SIGOPT International Conference on Optimization 2023

Cottbus, Germany
March 14–16, 2023

Welcome to the SIGOPT International Conference on Optimization 2023

Dear Participants,

on behalf of the whole organizing committee, I would like to welcome you to the SIGOPT International Conference on Optimization 2023 in Cottbus.

The scientific program comprises 48 presentations, as well as six invited talks. The social program with a guided tour through the old town of Cottbus and a conference dinner will provide additional opportunities for scientific exchange and networking.

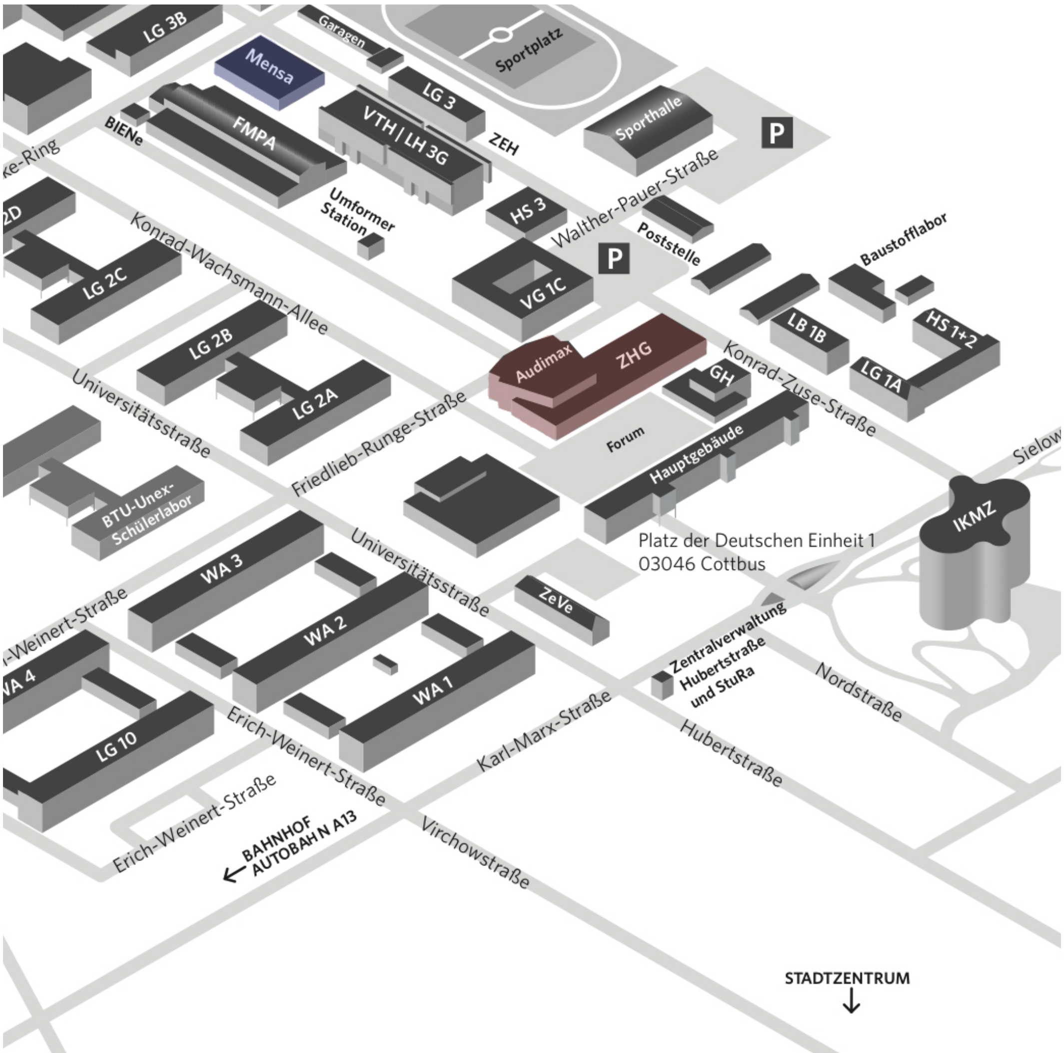
We would like to thank all the presenters who submitted their work and we hope that this conference will lead to many fruitful collaborations. We are grateful to the Deutsche Forschungsgemeinschaft DFG and the Gesellschaft für Operations Research GOR e.V. for their kind support of the conference.

Armin Fügenschuh

Contact Information

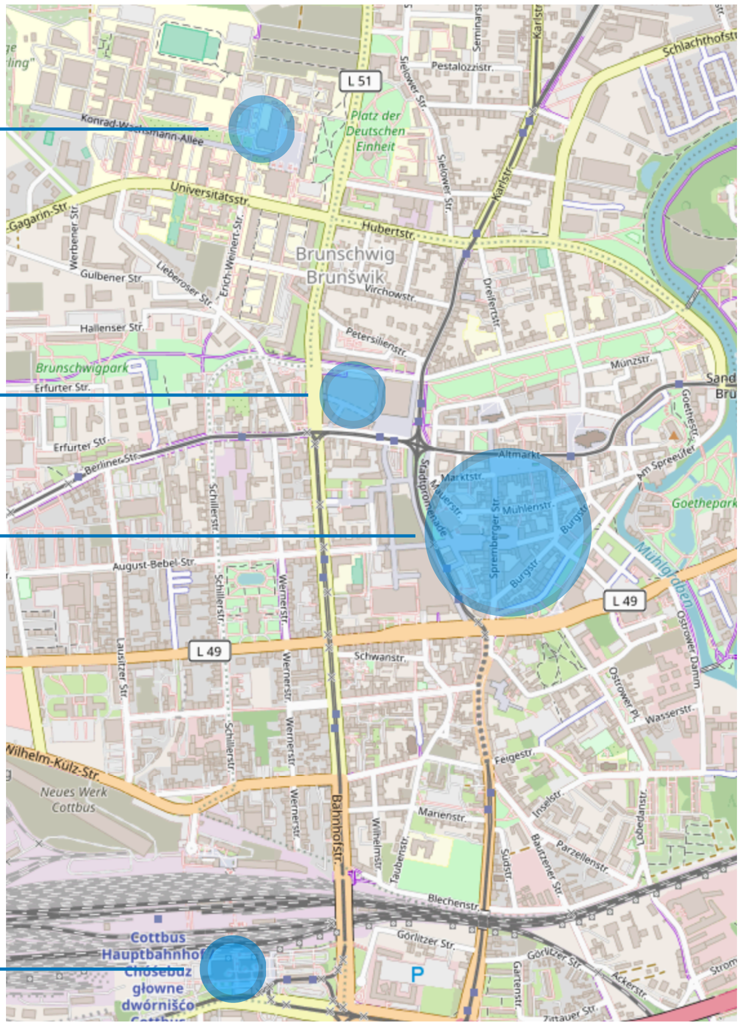
Email address Organizers	sigopt2023@b-tu.de

Map of the Campus



Plan of the BTU Campus area. The conference is located at the ZHG (colored in red). The university canteen (Mensa) is colored blue.

Map of the City Center



BTU Main Campus (Conference Venue)

Lindner Hotel

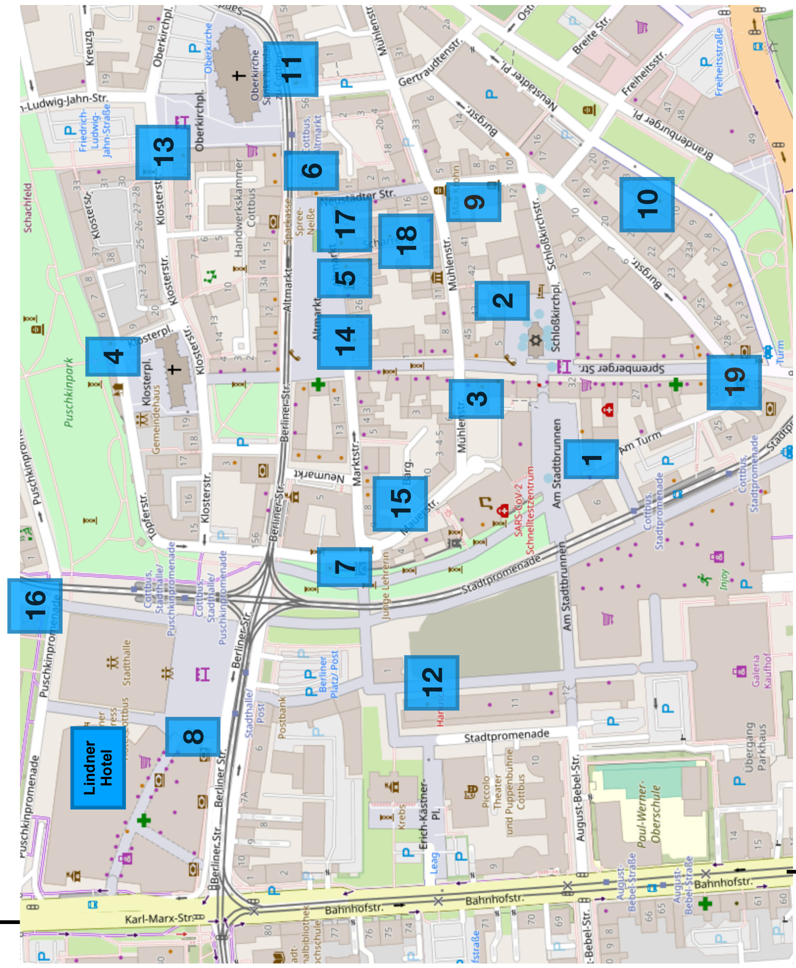
Old Town

Bus&Tram Stop at Cottbus Hbf (Central Station)

Hotel Lindner can be reached from the Central Station via Tram 2 (Sandow), Tram 4 (Neu Schmellwitz) or via Bus 15 (Sielow) at the stop “Stadthalle”. The University Campus can be reached via Bus 15 (Sielow) at the stop “Universitätsbibliothek” and Bus 16 (Stadthalle) at “Universität”.

