect to their global minimal points, while the connections between their local minimal points are more intricate. As an illustration, we numerically solve a regulator problem from economics for different values of the perturbation parameters.

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Stochastic Corrective Risk-Based Optimal Power Flow

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We propose a model that quantifies and controls the total system line overflow caused by contingencies via means of Conditional Value-at-Risk (CVaR) constraint. We then incorporate the wind uncertainty into our model and perform computational experiments.

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Nonlinear DEA models for technologies with undesirable outputs - an application of semidefinite programming

Maria Trnovska[1] Margareta Halicka[2]

Throughout its evolution, data envelopment analysis (DEA) has mostly relied on linear programming, particularly because of simple primal-dual relations and the existence of standard software for solving linear programs. Although also non-linear models, such as Russell measure model or hyperbolic model have been introduced, their use in applications has been limited mainly because of their computational inconvenience. In the presentation we provide a methodology for theoretical and practical treatment of non-linear models in DEA. We offer a general scheme for reformulation of the models as semidefinite programming problems and for the derivation of the corresponding dual programs. Two benefits of our approach are: the reformulated model can be solved efficiently using standard conic programming solvers and the derived dual programs are comparable with the multiplier forms of some linear DEA models and allow to establish the relation to the profit efficiency. Moreover, both models can be modified to deal with technologies with undesirable outputs and used in environmental applications. While the widely used environmental hyperbolic model may lead to misleading scores of the unit under evaluation, the modified Russell measure model always projects on the efficient boundary and hence the efficiency scores are appropriate. We demonstrate the negative features and compare the models using illustrative and empirical examples.

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Multistage stochastic dominance: an application to pension fund management

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A pension fund manager typically decides the allocation of the pension fund assets looking for a long term sustainability. Many Asset and Liability Management models in the form of multistage stochastic programming problem have been proposed to help the pension fund manager to define the optimal allocation given a multi-objective function. The recent literature proposes multistage stochastic dominance constraints to guarantee that the optimal strategy is able to stochastically dominate a benchmark portfolio. In this work we extend previous results to another type of stochastic dominance that appears more consistent to use in a multistage framework. Indeed, instead of considering multiple single-stage stochastic dominance constraints, we apply a unique constraint that involves jointly multiple stages. Numerical results show the difference between the different ways to interpret and apply the multistage stochastic dominance.

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Dampening the Curse of Dimensionality: Decomposition Methods for Stochastic Optimization Problems

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Large stochastic optimization problems are typically hard to solve. The computational complexity is driven by the number of decision stages and the size of the problems in each stage. We review different approaches to stochastic optimization and present an approach to solve problems with a Markov structure. The approach differs from classical solution methods in two ways: First, it uses scenario lattices instead of a scenario trees to represent uncertainty and thereby significantly reduces the complexity of the problem in the number of stages. Secondly, we use a dynamic programming framework based on decomposition that does not require the discretization of the whole state space and thereby allows for a large number of decision variables in the problem formulation. In combination, these two design choices make large stochastic programming problems with many stages computationally tractable. We demonstrate theoretical properties of the method and demonstrate the benefit of the proposed method on realistic problem instances.

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Utility Preference Robust Optimization: Piecewise Linear Approximation and Statistical Robustness

Huifu Xu[1]

Preference robust optimization (PRO) has recently received increasing attention in the research communities of robust optimization and decision analysis. Differing from traditional robust optimization models which deal with ambiguity of exogenous uncertainty of a decision making problem, PRO model focuses on endogenous uncertainty arising from decision maker's ambiguity of utility preference and/or risk attitude. In this talk, we discuss a PRO model where information on decision maker's utility preference is incomplete but can be elicited through partial information such as questionnaires and pairwise comparison, the optimal decision is based on the least favourable utility function elicited. Differing from the existing research in this area, we propose a piecewise linear approximation scheme for the elicited utility functions and then develop efficient computational schemes for solving the approximated problem. When the utility functions are concave, we can reformulate the approximated maximin problem as a single linear programming problem. The piecewise linear approximation scheme also enables us to derive an error bound for the optimal value which is a step forward from qualitative convergence results. A key assumption in the PRO model is that the true probability distribution is either known or can be recovered by empirical data which do not contain any noise. It is unclear however a statistical estimator such as the optimal value of a PRO model based on empirical data is reliable when the empirical data contain some noise. We move on to investigate the issue which is known as statistical robustness in the literature of robust statistics. We derive moderate sufficient conditions under which the robust optimal value changes continuously against small variation of the probability distribution of the underlying random variables and identify appropriate metrics under which the statistical estimator of the optimal value is uniformly asymptotically consistent which is also known as uniform Glivenko-Cantelli property. Finally, we demonstrate statistical robustness of the estimators of the optimal value and the optimal solutions for the PRO model, the results cover a wide range of utility optimization problems when the decision variable is fixed, and stochastic optimization problems when the ambiguity of the utility disappears.

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Multivariate Mixed CUSUM-EWMA (MMCE) Control Chart for effective Process Monitoring

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For more than one correlated quality characteristics, individual monitoring of each variable misses the important information on correlation structures and hence leads to misleading results. To avoid all these issues, multivariate control charts are very suitable and reliable tools. Multivariate cumulative sum (MCUSUM) and exponential weighted moving average (MEWMA) control charts utilize present and past information and are very effective to detect small-to-moderate shifts in the process parameter(s). In this study, we propose a new multivariate mixed CUSUM-EWMA control chart named as MMCE control chart. The MMCE control chart structure uses the output statistic of the MCUSUM chart as an input statistic in the MEWMA control chart. The average run length (ARL) measure for an individual shift is used as a performance measure to evaluate the performance of the proposed control chart and compare its ability with some existing counterparts including Hotelling-T2, MCUSUM, MEWMA and MC1 control charts. An application example is also presented for practical considerations using a real data set. We have observed that the proposed MMCE control chart provides good detection ability against to MCUSUM and MEWMA control charts for small shifts. At smaller choices of λ, the MMCE control chart has superior detection ability as compared to MC1 control chart for all shifts. Moreover, the MMCE control chart also competes well with the Hotelling-T2 control chart in terms of overall performance. Therefore, we conclude that our proposed MMCE control chart is a good addition in the literature for effective process monitoring.

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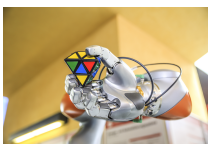

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