INTERNATIONAL CONFERENCE ON CONTINUOUS OPTIMIZATION

ICCOPT 2019 BERLIN

CONFERENCE BOOK

Mathematical Optimization Society
Technische Universität Berlin
WIAS Weierstrass Institute for Applied Analysis and Stochastics

Conference Book — Version 1.0
Sixth International Conference on Continuous Optimization
Berlin, Germany, August 5–8, 2019
Michael Hintermüller (Chair of the Organizing Committee)
Weierstrass Institute for Applied Analysis and Stochastics (WIAS)
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ICCOPT 2019

Sixth International Conference on Continuous Optimization

Berlin, Germany, August 5–8, 2019

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Welcome Address

On behalf of the ICCOPT 2019 Organizing Committee, the Weierstrass Institute for Applied Analysis and Stochastics Berlin, the Technische Universität Berlin, and the Mathematical Optimization Society, I welcome you to ICCOPT 2019, the 6th International Conference on Continuous Optimization.

The ICCOPT is a flagship conference of the Mathematical Optimization Society. Organized every three years, it covers all theoretical, computational, and practical aspects of continuous optimization. With about 150 invited and contributed sessions and twelve invited state-of-the-art lectures, totaling about 800 presentations, this is by far the largest ICCOPT so far. Besides that, the ICCOPT 2019 includes a Summer School (August 3–4), a poster session, and an exhibition. The finalists for the Best Paper Prize in Continuous Optimization will present their contributions, and the prize will be awarded at the conference banquet.

More than 900 participants from about 70 countries all over the world will learn about the most recent developments and results and discuss new challenges from theory and practice. These numbers are a clear indication of the importance of Continuous Optimization as a scientific discipline and a key technology for future developments in numerous application areas.

World-renowned cultural and research institutions, a thriving creative scene and a rich history make Berlin a popular place to live, work and travel. During a river cruise, participants of the Conference Dinner are invited to enjoy Berlin's historic city center and main sights while having dinner with colleagues from all over the world. I hope that you will also find the time to take a look around Berlin on your own, to obtain a feeling for the vibrant lifestyle, and to explore the many attractions of this wonderful city.

Finally, I would like to express my sincere appreciation to the many volunteers who made this meeting possible. I wish to acknowledge, in particular, the members of the program committee, the cluster chairs, and the many session organizers for setting up the scientific program. My sincere thanks go to the members of the organizing committee and everyone involved in the local organization — the system administrators, secretaries, student assistants, PhD students, and postdocs — for the many days, weeks and even months of work.

I wish you all a pleasant and memorable ICCOPT 2019, and a lot of exciting mathematics in the open-minded and international atmosphere of Berlin.

Berlin, August 2019 Michael Hintermüller

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Download the conference app at
`https://iccopt2019.berlin/app`

Download the online version of this book at
`https://iccopt2019.berlin/conference_book`

Overview of Events

Registration

The ICCOPT Registration Desk is located in the lobby of the Main Building, see the floor plan on page 7. The opening times are listed on page 8.

Welcome Reception, Sunday, 17:00–20:00

Everyone is invited to join the welcome reception in the Lichthof. Drinks and snacks will be offered, and you can already collect your conference materials at the ICCOPT Registration Desk.

Opening Ceremony, Monday, 09:00

The Opening of the ICCOPT with welcome addresses and an artistic sand show takes place in H 0105 (Audimax).

Best Paper Award in Continuous Optimization

The winner will be determined after the Best Paper Session on Monday, 16:20–18:20 in H 0105 (Audimax), see page 13. The prize will be awarded at the conference dinner, see below.

Plenary and Semi-Plenary Talks

Featured state-of-the-art talks are given by twelve distinguished speakers, see page 12.

Memorial Session, Tuesday, 16:30–17:45

A special session in honor of Andrew R. Conn, who passed away on March 14, 2019 takes place in H 0105 (Audimax), see page 15.

Parallel Sessions

More than 800 talks are given in almost 170 invited and contributed sessions, see the session overview on page 27 and the detailed session description starts on page 39. All alterations in the scientific program will be displayed on a board near the information desk in the lobby of the Main Building.

Poster Session

On Monday, a poster session with snacks and drinks is planned in the Lichthof, see page 21.

Conference Dinner

On Tuesday, the conference dinner will take place on the boat “MS Mark Brandenburg” on the river Spree. The cruise will depart at 19:00 (boarding starts at 18:30) and last four hours. More details can be found on page 8.