Restaurants in the City Center

to BTU



to Railway Station

American
1.. Jimmy's Diner

German
2.. EssCoBar
3.. Kartoffelkiste
4.. Klosterkeller
5.. Mosquito
6.. Brau & Bistro
7.. Stadtwächter
8.. Wunderbar
9.. U-Boot

Greek
10.. Artemis
11.. Mythos

Indian
12.. Jaipur
13.. Shiva

Italian
14.. Ristorante Amarone
15.. Ristorante Roma
16.. Trattoria il Sardo

Japanese
17.. Sakana Sushi

Spanish
18.. Taparia

Vietnamese
19.. Dreams

Monday, March 13th

18:00 – 20:00	**Welcome Reception and Registration**
	Hotel Lindner: 1st Floor

Tuesday, March 14th

08:00 – 08:30	**Registration**	
08:30 – 09:00	**Welcome**	
09:00 – 10:00	Audimax – Chair: Ekkehard Köhler	
	Algorithms Using Predictions: Online Routing and Network Design Nicole Megow	
10:00 – 10:30	**Coffee Break**	
Session 1	Hörsaal A	Hörsaal B
	Optimization in abstract spaces Chair: Sabine Pickenhain	**Combinatorial Optimization** Chair: Ekkehard Köhler
10:30 – 11:00	**Nonlinear Cone Separation Theorems in Real Reflexive Banach Spaces** Christian Günther	**Graph Based Time Series Analysis for Gait Segmentation** Christoph Helmberg
11:00 – 11:30	**On the Fuzzy Sum Rule for the Regular Subdifferential** Patrick Mehlitz	**The Traveling Salesman Problem with Memory** Anja Fischer
11:30 – 12:00	**A Trust-Region Algorithm for Parameter Identification in Multigroup Pandemic Models** Markus Friedemann	**New Lower Bounds for the Double Row Facility Layout Problem** Frank Fischer
12:00 – 12:30	**Proximal Methods for Point Source Localisation** Tuomo Valkonen	**A Two-Dimensional Cutting Stock Problem with Multiple Stocks and Divisible Items** Kasitinart Sangngern
12:30 – 13:30	**Lunch**	
Session 2	Hörsaal A	Hörsaal B
	Nonsmooth Optimization and Control (I) Chair: Constantin Christof	**Mixed-Integer Programming** Chair: Armin Fügenschuh
13:30 – 14:00	**Support Stability for Total (Gradient) Variation Regularization** Vincent Duval	**Multi-Objective Duty Scheduling using Mixed-Integer Programming in Hospitals** Saran Karthikeyan
14:00 – 14:30	**Learning Polynomial Optimal Feedback Laws for Control Problems** Donato Vásquez Varas	**A Solver for Multi-Objective Mixed-Integer Optimization Problems using Hybrid Patch Decomposition** Leo Warnow
14:30 – 15:00	**An Exponentially Converging Particle Method for the Mixed Nash Equilibrium of Continuous Games** Guillaume Wang	**Partial Packing Coloring and Quasi Packing Coloring of a Triangular Grid** Hubert Grochowski
15:00 – 15:30	**Asymptotic Linear Convergence of Fully–Corrective Generalized Conditional Gradient Methods** Kristian Bredies	**Minimization of Length of System of Linear XOR Equations** Konstanty Junosza-Szaniawski
15:30 – 16:00	**Coffee Break**	
Session 3	Hörsaal A	Hörsaal B
	Algorithmic Nonlinear Optimization Chair: Tuomo Valkonen	**Linear Optimization** Chair: Gennadiy Averkov
16:00 – 16:30	**Extended Convergence Analysis of the Scholtes-type Regularization for Cardinality-Constrained Optimization Problems** Sebastian Lämmel	**A Multi-Pivot Simplex Method for Solving a Linear Programming Problem** Panthira Jamrunroj
16:30 – 17:00	**Iteration Complexity of Fixed-Step Methods by Nesterov and Polyak for Convex Quadratic Functions** Melinda Hagedorn	**Tropical Medians by Transportation** Andrei Comăneci
17:00 – 17:15	**Break**	
17:15 – 18:15	~~Audimax – Chair: Ekkehard Köhler~~	
	~~**Algorithms Using Predictions: Online Routing and Network Design**~~ ~~Nicole Megow~~	

Wednesday, March 15th

08:00 – 09:00	Audimax – Chair: Armin Fügenschuh	
	A Model&Run Approach for Multistage Robust Optimization Ulf Lorenz	
09:00 – 09:15	**Coffee Break**	
Session 1	Hörsaal A	Hörsaal B
	Bilevel Optimization Chair: Gerd Wachsmuth	**Technical Operations Research (I)** Chair: Konstanty Junosza-Szaniawski
09:15 – 09:45	**Tackling a Class of Integer Bilevel Nonlinear Programs with SOCP-Based Disjunctive Cuts** Elisabeth Gaar	**Truck and Drone Collaborative Delivery** Yineng Sun
09:45 – 10:15	~~**The Robust Bilevel Selection Problem**~~ ~~Dorothee Henke~~	**The Graph 2-List-Colouring Problem: Formulations, Solution Algorithm and a Computational Study** Jonasz Staszek
10:15 – 10:45	**Bounding Techniques for the Minimal Value of Optimistic Semivectorial Bilevel Problems** Daniel Hoff	**Chances and Challenges in the Design of Transformable Bending Tools for Flexible Manufacturing** Jonas Reuter
10:45 – 11:15	**Coffee Break**	
11:15 – 12:15	Audimax – Chair: Gerd Wachsmuth	
	Optimal Control of Quasilinear Parabolic PDEs Ira Neitzel	
12:15 – 13:15	**Lunch**	
Session 2	Hörsaal A	Hörsaal B
	Nonsmooth Optimization and Control (II) Chair: Daniel Walter	**Technical Operations Research (II)** Chair: Anja Fischer
13:15 – 13:45	**Strong Stationarity Conditions for an Optimal Control Problem Involving a Rate-Independent Variational Inequality** Martin Brokate	**Trajectory Optimization for Arbitrary Layered Geometries in Wire-Arc Additive Manufacturing** Johannes Schmidt
13:45 – 14:15	**Quadratic Regularization of Bilevel Optimal Transport Problems** Christian Meyer	**Design and Optimization of Truss-like Structures** Julian Mrochen
14:15 – 14:45	**DC Reformulation of Cardinality Constrained Problems in Function Spaces** Bastian Dittrich	**When does Strategy matter in a Crane Scheduling Problem?** Florian Breda
14:45 – 15:15	**Variational Discretization of Optimal Control Problems with Measures** Evelyn Herberg	**Using Mathematical Optimization for the Comparison of different Control Strategies for Ventilation Systems** Julius H.P. Breuer
16:15 – 17:30	**Excursion**	
18:00 – 22:00	**Conference Dinner**	