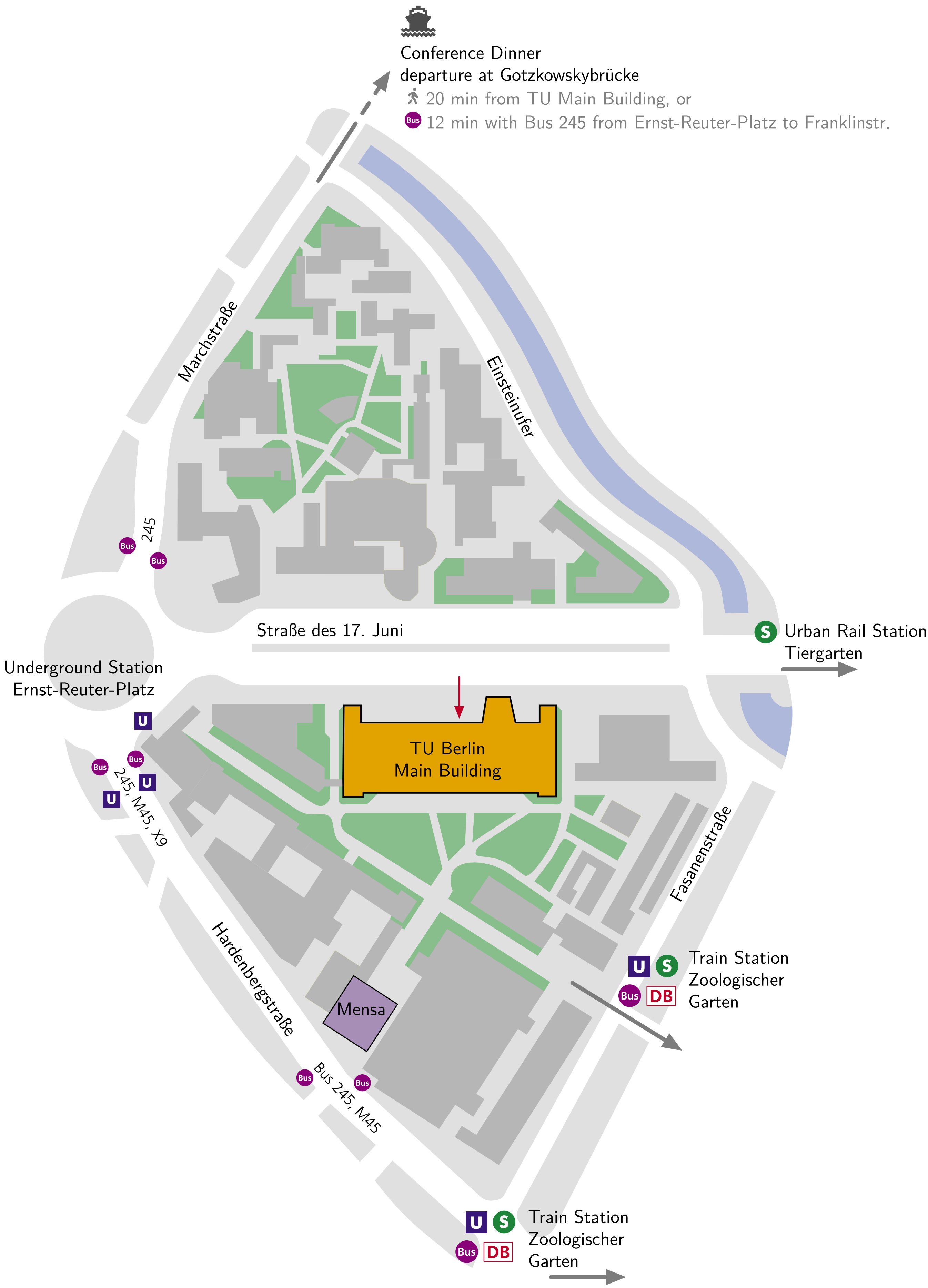
Board Meetings

The following board meetings will take place:

SIOPT	Tuesday,	August 6, 12:00	H 3005,
COAP	Wednesday,	August 7, 13:00	H 3005,
MOR	Wednesday,	August 7, 13:00	H 2036.

Snacks and beverages will be served. Please note that those events are not open to the public.

Campus Map



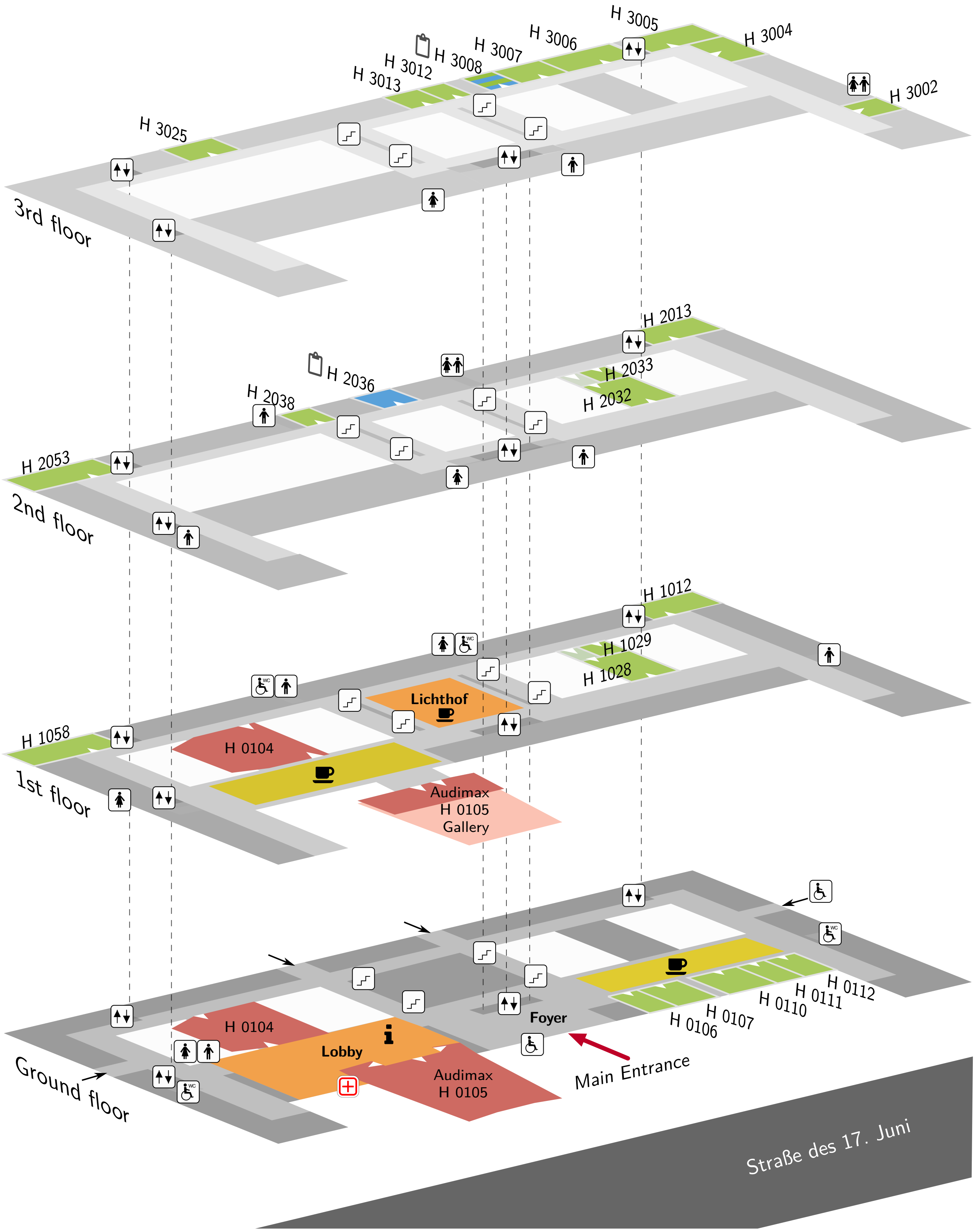
Conference Dinner
departure at Gotzkowskybrücke
20 min from TU Main Building, or
Bus 12 min with Bus 245 from Ernst-Reuter-Platz to Franklinstr.
Marchstraße
Einsteinufer
245
Bus
Straße des 17. Juni
S Urban Rail Station Tiergarten
Underground Station Ernst-Reuter-Platz
U
245, M45, X9
TU Berlin Main Building
Fasanenstraße
Hardenbergstraße
Mensa
Bus 245, M45
U S Bus DB Train Station Zoologischer Garten
U S Bus DB Train Station Zoologischer Garten

Floor Plan

Lobby ∘ ICCOPT Registration Desk
∘ Cloakroom

Lichthof ∘ Welcome Reception
∘ Exhibition
∘ Poster Session
∘ Coffee and snacks

Coffee Break Area
ICCOPT Registration Desk (page 8)
H 2036 and H 3008 can be reserved for meeting, calls, etc. (page 8)
Paramedic station
Room entrance



General Information

ICCOPT Registration Desk. The ICCOPT Registration Desk is located in the lobby (Foyer, ground floor, left) of the TU Berlin Main Building. The opening times are as follows:

Sunday, August 4:	17:00–20:00
Monday, August 5:	07:00–20:00
Tuesday, August 6:	08:00–18:00
Wednesday, August 7:	08:00–18:30
Thursday, August 8:	08:00–17:30

Registration fee. Your registration fee includes admittance to the complete technical program and most special programs. The following social/food events are also included: Opening ceremony including reception on Sunday evening, poster session on Monday evening, and two coffee breaks per day.

Badges required for conference sessions. ICCOPT badges must be worn at all sessions and events. Attendees without badges will be asked to go to the ICCOPT Registration Desk to register and pick up their badges. All participants, including speakers and session chairs, must register and pay the registration fee.