Thursday, March 16th

08:00 – 09:00	Audimax – Chair: Anja Fischer	
	Multiobjective Replacements for Set Optimization and Robust Multiobjective Optimization Gabriele Eichfelder	
09:00 – 09:15	**Coffee Break**	
Session 1	Hörsaal A	Hörsaal B
	Algorithmic Nonsmooth Optimization Chair: Christian Kanzow	**Modeling Operations Research** Chair: Christoph Helmberg
09:15 – 09:45	**A Cutting Quadratic Method for Min-Max Problem** Mina Saee	**A Heuristic Based Solution to the Multi Skilled Resource Constrained Multi Project and Multi Type Scheduling Problem (MS-RCM(P&T)SP)** Yasemin Arici
09:45 – 10:15	**Adaptive Difference-Of-Bundles with Extrapolation Algorithm for DC Programming with Polyhedral Constraints** Guillaume Van Dessel	**Facility Location Problems in Reverse Logistics of Polyurethane Waste: A Use Case of Stochastic Mixed-Integer Linear Optimization** Ruurd J.W. Buijs
10:15 – 10:45	**Interior Proximal Gradient Methods for Nonconvex Optimization** Alberto De Marchi	**Hardness Results for Integrated Last-Mile Deliveries** Moritz Stinzendörfer
10:45 – 11:15	**Coffee Break**	
Session 2	Hörsaal A	Hörsaal B
	Stability and Related Topics in Optimization Chair: Patrick Mehlitz	**Nonsmooth Optimization and Control (III)** Chair: Christian Meyer
11:15 – 11:45	**Lipschitz and Hölder Estimates for Minimizers under Data Perturbations** Diethard Klatte	**Optimal Control of Anisotropic Allen-Cahn Equations** Luise Blank
11:45 – 12:15	**On the Isolated Calmness Property of Implicitly Defined Multifunctions** Jiří V. Outrata	**A Proximal Newton Solver for Rate-Independent Formulations of Finite-Strain Plasticity** Oliver Sander
12:15 – 12:45	**Risk Aversion in Dynamic Optimization** Alois Pichler	**Semismoothness of the Solution Operator of the Obstacle Problem with Applications in Optimal Control** Gerd Wachsmuth
12:45 – 13:45	**Lunch**	
13:45 – 14:45	Audimax – Chair: Ekkehard Köhler	
	Explainable Clustering and Noisy Labels Ola Svensson	
14:45 – 15:00	**End**	

Invited Speakers

Anita Schöbel

Anita Schöbel is a Professor for Applied Mathematics at the Technical University in Kaiserslautern and head of the Fraunhofer Institute for Industrial Mathematics (ITWM). She studied Mathematics in Kaiserslautern, received her Diploma degree in 1994, her PhD in 1998 and her Habilitation in 2003. From 2003 to 2018 she was Professor in Göttingen and 2008/09 guest professor in Auckland. She is a member of the scientific senate of the National Research Data Infrastructure (NFDI) Germany, and speaker of the DFG Research Group on Integrated Optimization in Public Transport. She currently is President of the Association of European Operational Research Societies (EURO). Her research interests are in the area of multicriteria optimization, robust optimization, and transport and logistic applications.

AUDIMAX 09:00–10:00

Integrated Versus Sequential Planning: The Case of Public Transport Optimization

Many real-world problems are treated sequentially. One prominent example for such a sequential process is public transport optimization: One starts with network design, then plans lines and their frequencies. Based on these, the timetable is determined, and later on the vehicles' and drivers' schedules.
The sequential procedure sketched above can be regarded as a Greedy approach: in each planning stage one aims at the best one can do. This usually leads to suboptimal solutions. On the other hand, in public transport optimization many of the mentioned single steps are already NP hard such that solving the integrated problem to optimality seems to be out of scope.
We introduce a general framework to analyze integrated versus sequential planning. We define the price of sequentiality to measure how much can be gained by integrated approaches. We present results under which conditions the price of sequentiality is bounded or even zero. We also develop different approaches for integrated optimization, among them partial integration or the Eigenmodel. We illustrate our findings for the case of public transport optimization.

[back]

Nicole Megow

Nicole Megow holds the chair for Combinatorial Optimization in the Faculty of Mathematics and Computer Science at the University of Bremen. She studied Mathematics at TU Berlin and the Massachusetts Institute of Technology, USA. She received her PhD in Mathematics from TU Berlin in 2006, supervised by Rolf Möhring. She was postdoc and senior researcher at the Max Planck Institute for Informatics, Saarbrücken, held a position as interim professor for Discrete Optimization at TU Darmstadt 2011/12, and headed an Emmy Noether Research Group at TU Berlin starting 2012.
Subsequently, she was an assistant professor for Discrete Mathematics at TU Munich. Furthermore, she was an elected member of the Elisabeth-Schiemann-Kolleg of the Max Planck Society (2013-2016). Her research has won several awards, including the Heinz Maier-Leibnitz Prize, the major award for young scientists in Germany. Nicole Megow's research focuses on mathematical optimization, the theory of algorithm design and analysis, and operations research.

AUDIMAX 17:15–18:15

Algorithms Using Predictions: Online Routing and Network Design

Online optimization refers to solving problems where an initially unknown input is revealed incrementally, and irrevocable decisions must be made not knowing future requests. The assumption of not having any prior knowledge about future requests seems overly pessimistic. Given the success of machine-learning methods and data-driven applications, one may expect to have access to predictions about future requests. However, simply trusting them might lead to very poor solutions as these predictions come with no quality guarantee. In this talk we present recent developments in the young line of research that integrates such error-prone predictions into algorithm design to break through worst case barriers. We discuss algorithmic challenges with a focus on online routing and network design and present algorithms with performance guarantees depending on a novel error metric.

[back]

Ulf Lorenz

Ulf Lorenz is professor for Business Economics, especially for Technology Management at the University of Siegen and the speaker of the Siegener Mittelstandsinstitut. He studied Computer Science at the University of Paderborn, received his Diploma degree in 1995, his PhD in 2001 and his Habilitation in 2006. From 2007 to 2014 he was assistant professor in Darmstadt and has been professor at the University of Siegen since 2014. He is a member of the Gesellschaft für Operations Research (GOR) and in particular editor and member of the working group for Technical Operations Research (TOR). He is also one of the developers of the chess machine HYDRA, one of the leading chess machines between 2002 and 2006. His research interests are in technical operations research and optimization under uncertainty.

AUDIMAX 08:00–09:00

A Model&Run Approach for Multistage Robust Optimization

Robust optimization emerged as one of the predominant paradigms to produce solutions that hedge against uncertainty. In order to obtain an even more realistic description of the underlying problem, where the decision maker can react to newly disclosed information, multistage models can be used. However, due to their computational difficulty, multistage problems beyond two stages have received less attention and are often only addressed using approximation rather than optimization schemes. Even less attention is paid to the consideration of decision-dependent uncertainty in a multistage setting. In this talk, we present multistage robust optimization via quantified linear programs, which are linear programs with ordered variables that are either existentially or universally quantified. Building upon a (mostly) discrete setting where the uncertain parameters – the universally quantified variables – are only restricted by their bounds, we present an augmented version that allows stating the discrete uncertainty set via a linear constraint system that also can be affected by decision variables. We present a general search-based solution approach and introduce our solver Yasol that is able to deal with multistage robust linear discrete optimization problems, with final mixed-integer recourse actions and a discrete uncertainty set, which even can be decision-dependent.

[back]

Ira Neitzel

Ira Neitzel is a professor at the University of Bonn working on numerical analysis and optimal control of partial differential equations. She studied technomathematics at the Technical University of Berlin where she received her Diploma degree in 2006 and completed her PhD in 2011 under supervision of Fredi Tröltzsch. Afterwards, she worked as a research associate at the Technical University of Munich in the group of Boris Vexler before heading towards Bonn for her professorship in 2015.

AUDIMAX 11:15–12:15

Optimal Control of Quasilinear Parabolic PDEs

In this talk, we are concerned with theoretical and algorithmic aspects of optimal control problems subject to quasilinear parabolic differential equations. Due to the nonconvex structrure of the optimal control problem, second order sufficient optimality conditions will be one main focus of the talk, in addition to first order necessary optimality conditions. We provide some insight into the required regularity analysis of the underlying partial differential equations and highlight the challenges when comparing the problem to other nonlinear settings, such as problems with semilinear equations. We address different control types and additional constraints, such as state constraints.
Parts of this talk are joint work with Fabian Hoppe

[back]

Gabriele Eichfelder

Gabriele Eichfelder is a full Professor for Mathematical Methods of Operations Research at the Institute of Mathematics of the Technische Universität Ilmenau in Germany since 2012. She earned her doctoral degree in 2006 and completed habilitation at the Department of Applied Mathematics at the University of Erlangen-Nuremberg in Germany in 2012. She is working in the field of Mathematical Optimization with a special interest in optimization with vector-valued and set-valued objective functions and in global optimization techniques. In addition to fundamental theoretical studies, she has also been working on numerical solvers for applied engineering problems.

AUDIMAX 08:00–09:00

Multiobjective Replacements for Set Optimization and Robust Multiobjective Optimization

Set-valued optimization using the set approach is a research topic of high interest due to its practical relevance and numerous interdependencies to other fields of optimization. An important example are robust approaches to uncertain multiobjective optimization problems which result in such a set optimization problem. However, it is a very difficult task to solve these optimization problems even for specific cases.

In this talk, we present parametric multiobjective optimization problems for which the optimal solutions are strongly related to the optimal solutions of the set optimization problem. This corresponds to the well-known idea of scalarization in multiobjective optimization. We give results on approximation guarantees and we examine classes of set-valued mappings for which the corresponding set optimization problem is in fact equivalent to a multiobjective optimization problem.