Conference dinner tickets. The conference dinner on Tuesday evening is open to attendees and guests who registered and paid in advance for tickets. Tickets are included in your registration envelope. There may be a limited number of tickets available on site. You may go to the ICCOPT Registration Desk to enquire. Tickets are 65 EUR.
For further details, see page 26.

Info board. Changes at short notice and other important items will be displayed on an info board next to the ICCOPT Registration Desk.

Rooms for spontaneous meetings. The following rooms are available for spontaneous meetings, phone calls, or other:

H 2036:	Monday–Thursday
H 3008:	Monday, Tuesday, and Thursday

A reservation form will be available outside of each room.

Internet access. If your home institution participates in eduroam and you have an account, you can directly connect to the eduroam Wi-Fi. Otherwise, a guest account, for using the Wi-Fi network at the TU Berlin, is included in your conference materials. If you need help, please visit the Wi-Fi helpdesk, which is located in the lobby of the Main Building.

Cloakroom. Participants are asked to carefully look after their belongings for which the organizers are not liable. You will find a cloakroom next to the ICCOPT Registration Desk.

Snacks and coffee breaks. Coffee, tea, and beverages are served during all breaks at the conference venue. Water and fruits will be available over the whole conference period. Moreover, various cafeterias are located in or close to the Main Building of TU Berlin.

Food. The Mensa of the TU Berlin offers plenty of opportunities for lunch at moderate prices. Payment is only permitted with a "Mensa card": it will be possible to get one on the conference premises. In the vicinity of the TU Berlin, there is also a variety of restaurants from fast food to gourmet restaurants. For the daily lunch break, please consult the Restaurant Guide for a list of nearby cafeterias and restaurants. You will find this guide in your conference bag and on the ICCOPT USB flash drive.

Getting around by public transport. The conference badge allows you to use all public transport in and around Berlin (zone ABC) during the conference from August 5 to August 8. In order to identify yourself, you need to carry along your passport or national ID card. The "FahrInfo Plus" app for Android and iOS will help you move inside the city. For more information on public transport in Berlin, visit the BVG webpage

`https://www.bvg.de/en/`

Shopping. Most supermarkets are open from 08:00 to 22:00 in the city. The opening times of cafés, restaurants and small shops varies, but the vast majority should be accessible between 10:00 and 18:00. Note that most shops are closed on Sundays.

Since Berlin is a vibrant city, a variety of different kinds of shops can be found around the TU Berlin. Indeed, the famous shopping center KaDeWe is only two subway stations away from the conference venue. Prices can drastically vary from store to store.

Emergency numbers. On the ground floor, next to the lobby and the Audimax, a paramedic station will be manned during the conference. In case of an emergency keep the following important phone numbers in your mind.

Police:	110
Ambulance:	112
Fire brigade:	112

Questions and information. The organizers, staff of the registration desk, and student assistants will be identifiable by colored name tags and green T-shirts. Please contact them if you have any questions. Do not hesitate to enquire about all necessary information concerning the conference, orientation in Berlin, accommodations, restaurants, going out, and cultural events at the information desk which is located in the lobby of the Main Building.

Social Program/City Tours

Tour 1: Monday, August 5, 14:00–16:00

Discover the historic heart of Berlin

Every street in the center of Berlin has its history, much of it no longer visible: On this walk you will meet the ghosts and murmurs of Prussians and Prussian palaces, Nazis and Nazi architecture, Communists and real, existing socialist architecture, as well as visit some sites of the present.
Meeting point: Berliner Abgeordnetenhaus, Niederkirchnerstraße (near Potsdamer Platz)
End: Unter den Linden/ Museumsinsel

Tour 2: Tuesday, August 6, 14:00–16:00

Where was the Wall?

Berlin: The heart of the cold war. So little is left. Walking the former “deathstrip” between Checkpoint Charlie and Potsdam Square, listen to the stories of how a city was violently split in 1961, how one lived in the divided city, how some attempted to escape from the east, how the wall fell in 1989, and memory today.
Meeting point: U-Bhf. Stadtmitte, at the platform of U6 (not U2!)
End: Potsdamer Platz

Tour 3: Wednesday, August 7, 14:00–16:00

Kreuzberg — Immigrant City

From Immigrants to Inhabitants
Huguenots, Viennese Jews, Silesians: Immigration has always characterized the history of Berlin. One of the most vibrant Berlin districts today consists of Turkish, Swabian, Polish and other “Kreuzbergers”. Encounter churches, mosques, synagogues, and a variety of ethnic food. Social tensions become visible here, too. Is Kreuzberg an example of a modern multi-cultural society made up of many (sub-)cultures? Is the district truly a melting pot, or do its inhabitants simply co-exist in parallel worlds?
Meeting point: Kottbusser Tor/ Corner Admiralstraße, before the "is-bank" (U-Bhf. Kottbusser Tor)
End: Oranienplatz

Tour 4: Thursday, August 8, 14:00–16:00

Where was the Wall?

Berlin: The heart of the cold war. So little is left. Walking the former "deathstrip" between Checkpoint Charlie and Potsdam Square, listen to the stories of how a city was violently split in 1961, how one lived in the divided city, how some attempted to escape from the east, how the wall fell in 1989, and memory today.
Meeting point: U-Bhf. Stadtmitte, at the platform of U6 (not U2!)
End: Potsdamer Platz

Tours must be booked online at

`https://iccopt2019.berlin/tours.html`

All sightseeing tours are held in English and are offered by StattReisen Berlin GmbH. The following holds for all tours:

- Price: 10 EUR
- Payment: *cash only*, on site to the guide
- Every participant needs to register herself/himself
- Group size: min. 6, max. 25; if a tour has more than 25 bookings, the participants are split into groups.
- Booking deadline: July 28, 2019

The tour operator offers additional tours: you may have a look at their offering at

`https://www.stattreisenberlin.de/english/`

Speaker and Chair Information

General guidelines

- Date, timeslot, and location of the parallel sessions are listed as an overview on page 27. The detailed description starts on page 39.
- For each session, helpers will be present to help with potential technical issues. Speakers and chairs can approach them for help with conference equipment. For general questions about the conference, consult the conference web page `https://iccopt2019.berlin` or address the ICCOPT Registration Desk located in the lobby.

Speaker guidelines

- Please bring a USB flash drive with a copy of your presentation with you.
- Please arrive *at least* 15 minutes before the beginning of the session. This is needed as a reaction time in case of unforeseen complications.
- To guarantee a smooth running of the conference activities, we ask to ensure that the presentation lasts 20 mins, so as to leave 5 mins for questions and change of speakers.
- In justified exceptional cases, it is possible to connect your laptop to the conference equipment. Under these circumstances, make sure to bring a power adapter compatible to the German power grid (230 V, 50 Hz). All session rooms are equipped with a video projector with HDMI and VGA input. If your device does not support that format, please have the required adapter at hand. However, we do recommend the use of a USB flash drive instead.

Chair guidelines

- The chairs introduce the speakers, ensure the compliance of the speaking time limit and guarantee the smooth running of the session. Each presentation is supposed to last 20 minutes, the discussion together with the change of speaker to last 5 minutes.
- Please arrive *at least* 15 minutes before the beginning of the session. This is needed as a reaction time in case of unforeseen complications.
- We ask the chairs to notify the ICCOPT Registration Desk about short notice changes and cancellations.

List of Clusters and Cluster Chairs

Applications in Economics, Energy, Engineering and Science APP

Lars Schewe (FAU Erlangen–Nürnberg, Germany)
Peter Schütz (NTNU, Norway)
Golbon Zakeri (U Auckland, New Zealand)

Big Data and Machine Learning BIG

Gitta Kutyniok (TU Berlin, Germany)
Kim-Chuan Toh (NUS, Singapore)

Complementarity and Variational Inequalities VIS

Michael Ferris (U Wisconsin–Madison, USA)
Thomas Surowiec (U Marburg, Germany)

Conic, Copositive, and Polynomial Optimization CON

Etienne de Klerk (Tilburg U, The Netherlands)
Luis Zuluaga (Lehigh U, USA)

Convex and Nonsmooth Optimization CNV

Russell Luke (U Göttingen, Germany)
René Vidal (Johns Hopkins U, USA)

Derivative-free and Simulation-based Optimization DER

Ana Luisa Custodio (NOVA Lisbon, Portugal)
Francesco Rinaldi (U Padova, Italy)

Global Optimization GLO

Ernesto Birgin (USP, Brasil)
Man-Cho So (Chinese U Hong Kong, China)

Multi-Objective and Vector Optimization MUL

Gabriele Eichfelder (TU Ilmenau, Germany)
Alexandra Schwartz (TU Darmstadt, Germany)

Nonlinear Optimization NON

Coralia Cartis (U Oxford, UK)
Sandra Santos (U Campinas, Brazil)

Optimization Applications in Mathematics of Planet Earth PLA

Emil Constantinescu (Argonne National Laboratory, USA)
Pedro Gajardo (UTSM, Chile)

Optimization Implementations and Software IMP

Todd Munson (Argonne National Laboratory, USA)
Dominique Orban (Polytechnique Montréal, Canada)

PDE-constrained Optimization and Optimal Control PDE

Juan Carlos De los Reyes (EPN Quito, Ecuador)
Denis Ridzal (Sandia National Laboratory, USA)

Robust Optimization ROB

Melvyn Sim (NUS, Singapore)
Wolfram Wiesemann (Imperial College, UK)

Sparse Optimization and Information Processing SPA

Mario Figueiredo (Instituto Superior Técnico, Portugal)
Shoham Sabach (Technion, Israel)