[back]

Ola Svensson

Ola Svensson is an Associate Professor at the School of Computer and Communication Sciences at EPFL, Switzerland. He is interested in theoretical aspects of computer science with an emphasis on the approximability of NP-hard optimization problems. Ola was an invited speaker at the International Congress of Mathematicians (ICM) 2022, and his work has received several recognitions including the 2019 Michael and Sheila Held Prize by the National Academy of Sciences and best paper awards at FOCS and STOC.

AUDIMAX 13:45–14:45

Explainable Clustering and Noisy Labels

In this talk, we explore novel aspects of k-median and k-means clustering, which are central optimization problems with many applications in data analysis and machine learning. We focus on what makes a clustering explainable and on how to use side information, such as noisy labels, in the design of algorithms. We present simple algorithms that have strong theoretical guarantees for both of these settings. We complement these findings with several interesting related directions and open questions.

[back]

Abstracts

HÖRSAAL A 10:30–11:00

Nonlinear Cone Separation Theorems in Real Reflexive Banach Spaces

Christian Günther, Bahareh Khazayel and Christiane Tammer

The separation of two sets (or more specific of two cones) plays an important role in different fields of mathematics (such as variational analysis, convex analysis, convex geometry, optimization). In the talk, we show some new results for the separation of two (not necessarily convex) cones by a (convex) cone / conical surface in real reflexive Banach spaces. We follow basically the separation approach by Kasimbeyli (2010, SIAM J. Optim. 20) based on augmented dual cones and normlinear separation functions. Classical separation theorems for convex sets will be the key tool for proving our main nonlinear cone separation theorems.

HÖRSAAL B 10:30–11:00

Graph Based Time Series Analysis for Gait Segmentation

Tobias Hofmann and Christoph Helmberg

Given a high dimensional time series of sensor data, the task is to identify repeating segments that likely correspond to presumable states of an observed object. We propose a graph based approach via sparsest cut and present first steps towards a rigorous analysis. Preliminary numerical results are presented for gait segmentation data recorded by body attached sensor networks.

[back]

HÖRSAAL A 11:00–11:30

On the Fuzzy Sum Rule for the Regular Subdifferential

Marián Fabian, Alexander Y. Kruger, and Patrick Mehlitz

Motivated by the derivation of necessary optimality conditions for nonsmooth optimization problems in abstract spaces, we review available (fuzzy) sum rules for the regular subdifferential of two lower semicontinuous functions. Most of the available literature seems to indicate that one of the involved summands needs to be locally Lipschitz continuous for the fuzzy sum rule to work. In this talk, we do away with this broadly accepted myth. For that purpose, we introduce the notion of joint lower semicontinuity of two lower semicontinuous functions and show that the latter is sufficient for applicability of the fuzzy sum rule. Some calculus reveals that joint lower semicontinuity is present whenever one of the involved summands is locally uniformly continuous which is much weaker than local Lipschitzness. By means of examples from optimal control, we visualize that joint lower semicontinuity might be present even in situations where both summands are discontinuous and use this observation to state necessary optimality conditions for optimal control problems with sparsity-promoting terms in the objective function.

HÖRSAAL B 11:00–11:30

The Traveling Salesman Problem with Memory

Anja Fischer

In this talk we introduce a new variant of the traveling salesman problem (TSP). Given points in the Euclidean plane, some minimal radius and a memory level we look for a shortest tour such that each point is visited exactly once and such that the memory and distance requirements are satisfied. Indeed, the distances between neighboring points along the tour must be larger than a given value and after visiting some point it is not allowed to enter the area of the circle around that point in a given number of steps depending on the memory level. This problem is motivated by an application in laser beam melting. We present two different formulations which are extensions of models for the TSP and the quadratic TSP. These models are strengthened by new cutting planes which exploit the geometric properties of the TSP with memory (TSPM). We present computational results for randomly generated instances as well as instances from laser beam melting and consider some special cases of the TSPM related to the application from a combinatorial point of view.

[back]

HÖRSAAL A 11:30–12:00

A Trust-Region Algorithm for Parameter Identification in Multigroup Pandemic Models

Markus Friedemann

Parameter identification for a nonlinear ODE describing a pandemic model is studied. In the model, the population is divided into several spatially separated subpopulations. Between those subpopulations, there is some (possibly infectious) contact due to traveling. The main goal is the identification of time-dependent contact parameters in the interaction terms between subgroups. The parameters can be considered in $L^2(0,T)$ and $H^1(0,T)$ to provide the possibility of regularizing the solution in the case of noisy data. Existence of solutions is proven and optimality conditions are discussed. A penalty approach is chosen to handle constraints. A solution algorithm based on a trust-region approach with Steihaug CG as an inner solver is introduced. Global and local convergence properties are investigated and fast local convergence is proven. Numerical results are presented.

HÖRSAAL B 11:30–12:00

New Lower Bounds for the Double Row Facility Layout Problem

Frank Fischer

The Double Row Facility Layout Problem (DRFLP) aims for arranging machines along two sides of a path such that the machines do not overlap and the weighted sum of the pairwise distances is minimized. In contrast to the single row version of the problem (SRFLP), an optimal solution may contain free space between adjacent machines. This makes a direct generalization of optimization models for the SRFLP to the DRFLP difficult. In this talk we present a new approach to combine the most successful models for the SRFLP with a new approach to handle the local arrangements of adjacent machines including their gaps. Indeed, the SRFLP model based on betweenness variables is used to model the distances between machines that are arranged with a relatively large distance between them, whereas machines that are arranged close to each other are modelled by solving exact subproblems consisting only few machines. Each subproblem provides lower bounds on some distances and the best lower bounds are then combined in an Lagrangian relaxation approach. The model is then solved with a specialized bundle method. This approach does not solve the DRFLP exactly but aims at computing good lower bounds on the optimal solution value. We present some first numerical experiments.

[back]

HÖRSAAL A 12:00–12:30

Proximal Methods for Point Source Localisation

Tuomo Valkonen

Point source localisation is generally modelled as a Lasso-type problem on measures. However, optimisation methods in non-Hilbert spaces, such as the space of Radon measures, are much less developed than in Hilbert spaces. Most numerical algorithms for point source localisation are based on the Frank–Wolfe conditional gradient method, for which ad hoc convergence theory is developed. We develop extensions of proximal-type methods to spaces of measures. This includes forward-backward splitting, its inertial version, and primal-dual proximal splitting. Their convergence proofs follow standard patterns. We demonstrate their numerical efficacy.

HÖRSAAL B 12:00–12:30

A Two-Dimensional Cutting Stock Problem with Multiple Stocks and Divisible Items

Kasitinart Sangngern and Aua-aree Boonperm

This work studies a two-dimensional cutting stock problem with multiple stocks and divisible sheets (2DCSP-MD). In this problem, the stock rolls are of various sizes, each with multiple copies, and each output sheet has a rectangular shape with a specific width and length; each is normally longer but narrower than the stock rolls. Hence, it can be divided into smaller sheets with the same width, then recombined again by joining. This problem aims to minimize the number of divided output sheets from stock rolls to generate all output sheets since the recombining operation has a cost. In this work, we propose an integer linear programming (ILP) model to solve 2DCSP-MD. The ILP model represents 2DCSP-MD as a modification of a transportation problem, in which sources and sinks are referred to as stock rolls and the demand lengths, respectively. Then, the proposed heuristic method is proposed to solve 2DCSP-MD. It starts by rearranging the stock rolls by their widths, and then the number of suitable cuts of each sheet from each roll is computed. Each iteration stops when the current roll's width is insufficient to cut any sheets. The computational experiments show that the proposed heuristic method's gap percentage of the solution is very tiny.

[back]

HÖRSAAL A 13:30–14:00

Support Stability for Total (Gradient) Variation Regularization

Yohann De Castro, Vincent Duval, and Romain Petit

The total (gradient) variation is a regularizer which has been widely used in inverse problems arising in image processing, following the pioneering work of Rudin, Osher and Fatemi. When there is only a finite number of measurements, it is possible to prove that some solutions are piecewise constant. In this talk, I will show that under some assumptions, that representation is stable: the solutions at low noise and low regularization have the same number of values as the unknown image and their level sets converge to those of the unknown image.

HÖRSAAL B 13:30–14:00

Multi-Objective Duty Scheduling using Mixed-Integer Programming in Hospitals

Saran Karthikeyan, Sasanka Potluri, Thomas Weidauer, and Cord Spreckelsen

Emerging hospitalizations increase demand for health-care workers causing dynamics in resource allocation (distribution of employees in desired shift, task assignment). This requires efficient scheduling with quality care, which involves combinatorial optimization (discrete space). Developing mathematical model for scheduling with factors (balancing workload, regulatory aspects, fairness measures, and hospital requirements) is non-deterministic. It imposes difficulties to find a best solution within polynomial time. Most studies have shown reliable results using Mixed-Integer Programming (MIP) for various instance sizes and planning periods by balancing workload and preferences. This research work addresses an employee scheduling problem (pharmacy at University Hospital Jena) for 5 employees over an entire year. This work uses a mathematical model by MIP with multiple objectives to transform all requirements into bounded constraints. The main goal is to create non-repetitive schedules considering employees' vacation preferences and fair distribution of weekend shifts (including shift type) to minimize deviations in total working hours by satisfying the constraints. The obtained results reach the goal with reliable (+/- 7 hours) mean deviations of all employees even for larger planning periods adhering to requirements. The challenges are limitations on instance size due to constraints, restrictions on vacation preferences due to fair weekend shift distribution and unavailability of the same employees for consecutive weekends. It is of eminent research interest in the future to develop a machine learning model for duty scheduling and rescheduling with dynamic requirements.