Stochastic Optimization STO

René Henrion (Weierstrass Institute, Germany)
Shu Lu (U North Carolina, USA)

Program Overview

Sun, Aug 4

- 17:00–20:00 **Welcome Reception**

Mon, Aug 5

- 09:00–09:30 **Opening**
- 09:30–10:30 **Plenary Talk** Amir Beck, page 12
- 10:30–11:00 Coffee Break
- 11:00–12:15 **Parallel Sessions** Mon.1, page 27
- 12:15–13:45 Lunch Break
- 13:45–15:00 **Parallel Sessions** Mon.2, page 28
- 15:00–15:30 Coffee Break
- 15:30–16:15 **Semi-Plenary Talks** Darinka Dentcheva, Amr S. El-Bakry, page 12
- 16:20–18:20 **Best Paper Session**, page 13
- 18:20–20:30 **Poster Session**, page 21

Tue, Aug 6

- 09:00–10:00 **Plenary Talk** Uday V. Shanbhag, page 14
- 10:00–10:30 Coffee Break
- 10:30–11:45 **Parallel Sessions** Tue.1, page 29
- 11:45–13:15 Lunch Break
- 13:15–14:30 **Parallel Sessions** Tue.2, page 30
- 14:45–16:00 **Parallel Sessions** Tue.3, page 31
- 16:00–16:30 Coffee Break
- 16:30–17:45 **Parallel Sessions** Tue.4, page 32
- 19:00–23:00 **Dinner**

Wed, Aug 7

- 09:00–10:00 **Plenary Talk** Tamara G. Kolda, page 15
- 10:15–11:00 **Semi-Plenary Talks** Radu I. Boţ, Frauke Liers, page 16
- 11:00–11:30 Coffee Break
- 11:30–12:45 **Parallel Sessions** Wed.1, page 33
- 12:45–14:15 Lunch Break
- 14:15–15:30 **Parallel Sessions** Wed.2, page 34
- 15:30–16:00 Coffee Break
- 16:00–17:15 **Parallel Sessions** Wed.3, page 35
- 17:30–18:15 **Semi-Plenary Talks** Heinz Bauschke, Lieven Vandenberghe, page 17

Thu, Aug 8

- 09:00–10:15 **Parallel Sessions** Thu.1, page 36
- 10:15–10:45 Coffee Break
- 10:45–12:00 **Parallel Sessions** Thu.2, page 37
- 12:00–13:30 Lunch Break
- 13:30–14:45 **Parallel Sessions** Thu.3, page 38
- 14:45–15:15 Coffee Break
- 15:15–16:00 **Semi-Plenary Talks** Frank E. Curtis, Piermarco Cannarsa, page 18
- 16:15–17:15 **Plenary Talk** Michael Ulbrich, page 19
- 17:15–17:30 **Closing**

Special Events

Plenary Talk

Mon 09:30–10:30 H 0105

Amir Beck, Tel Aviv University

Coordinate Descent Methods for Optimization Problems with Sparsity Inducing Terms

Chair: Marc Teboulle

We consider nonconvex optimization problems in which coordinate-wise type optimality conditions are superior to standard optimality conditions such as stationarity. Among the models that we explore are those based on sparsity-inducing terms. We illustrate that the hierarchy between optimality conditions induces a corresponding hierarchy between various optimization algorithms.

Semi-Plenary Talk

Mon 15:30–16:15 H 0105

Darinka Dentcheva, Stevens Institute of Technology

On Statistical Inference for Optimization Problems with Composite Risk Functionals

Chair: René Henrion

We analyze risk models representing distributional characteristics of a functional depending on the decision maker's choice and on random data. Very frequently, models of risk are nonlinear with respect to the underlying distributions; we represent them as structured compositions.

We discuss the statistical estimation of risk functionals and present several results regarding the properties of empirical and kernel estimators. We compare the performance of the estimators theoretically and numerically. Several popular risk measures will be presented as illustrative examples. Furthermore, we consider sample-based optimization problems which include risk functionals in their objective and in the constraints. We characterize the asymptotic behavior of the optimal value and the optimal solutions of the sample-based optimization problems. While we show that many known coherent measures of risk can be cast in the presented structures, we emphasize that the results are of more general nature with a potentially wider applicability. Applications of the results to hypothesis testing of stochastic orders, portfolio efficiency, and others will be outlined.

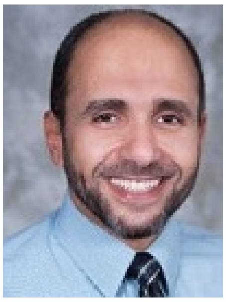
Semi-Plenary Talk

Mon 15:30–16:15 H 0104

Amr S. El-Bakry, ExxonMobil Upstream Research Comp

Optimization in Industry: Overview from the Oil and Gas Energy Sector

Chair: Peter Schütz



The oil and gas energy industry is witnessing a renewed interest in optimization technology across the value chain. With applications spanning exploration, development, production, and transportation of extracted material, there is greater awareness of the value optimization technology can provide. The questions of whether this resurgence of optimization in this sector of the economy is sustainable or is a part of the cyclic technology interest remains to be seen.

This talk will provide an overview of some classical optimization models and other newer ones. Examples from the area of production optimization will be presented. Links to machine learning will be emphasized in multiple applications. Opportunities and challenges will be discussed.

Best Paper Session

Mon 16:20–18:20 H 0105

Chair: Andrzej Ruszczyński

Four papers have been selected as finalists of the best paper competition by the best paper committee

- Andrzej Ruszczyński
  Rutgers University, Chair
- Dietmar Hömberg
  Weierstrass Institute/TU Berlin
- Philippe L. Toint
  University of Namur
- Claudia Sagastizábal
  University of Campinas

The finalists will be featured in a dedicated session at ICCOPT 2019, and the prize winner will be determined after the finalist session.

Amal Alphonse, Weierstrass Institute for Applied Analysis and Stochastics (WIAS) (joint work with Michael Hintermüller, Carlos Rautenberg)

Directional differentiability of quasi-variational inequalities and related optimization problems

In this talk, which is based on recent work with Prof. Michael Hintermüller and Dr. Carlos N. Rautenberg, I will discuss the directional differentiability of solution maps associated to elliptic quasi-variational inequalities (QVIs) of obstacle type. QVIs are generalisations of variational inequalities (VIs) where the constraint set associated to the inequality also depends on the solution, adding an extra source of potential nonlinearity and nonsmoothness to the problem. I will show that the map taking the source term into the set of solutions is directionally differentiable in a certain sense and give an outline of the proof, and we will see that the directional derivative can be characterised as the monotone limit of directional derivatives associated to certain VIs. If time allows, the theory will be illustrated with an application of QVIs in thermoforming.

Yuxin Chen, Princeton University (joint work with Emmanuel J. Candes)

Solving Random Quadratic Systems of Equations Is Nearly as Easy as Solving Linear Systems

We consider the fundamental problem of solving quadratic systems of equations in n variables. We propose a novel method, which starting with an initial guess computed by means of a spectral method, proceeds by minimizing a nonconvex functional. There are several key distinguishing features, most notably, a distinct objective functional and novel update rules, which operate in an adaptive fashion and drop terms bearing too much influence on the search direction. These careful selection rules provide a tighter initial guess, better descent directions, and thus enhanced practical performance. On the theoretical side, we prove that for certain unstructured models of quadratic systems, our algorithms return the correct solution in linear time, i.e. in time proportional to reading the data as soon as the ratio between the number of equations and unknowns exceeds a fixed numerical constant. We extend the theory to deal with noisy systems and prove that our algorithms achieve a statistical accuracy, which is nearly un-improvable. We complement our theoretical study with numerical examples showing that solving random quadratic systems is both computationally and statistically not much harder than solving linear systems of the same size. For instance, we demonstrate empirically that the computational cost of our algorithm is about four times that of solving a least-squares problem of the same size.

Damek Davis, Cornell University (joint work with Dmitriy Drusvyatskiy, Sham Kakade, Jason D. Lee)
Stochastic Subgradient Method Converges on Tame Functions

The stochastic subgradient method forms the algorithmic core of modern statistical and machine learning. We understand much about how it behaves for problems that are smooth or convex, but what guarantees does it have in the absence of smoothness and convexity? We prove that the stochastic subgradient method, on any semialgebraic locally Lipschitz function, produces limit points that are all first-order stationary. More generally, our result applies to any function with a Whitney stratifiable graph. In particular, this work endows the stochastic subgradient method, and its proximal extension, with rigorous convergence guarantees for a wide class of problems arising in data science—including all popular deep learning architectures.

Xudong Li, Fudan University
Exploiting Second Order Sparsity in Big Data Optimization

In this talk, we shall demonstrate how second order sparsity (SOS) in important optimization problems can be exploited to design highly efficient algorithms. The SOS property appears naturally when one applies a semismooth Newton (SSN) method to solve the subproblems in an augmented Lagrangian method (ALM) designed for certain classes of structured convex optimization problems. With in-depth analysis of the underlying generalized Jacobians and sophisticated numerical implementation, one can solve the subproblems at surprisingly low costs. For lasso problems with sparse solutions, the cost of solving a single ALM subproblem by our second order method is comparable or even lower than that in a single iteration of many first order methods. Consequently, with the fast convergence of the SSN based ALM, we are able to solve many challenging large scale convex optimization problems in big data applications efficiently and robustly. For the purpose of illustration, we present a highly efficient software called SuiteLasso for solving various well-known Lasso-type problems.