[back]

HÖRSAAL A 14:00–14:30

Learning Polynomial Optimal Feedback Laws for Control Problems

Donato Vásquez Varas

The problem of computing an optimal feedback law for a high dimensional, nonlinear, continuous time control system over a finite time horizon is considered. The approach consists in approximating the problem as a learning task in the space of multivariate polynomials. Results on the convergence and the generalization power of the solutions of the learning problem are provided. Finally, the capability of our approach to mitigate the curse of dimensionality is illustrated through high dimensional examples.

HÖRSAAL B 14:00–14:30

A Solver for Multi-Objective Mixed-Integer Optimization Problems using Hybrid Patch Decomposition

Gabriele Eichfelder and Leo Warnow

In multi-objective mixed-integer convex optimization multiple convex objective functions need to be optimized simultaneously while some of the variables are only allowed to take integer values. In this talk, we present a new approach to compute an enclosure of the nondominated set of such optimization problems. More precisely, we decompose the multi-objective mixed-integer convex optimization problem into several multi-objective continuous convex optimization problems, which we refer to as patches. We then dynamically compute and improve coverages of the nondominated sets of those patches to finally combine them to obtain an enclosure of the nondominated set of the multi-objective mixed-integer convex optimization problem. Additionally, we introduce a mechanism to reduce the number of patches that need to be considered in total.

[back]

HÖRSAAL A 14:30–15:00

An Exponentially Converging Particle Method for the Mixed Nash Equilibrium of Continuous Games

Guillaume Wang

We consider the problem of computing mixed Nash equilibria of two-player zero-sum games with continuous sets of pure strategies and with first-order access to the payoff function. This problem arises for example in game-theory-inspired machine learning applications, such as distributionally-robust learning. In those applications, the strategy sets are high-dimensional and thus methods based on discretisation cannot tractably return high-accuracy solutions. In this paper, we introduce and analyze a particle-based method that enjoys guaranteed local convergence for this problem. This method consists in parametrizing the mixed strategies as atomic measures and applying proximal point updates to both the atoms' weights and positions. It can be interpreted as a time-implicit discretization of the "interacting" Wasserstein-Fisher-Rao gradient flow. We prove that, under non-degeneracy assumptions, this method converges at an exponential rate to the exact mixed Nash equilibrium from any initialization satisfying a natural notion of closeness to optimality. We illustrate our results with numerical experiments and discuss applications to max-margin and distributionally-robust classification using two-layer neural networks, where our method has a natural interpretation as a simultaneous training of the network's weights and of the adversarial distribution.

HÖRSAAL B 14:30–15:00

Partial Packing Coloring and Quasi Packing Coloring of a Triangular Grid

Konstanty Junosza-Szaniawski and Hubert Grochowski

The packing coloring of graphs is inspired by the problem of frequency assignment in radio networks. In this model, we assign positive integers to nodes and require that for each label (color) i and every two nodes with this label, their distance must be greater than i. Recently, the minimal number of colors needed for packing coloring of an infinite square grid has been established to 15. Moreover, for a hexagonal grid 7 is the minimal number of needed colors and a triangular grid is not colorable in a packing way. Two natural questions appear: what fraction of a triangular grid can be colored in a packing model and how much do we need to weaken the condition of packing coloring to enable coloring a triangular grid with a finite number of colors? With a partial help of the MILP solver, we proved that we can color at least 72.8% but no more than 82.2% of a triangular grid in a packing way. Moreover, we have specified the weakest (in some sense) relaxation of a condition in the definition of the packing coloring and we proved that the triangular grid is colorable in this weakened packing model with 44 colors and it requires at least 9 colors. As an open problem remains: what is the exact fraction of the grid, that is colorable in a packing model, and what is the minimum number of colors required to color this grid in a weakened packing model or at least can we improve above bounds?

[back]

HÖRSAAL A 15:00–15:30

Asymptotic Linear Convergence of Fully–Corrective Generalized Conditional Gradient Methods

Kristian Bredies, Marcello Carioni, Silvio Fanzon and Daniel Walter

We discuss a fully-corrective generalized conditional gradient (FC-GCG) method for the minimization of the sum of a smooth, convex loss function and a convex one-homogeneous regularizer over a Banach space. The algorithm alternates between updating a finite set of extremal points of the unit ball of the regularizer and optimizing on the conical hull of these extremal points, where each iteration requires the solution of one linear problem and one finite-dimensional convex minimization problem. We show that the algorithm converges sublinearly to a solution and that imposing additional assumptions on the associated dual variables accelerates the method to a linear rate of convergence. The proofs rely on lifting, via Choquet's theorem, the considered problem to a particular space of Radon measures well as the equivalence of the FC-CGC method to a primal-dual active point (PDAP) method for which linear convergence was recently established. Finally, we present applications scenarios where the stated assumptions for accelerated convergence can be satisfied.

HÖRSAAL B 15:00–15:30

Minimization of Length of System of Linear XOR Equations

Konstanty Junosza-Szaniawski and Daniel Waszkiewicz

SAT-solvers are one of the primary tools to assess the security of block ciphers automatically. A construction of a Boolean formula describing performance of a block cypher requires often an encoding a system of linear XOR equations over the field GF(2). Such systems are complex to write as MILP and requires many additional variables. If we model the system as CNF formula in a strait forward way the resulting formula contains many long clauses, which is not suitable for solvers. The standard procedure includes a greedy shortening algorithm and is not always satisfactory. Recently, the problem of a straight-line program has been successfully applied in obtaining efficient implementations of MDS matrices.
Inspired by this result, we consider the problem of minimization of the length of the linear equations XOR system, where by length of a system we mean the largest number of non-zero coefficient in an equation. We can decrease a number of non-zero coefficient in a system by introducing new variables and by adding equations one to another. There are two variants of the problem: first - how much can we shorter the system with a fixed number of new variables, second how many new variables do we need to shorten the system to a fixed length. We model the problem in both variants as SAT-problem and MILP. We hope that shorter systems can be more adequate for SAT and MILP solvers and allow solving bigger problems, in particular in cryptography.

[back]

HÖRSAAL A 16:00–16:30

Extended Convergence Analysis of the Scholtes-type Regularization for Cardinality-Constrained Optimization Problems

Sebastian Lämmel and Vladimir Shikhman

We extend the convergence analysis of the Scholtes-type regularization method for cardinality-constrained optimization problems. Its behavior is clarified in the vicinity of saddle points, and not just of minimizers as it has been done in the literature before. This becomes possible by using as an intermediate step the recently introduced regularized continuous reformulation of a cardinality-constrained optimization problem. We show that the Scholtes-type regularization method is well-defined locally around a nondegenerate T-stationary point of this regularized continuous reformulation. Moreover, the nondegenerate Karush-Kuhn-Tucker points of the corresponding Scholtes-type regularization converge to a T-stationary point having the same index, i.e. its topological type persists. Overall, we conclude that the global structure of the regularized continuous reformulation and its Scholtes-type regularization essentially coincide.

HÖRSAAL B 16:00–16:30

A Multi-Pivot Simplex Method for Solving a Linear Programming Problem

Panthira Jamrunroj and Aua-aree Boonperm

The simplex method is an iterative method for solving a linear programming problem. Generally, it can exchange only one entering and leaving variable to improve the solution in each iteration that requires more iterations. Therefore, if we can exchange more than one variable in each iteration, the number of iterations of the simplex method might be reduced. In this work, we present a new pivot rule for the simplex method that can exchange at most three variables in each iteration, called the multi-pivot simplex method. It uses the proposed interior search algorithms in a two- or three-linear programming problem to search for two or three leaving variables. In each iteration, if there are three negative reduced costs of non-basic variables (for a maximization linear programming problem), a special three-dimensional linear programming problem is constructed, and the proposed interior search for three leaving variables is performed. Otherwise, if two negative reduced costs of non-basic variables exist, then the two-dimensional linear programming problem is constructed, and the proposed interior search for two leaving variables is used. Otherwise, Dantzig's pivot is used to update the simplex tableau. The computational results exhibit that the proposed method can reduce the average number of iterations and the average running time compared with the interior point method and the simplex method.

[back]

HÖRSAAL A 16:30–17:00

Iteration Complexity of Fixed-Step Methods by Nesterov and Polyak for Convex Quadratic Functions

Melinda Hagedorn

This note considers the momentum method by Polyak and the accelerated gradient method by Nesterov, both without line search but with fixed step length applied to strictly convex quadratic functions assuming that exact gradients are used and appropriate upper and lower bounds for the extreme eigenvalues of the Hessian matrix are known. Simple 2-d-examples show that the Euclidean distance of the iterates to the optimal solution is non-monotone. In this context an explicit bound is derived on the number of iterations needed to guarantee a reduction of the Euclidean distance to the optimal solution by a factor ε. For both methods the bound is optimal up to a constant factor, it complements earlier asymptotically optimal results for the momentum method, and it establishes another link of the momentum method and Nesterov's accelerated gradient method.

HÖRSAAL B 16:30–17:00

Tropical Medians by Transportation

Andrei Comăneci and Michael Joswig

In this talk, we present the Fermat–Weber problem under a simplicial distance. We describe the location of the optimum in terms of tropical geometry, which gives a combinatorial interpretation of the set of solutions. Moreover, it turns out that this location problem is equivalent to a transportation problem, allowing for fast computation.
Finally, we show how we can exploit the connection to tropical convexity for an application to the consensus problem from computational biology. The geometric interpretation also gives desirable properties for the resulting consensus method.

[back]

HÖRSAAL A 09:15–09:45

Tackling a Class of Integer Bilevel Nonlinear Programs with SOCP-Based Disjunctive Cuts

Elisabeth Gaar, Jon Lee, Ivana Ljubić, Markus Sinnl, and Kübra Tanınmış

We study a class of integer bilevel programs with second-order cone constraints at the upper-level and a convex-quadratic objective function and linear constraints at the lower-level. We develop disjunctive cuts (DCs) to separate bilevel-infeasible solutions using a second-order-cone-based cut-generating procedure. We propose DC separation strategies and consider several approaches for removing redundant disjunctions and normalization. Using these DCs, we propose a branch-and-cut algorithm for the problem class we study, and a cutting-plane method for the problem variant with only binary variables.
We present an extensive computational study on a diverse set of instances, including instances with binary and with integer variables, and instances with a single and with multiple linking constraints. Our computational study demonstrates that the proposed enhancements of our solution approaches are effective for improving the performance. Moreover, both of our approaches outperform a state-of-the-art generic solver for mixed-integer bilevel linear programs that is able to solve a linearized version of our binary instances.

HÖRSAAL B 09:15–09:45

Truck and Drone Collaborative Delivery

Yineng Sun, Armin Fügenschuh and Vikrant Vaze

As digital commerce growing faster during the past decades, efficient parcel delivery for online shopping becomes more and more essential. Besides the traditional way of delivering only by truck, e-commerce companies gained interests in exploring the possibility of auxiliary delivery by drone. This is because the physical flexibility and energy efficiency of drones could potentially allow much faster and lower cost deliveries. In this work, we extended and modified the state-of-art combined truck and drone delivery model. More specifically, instead of assuming all drone flying data as parameters given to the model, we included detailed physical dynamics of the drones as part of the integrated model to obtain precise drone trajectories. Secondly, our work also permitted scenarios where the drone can take-off from or land back onto a moving truck along the way. This additional permission could save energy of drone and thus allow further reachability of the truck and drone system within the same time span. Thirdly, our work proposed a new algorithm for solving this truck and drone collaborative delivery model at a larger scale than state-of-art exact solution method. Numerical tests of our algorithm are presented.

[back]

HÖRSAAL A 09:45–10:15

The Robust Bilevel Selection Problem

Dorothee Henke

In bilevel optimization problems, two players, the leader and the follower, make their decisions in a hierarchy, and both decisions influence each other. Usually one assumes that both players have full knowledge also of the other player's data. In a more realistic model, uncertainty can be quantified, e.g., using the robust optimization approach: Assume that the leader does not know the follower's objective function precisely, but only knows an uncertainty set of potential follower's objectives, and her aim is to optimize the worst case of the corresponding scenarios. Now the question arises how the computational complexity of bilevel optimization problems changes under the additional complications of this type of uncertainty.
We make a step towards answering this question by examining a simple bilevel problem. In the bilevel selection problem, the leader and the follower each select some items, while a common number of items to select in total is given, and each of the two players maximizes the total value of the selected items, according to different sets of item values. We show that this problem can be solved in polynomial time without uncertainty and then investigate the complexity of its robust version. If the item sets controlled by the leader and by the follower are disjoint, it can still be solved in polynomial time in case of a finite uncertainty set or interval uncertainty. Otherwise, the robust problem version becomes NP-hard, even for a finite uncertainty set.

HÖRSAAL B 09:45–10:15

The Graph 2-List-Colouring Problem: Formulations, Solution Algorithm and a Computational Study

Alexander Martin and Jonasz Staszek

Given a simple, undirected graph $G = (V, E)$ and two colour families C and D, the *graph 2-list-colouring problem with compatibility constraints (G2LC-CC)* consists in assigning a pair (c, d) of colour from both families of colours to as many nodes $v \in V$ as possible, while complying with compatibility constraints pertaining to both vertices (i.e. only a subset of colours $C^v \subseteq C$ and $D^v \subseteq D$ may be chosen for a node $v \in V$) and the colours themselves (i.e. only a subset $D_c \subseteq D$ may be chosen together with colour $c \in C$ for some node $v \in V$ and the other way round). This problem originates from the applied problem of integrated locomotive scheduling and driver assignment, studied by the authors in the past. We present two formulations of this problem, as well as ways to improve them. For one of the formulations, we present a special case for which a complete polyhedral description may be given. Additionally, for one of the formulations, we introduce a decomposition-based solution algorithm. We then test its performance against a set of real-world instances from DB Cargo Polska S.A., as well as a set of standard graph-colouring instances adjusted to the context of *(G2LC-CC)*. Overall, we conclude that our solution algorithm generally outperforms both formulations, both in terms of solution time and of number of instances solved.

[back]

HÖRSAAL A 10:15–10:45

Bounding Techniques for the Minimal Value of Optimistic Semivectorial Bilevel Problems

Daniel Hoff

In bilevel optimization one considers an optimization problem, the upper-level problem, which contains the solution set of another optimization problem, the lower-level problem, as a constraint. We assume that the objective function on the lower-level is vector-valued and follow the optimistic approach, i.e., we choose the weakly efficient points of the lower-level problem that are most suitable for the upper-level objective function. Thereby, we assume, that the objective and constraint functions are sufficiently smooth and a regularity condition like the MFCQ holds at all feasible points for the lower-level problem. This ensures the upper semicontinuity of the lower-level weakly efficient set map, which is defined by the parametric multiobjective optimization problem on the lower-level. Furthermore, this assumption allows us to derive existence results for minimal and ε-minimal points for optimistic semivectorial bilevel problems. As a next step, we follow the approach of replacing the weakly efficient set of the lower-level problem by using the optimal value function and obtain the lower-level value function reformulation. This provides a starting point for bounding the optimal value of the semivectorial bilevel problem, by bounding the value function of the lower-level by appropriate lower and upper bound sets. This serves as a base for branch-and-bound methods in optimistic semivectorial bilevel optimization.

HÖRSAAL B 10:15–10:45

Chances and Challenges in the Design of Transformable Bending Tools for Flexible Manufacturing

Jonas Reuter and Bernd Engel

Increasing mass customization and product individualization require agile, flexible and resilient production systems in manufacturing technology. While some forming techniques have inherent flexibility due to their shape giving free tool movement, other processes are limited in the variety of geometries that can be achieved with a single tool set. In order to maintain their advantages of process controllability and accuracy and at the same time to enhance flexibility, new tools are needed. To this aim, a break-up or a segmentation respectively of the conventionally closed tool surfaces and an active adjustment of these surfaces offer a way forward. However, such a discrete surface influences the resulting part properties. Furthermore, a tool structure which takes the process loads while being able to induce surface adjustments due to its mobility and integrated actuators is crucial. Mixed-Integer Linear Programming (MIP) potentially offers the possibility to design movable truss structures as tool structures that meet these requirements, especially considering the enhanced design freedom of additive manufacturing techniques. This contribution discusses various chances and challenges with respect to the forming process itself, the design, the manufacturability and the application of transformable bending tools. This is done on the basis of a first demonstrator resulting from the underlying research project.

[back]

HÖRSAAL A 13:15–13:45

Strong Stationarity Conditions for an Optimal Control Problem Involving a Rate-Independent Variational Inequality

Martin Brokate and Constantin Christof

We prove strong stationarity conditions for an optimal control problem involving the scalar stop operator, that is, the solution operator of a certain basic rate-independent evolution variational inequality. The results are based on previous work concerning the Hadamard differentiability of that operator as well as on a new concept of temporal polyhedricity.

HÖRSAAL B 13:15–13:45

Trajectory Optimization for Arbitrary Layered Geometries in Wire-Arc Additive Manufacturing

Armin Fügenschuh and Johannes Schmidt

In wire-arc additive manufacturing (WAAM), a wire is molten by an electrical or laser arc and deposited droplet-by-droplet to construct the desired workpiece given as a set of two-dimensional layers. The weld source can move freely over a substrate plate, processing each layer, but there is also the possibility of moving without welding. The main issue about this manufacturing technique is the temperature distribution within the workpiece since the large thermal gradients caused by the welding process can cause thermal stress, leading to strain or even cracks. Thus, it is desirable to control the temperature of the workpiece during the process by planning the trajectory of the weld source carefully. We consider the problem of finding a trajectory of the moving weld source for a given two-dimensional layer of arbitrary geometry that maximizes the quality of the part. The resulting optimization problem is formulated as a mixed-integer PDE-constrained problem, including heat conduction and thermal radiation for calculating a detailed temperature distribution and measuring the overall quality. After linearization, it is solved using the state-of-the-art numerical solver IBM CPLEX and its performance is examined by several computational studies.

[back]

HÖRSAAL A 13:45–14:15

Quadratic Regularization of Bilevel Optimal Transport Problems

Christian Meyer

We consider a bilevel optimization problem, where the lower level problem is given by the Kantorovich problem of optimal transportation. The upper level optimization variables are the optimal transport plan and one of the marginals. A possible application of the problem under consideration is the identification of a marginal based on measurements of the transportation process. Due to the curse of dimensionality associated with the Kantorovich problem, regularization techniques are frequently employed for its numerical solution. A prominent example is the entropic regularization leading to the well-known Sinkhorn algorithm. Here, we pursue a different approach and apply a quadratic regularization leading to transport plans in $L^2(\Omega_1 \times \Omega_2)$, where Ω_1 and Ω_2 are the domains of the marginals. The dual problem is a problem in $L^2(\Omega_1) \times L^2(\Omega_2)$, which yields the desired reduction of the dimension. We investigate the convergence behavior of the regularized bilevel problems (where the Kantorovich problem as lower level problem is replaced by its quadratic regularization) for regularization parameter tending to zero. It turns out that, under additional assumptions, weak-$*$ accumulation points of sequences of optimal solutions of the regularized bilevel problems are solutions of the original bilevel Kantorovich problem. Finally, the results are applied to optimal control problems with controls in Wasserstein spaces.

HÖRSAAL B 13:45–14:15

Design and Optimization of Truss-like Structures

Julian Mrochen

We introduce a novel method for designing and optimizing truss-like structures through mathematical optimization. With the advent of new manufacturing possibilities mainly additive manufacturing, innovative structural design methods become more applicable in practice. Therefore, we present an approach that combines the well-known techniques of truss optimization in engineering with methods of technical operations research. The model is able to create optimized truss structures based on multiple loading scenarios. Previously it could only process a single loading scenario. Optimality of the model is to minimize the volume of the created structure since the primary cost drivers of additive manufacturing are usage of material as well as construction volume. In addition to a theoretical optimal structure the model also provides solutions that take real manufacturing constraints into account i.e., requiring a symmetrical output, to be able to produce structures for prototyping.

[back]

HÖRSAAL A 14:15–14:45

DC Reformulation of Cardinality Constrained Problems in Function Spaces

Bastian Dittrich

We consider cardinality constrained problems in the space of integrable functions. It is shown that this non-convex and discontinuous constraint can be equivalently reformulated by the difference of two convex and continuous functions, namely the L^1-norm and the so called largest-K norm. The convex subdifferential of the largest-K norm is calculated. To solve this problem practically we furthermore provide a finite dimensional exact reformulation for cardinality constraints in the space of piecewise linear functions on arbitrary triangular finite elements. An exemplary problem is solved by applying a DC method to the penalized reformulated problem, for which we also prove an exact penalty result.

HÖRSAAL B 14:15–14:45

When does Strategy matter in a Crane Scheduling Problem?

Florian Breda

Scheduling problems are of daily importance for people and have to be solved permanently. Often, a deterministic case is simply assumed and possible disturbances in the planning process are ignored until they occur. However, this strategy pursued can be worse than a robust strategy in uncertain disruption scenarios. In this contribution we consider a multi-stage optimization problem in which a crane is supposed to pick up and move containers in the most efficient way to reduce the overall tardiness of containers. We show the influence of a limited planning horizon on planning strategies that are developed under deterministic assumptions and uncertain assumptions. The uncertainties considered in our model are related to the constant addition of containers and disruptions in the transport of these containers. We discuss different parameters in our model and show in which cases a robust strategy is beneficial for planners.

[back]

HÖRSAAL A 14:45–15:15

Variational Discretization of Optimal Control Problems with Measures

Evelyn Herberg

We consider optimal control problems with partial differential equations and measure control, which are motivated e.g. by source identification and actuator placement tasks. Due to the measure control such problems have an inherent sparsity structure. Our goal is to retain the sparsity on the discrete level. We use variational discretization of the control problems utilizing a Petrov-Galerkin approximation of the state. The optimality conditions in combination with the chosen variational discretization approach induce controls that are composed of Dirac measures, centered at points on the discrete grid. We present numerical experiments to illustrate our results.

HÖRSAAL B 14:45–15:15

Using Mathematical Optimization for the Comparison of different Control Strategies for Ventilation Systems

Julius H.P. Breuer and Peter F. Pelz

In Germany, the building sector is responsible for one third of total final energy consumption - a significant proportion of which is accounted for by ventilation systems. This share can already be reduced in the planning phase of a building, e.g. by considering different load scenarios or by adjusting the control strategy. Control strategies range from centralized systems with constant fan speed to distributed system topologies with variable-speed fans. The numerous common as well as novel control strategies differ in terms of energy efficiency, investment costs and complexity.
In this study, different control strategies are compared using an example system. To make the comparison as meaningful as possible, an optimal ventilation system is planned for each control strategy. Thus, a decision must be made on the number, size, position and connection of the fans - subject to the control strategy's limitations. These topology decisions are far from trivial for more complex control strategies. To this end, we consider the ventilation system, all design decisions, and the particular control strategy, and formulate and solve a mixed-integer nonlinear program (MINLP). The resulting pareto-optimal ventilation systems create transparency for builders regarding the trade-off between energy efficiency, investment cost and the complexity of the control strategy. This transparency, created through algorithmic design using discrete optimization, enables stakeholders to build more sustainable ventilation systems.

[back]

HÖRSAAL A 09:15–09:45

A Cutting Quadratic Method for Min-Max Problem

Mina Saee and D. Russell Luke

We present a Cutting Quadratic method for minimizing the maximum of smooth convex functions which incorporates recent developments in nonsmooth analysis. Our proposed method is a two-phase approach where in the first phase random sampling and "cutting quadratics" are applied to identify the active manifolds at the solution. This phase of the algorithm is finitely terminating. The second phase of the algorithm proceeds along the lines of conventional approaches, though our analysis shows superlinear convergence without the usual assumptions of strong convexity.

HÖRSAAL B 09:15–09:45

A Heuristic Based Solution to the Multi Skilled Resource Constrained Multi Project and Multi Type Scheduling Problem (MS-RCM(P&T)SP)

Yasemin Arici

Optimally scheduling projects is a critical task for many organizations. Increased regulation and the need to collaborate with supply chain partners means that some projects are mandatory and may generate negative returns. Ideally the implementation of projects which generate negative return should be scheduled as late as possible in the scheduling window. In order to facilitate this, the classical Resource Constrained Project Scheduling Problem (RCPSP) must be extended to allow for three project types (optional, positive mandatory and negative mandatory). We introduce the multi skilled resource constrained multi project and multi type scheduling problem (MS-RCM(P&T)SP). Priority rule based heuristics are used to solve this problem. Specifically, forward scheduling is applied to projects expected to generate positive returns (optional and mandatory) and backward scheduling for mandatory projects with negative returns (negative mandatory), thus avoiding the generation of excessive negative returns. To evaluate the proposed heuristic, datasets with different variations are developed using Design of Experiments (DoE) and tested. The results from our approach were compared to randomly generated scheduled based on large simulations. The results support the use of the heuristics.

[back]

HÖRSAAL A 09:45–10:15

Adaptive Difference-Of-Bundles with Extrapolation Algorithm for DC Programming with Polyhedral Constraints

Guillaume Van Dessel and François Glineur

In the last decades, many dedicated algorithmic ideas and techniques were developed to speed-up the solving of convex optimization problems. Among the most successful ones we find Nesterov's momentum, the non-monotone backtracking line-search and the use of cutting-plane models (bundles). These relie on exogenous information about the structure at hand, either from the objective function or the convex constraints. We propose to exploit these techniques all at once in this non-convex setting: difference of convex (DC) optimization with polyhedral constraints. We start by providing an extended sufficient descent lemma tailored for polyhedral DC problems. By solving a sequence of such subproblems, we propose an approach, dubbed Adaptive Difference-Of-Bundles with extrapolation (ADOBe) involving all mentioned features, which provably converges to a critical point of the problem. We also highlight the possible implementation of a post-processing step that drives our algorithm only towards stronger directional-stationary points. We illustrate the performance of our procedure on several practical DC formulations including fitting, sparse regression and clustering problems.

HÖRSAAL B 09:45–10:15

Facility Location Problems in Reverse Logistics of Polyurethane Waste: A Use Case of Stochastic Mixed-Integer Linear Optimization

Ruurd J.W. Buijs, Rob D. van der Mei, Elenna D. Dugundji, and Sandjai Bhulai

Our research aims to draw up a recycling framework for rigid polyurethane (PU) foam, in which designing the reverse supply chain constitutes a key component. More specifically, we focus on the problem of facility location in the reverse supply chain of PU foam waste that is retrieved from insulation panels in the construction sector. Determining the optimal locations of different (capacitated) facilities is a complex problem, due to the uncertain nature of future waste demand in terms of location, quality and quantity. Moreover, we have to deal with subjectivity in the multi-objective function, which allows to reflect different actors and interests within the reverse supply chain. Our current work focuses on the uncertainty of quantity while solving a facility location problem based on the PU-recycling context in the Amsterdam region. We provide a stochastic Mixed-Integer Linear Program formulation which incorporates the stochastic nature of the waste demand. Additional decision variables are used to investigate whether it would be economically beneficial to compress the material at certain facilities in the network, a feature that has not yet been addressed in earlier literature. Our formulation is flexible since the aspects of location and quality uncertainty can be integrated into it relatively easily.

[back]

HÖRSAAL A 10:15–10:45

Interior Proximal Gradient Methods for Nonconvex Optimization

Alberto De Marchi and Andreas Themelis

We consider composite minimization problems subject to smooth inequality constraints and present an algorithm that combines interior point and proximal gradient schemes. While traditionally the latter cannot handle complicated constraints and the former cannot cope with nonsmooth objective functions, their combined usage is shown to successfully surpass the respective shortcomings. We provide a theoretical characterization of the algorithm and its asymptotic properties, deriving convergence results for fully nonconvex problems, thus bridging the gap with previous works that successfully addressed the convex case. Our interior proximal gradient algorithm benefits from warm starting, generates strictly feasible iterates with decreasing objective value, and returns after finitely many iterations a primal-dual pair approximately satisfying suitable optimality conditions.

HÖRSAAL B 10:15–10:45

Hardness Results for Integrated Last-Mile Deliveries

Moritz Stinzendörfer

We present a hybrid last-mile delivery concept that addresses the growing challenges of urban delivery, including traffic congestion and limited parking. Our concept leverages the strengths of existing infrastructure like public transport and small flexible vehicles such as cargo bikes or drones to achieve an optimal balance between delivery efficiency and environmental impact. Unlike traditional models that require separate mini-hubs for stocking the small vehicles, our model integrates the two modes of transportation and utilizes the public transport vehicle as a moving mini-depot. This approach eliminates the need for additional infrastructure and allows for greater flexibility in adapting to changing demands. We explore the complexity of scheduling the tour of the small vehicle posed by different capacity sizes and derive polynomial-time algorithms. In particular, we propose an approximation algorithm for variants involving multiple drones and provide bounds on the solution quality.

[back]

HÖRSAAL A 11:15–11:45

Lipschitz and Hölder Estimates for Minimizers under Data Perturbations

Diethard Klatte and Bernd Kummer

Given a minimizer of an optimization problem, we are interested in estimating the distance of nearby solutions of a slightly perturbed problem to the minimzing set of the initial problem. For it, we use the concept of q-order calmness of multifunctions, which is suitable for the desired kind of Lipschitz ($q = 1$) or Hölder ($q < 1$) estimate. Sufficient conditions for q-order calmness of the argmin mapping of a general parametric optimization problem in finite dimensions are presented. It turns out that relatively weak stability assumptions for the constraint set mapping and a suitable growth condition will guarantee the q-order calm behavior of minimizers. This extends classical results known from the literature for particular settings. A main purpose is to discuss verifiable conditions which specialize our general results to concrete models of perturbed optimization, including semi-infinite problems with convex or smooth data functions. This talk is particularly given in memory of Bernd Kummer who passed away on December 15, 2022.

HÖRSAAL B 11:15–11:45

Optimal Control of Anisotropic Allen-Cahn Equations

Luise Blank and Johannes Meisinger

Anisotropic Allen-Cahn equations model for example the interface evolution in crystal growth. The focus of this talk is the control of such an evolution. Due to the anisotropy nondifferentiable terms occur which have to be treated appropriately to obtain an efficient optimization solver. Here we propose a particular regularization. The issue of differentiability also leads us to choose the implicit time discretization dG(0) where in addition energy stability is obtained.
First the existence of the control-to-state operator and its Lipschitz-continuity is shown for the time discretized as well as for the time continuous problem. The existence of a global minimizer of the original and of the regularized problem is provided in the time discretized as well as in the continuous setting. Also the convergence with respect to regularization and to discretization is considered. Furthermore the Fréchet differentiability of the regularized problem is studied and optimality conditions are obtained.
Subsequently the trust-region Newton Steihaug-cg method is applied to the time discretized problem which is then discretized in space. This provides us with iteration numbers independent of the discretization level, where evidence is given numerically. Finally numerical examples with various anisotropies and configurations are presented.

[back]

HÖRSAAL A 11:45–12:15

On the Isolated Calmness Property of Implicitly Defined Multifunctions

Helmut Gfrerer and Jiří V. Outrata

The contribution deals with an extension of the available theory of SCD (subspace containing derivatives) mappings to mappings between spaces of different dimensions. This extension enables us to derive workable sufficient conditions for the isolated calmness of implicitly defined multifunctions around given reference points. This stability property differs substantially from isolated calmness at a point and, possibly in conjunction with the Aubin property, offers a new useful stability concept. The application area includes a broad class of parameterized generalized equations, where the respective conditions ensure a rather strong type of Lipschitzian behavior of their solution maps.

HÖRSAAL B 11:45–12:15

A Proximal Newton Solver for Rate-Independent Formulations of Finite-Strain Plasticity

Patrick Jaap, Bastian Pötzl, and Oliver Sander

Time discretization of the energetic rate-independent formulation of plasticity leads to a sequence of minimization problems in the space of deformations and plastic strains. In the finite-strain setting these problems are nonconvex. Furthermore, they are nonsmooth due to the rate-independent dissipation, and the common assumption of plastic incompressibility adds a further equality constraint. Nevertheless, the problems have important algebraic and geometric structure, which can be used to construct robust and efficient solvers. We approach the problem with a Proximal Newton method, which solves a sequence of intermediate problems that are coercive and convex, but still nonsmooth. Global convergence can be shown even if the intermediate problems are solved only inexactly. These intermediate problems have the same structure as small-strain primal plasticity problems. In particular, they are block-separable, and can be solved with a nonsmooth multigrid method such as TNNMG. Together, we obtain a globally convergent solver that reliably and efficiently handles situations with extreme strains.

[back]

HÖRSAAL A 12:15–12:45

Risk Aversion in Dynamic Optimization

Alois Pichler

The contribution features nested and conditional risk measures in dynamic optimization environments. We derive their properties, and investigate if they are suitable for dynamic optimization in continuous and discrete time. In analogy to the generator in stochastic differential equations, we define a risk-averse generator. The generator is a non-linear differential operator, the non-linear term accounting for risk-aversion. It turns out that the generator is independent of the risk measure, which is employed to construct the nested analogue. The results generalize classical models in financial and actuarial sciences by introducing and involving a new, risk-averse aspect.

HÖRSAAL B 12:15–12:45

Semismoothness of the Solution Operator of the Obstacle Problem with Applications in Optimal Control

Gerd Wachsmuth

We address the solution mapping $f \mapsto u$ of the classical obstacle problem

$$u \in K, \quad \langle -\Delta u - f, v - u \rangle_{H_0^1(\Omega)} \geq 0 \; \forall v \in K$$

in which the closed, convex set $K \subset H_0^1(\Omega)$ is given by unilateral or bilateral constraints. It is shown that this solution operator is semismooth. As an application, we consider the optimal control problem

$$\begin{aligned} \text{Minimize} \quad & \frac{1}{2}\|y - y_d\|_{L^2(\Omega)}^2 + \frac{\alpha}{2}\|\nabla u\|_{L^2(\Omega)}^2 \\ \text{such that} \quad & -\Delta y + y = u \text{ in } \Omega,\ \partial_n y = 0 \text{ on } \partial\Omega \\ & u \in K. \end{aligned}$$

The main feature of this problem is the $H_0^1(\Omega)$-regularization of the control u. The necessary optimality condition of this optimal control problem contains the obstacle problem. Due to the semismoothness, we are able to apply the semismooth Newton method and this allows to solve the optimality system with a q-superlinear rate.

[back]

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