Plenary Talk

Tue 09:00–10:00 H 0105

Uday Shanbhag, Penn State University
Addressing Uncertainty in Equilibrium Problems

Chair: Jong-Shi Pang

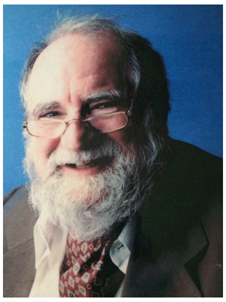
We address two sets of fundamental problems in the context of equilibrium problems: (i) Of these, the first pertains towards the development of existence statements for stochastic variational inequality and complementarity problems. A naive application of traditional deterministic existence theory requires access to closed-form expressions of the expectation-valued map; instead, we develop a framework under which verifiable a.s. requirements on the map allow for making existence claims in a broad set of monotone and non-monotone regimes. Time permitting, we consider how such avenues can allow for building a sensitivity theory for stochastic variational inequality problems. (ii) Our second question considers the development of synchronous, asynchronous, and randomized inexact best-response schemes for stochastic Nash games where an inexact solution is computed by using a stochastic gradient method. Under a suitable spectral property on the proximal best-response map, we show that the sequence of iterates converges to the unique Nash equilibrium at a linear rate. In addition, the overall iteration complexity (in gradient steps) is derived and the impact of delay, asynchronicity, and randomization is quantified. We subsequently extend these avenues to address the distributed computation of Nash equilibria over graphs in stochastic regimes where similar rate statements can be derived under increasing rounds of communication and variance reduction.

Memorial Session

Tue.4 16:30–17:45 H 0105

Reflections on the Life and Work of Andrew R. Conn

Chair: Michael Overton



Andrew R. Conn passed away on March 14, 2019. He played a pioneering role in nonlinear optimization and remained very active in the field until shortly before his death. At this session, 5 of his friends and colleagues will give 10-minute tributes to his work and his life. These will be followed by 30 minutes where everyone will have the opportunity to contribute a few words in memory of Andy, as he was always known. The five speakers are:

- Philippe L. Toint, University of Namur
- Katya Scheinberg, Lehigh University
- Annick Sartenaer, University of Namur
- Henry Wolkowicz, University of Waterloo
- James Burke, University of Washington

Andrew R. Conn was born in London on Aug. 6, 1946, and died at his home in Westchester County, NY, on Mar. 14, 2019. He played a pioneering role in nonlinear optimization starting in the early 1970s, and he remained very active in the field until shortly before his death. Andy obtained his B.Sc. with honours in Mathematics at Imperial College, London, in 1967, and his Ph.D. from the University of Waterloo in 1971. He was a faculty member at Waterloo for 18 years starting in 1972, and then moved to the IBM T.J. Watson Research Center in Yorktown Heights, NY, where he spent the rest of his career.

Andy's research interests were extensive but centered on nonlinear optimization. They were typically motivated by algorithms, and included convergence analysis, applications and software. His first published paper, *Constrained optimization using a nondifferentiable penalty function*, which appeared in SIAM J. Numer. Anal. in 1973, was already quite influential, helping to pave the way for the eventually widespread use of exact penalty functions in nonlinear programming. Later work included an extraordinarily productive collaboration with Nick Gould and Philippe Toint, resulting in more than 20 publications by these three authors alone. One highlight of this collaboration was the definitive treatise *Trust Region Methods* (2000), the first book in the optimization series published by the Mathematical Programming Society (MPS, later MOS) in collaboration with SIAM. Another highlight was the LANCELOT software for large-scale constrained optimization, for which the authors were awarded the prestigious Beale–Orchard-Hays Prize for Excellence in Computational Mathematical Programming in 1994. A third highlight was the introduction of the influential Constrained and Unconstrained Testing Environment (CUTE). In more recent years, Andy became interested in derivative-free optimization (DFO) and, together with Katya Scheinberg and Luis Nunes Vicente, published several papers on DFO as well as a book, *Introduction to Derivative-Free Optimization* (MPS-SIAM Series on Optmization, 2009), for which they were awarded the Lagrange Prize in Continuous Optimization by MOS and SIAM in 2015. The citation states that the book "includes a groundbreaking trust region framework for convergence that has made DFO both principled and practical".

Andy is survived by his wife Barbara, his mother and four siblings in England, his daughter Leah and his son Jeremy, and three grandchildren. He will be greatly missed by his family, the optimization community, and his many friends.

Plenary Talk

Wed 09:00–10:00 H 0105

Tamara G. Kolda, Sandia National Laboratories

Randomized Methods for Low-Rank Tensor Decomposition

Chair: Kim-Chuan Toh

Tensor decomposition discovers latent structure in higher-order data sets and is the higher-order analogue of the matrix decomposition. Variations have proliferated, including symmetric tensor decomposition, tensor completion, higher-order singular value decomposition, generalized canonical tensor decomposition, streaming tensor decomposition, etc. All of these scenarios reduce to some form of nonconvex optimization. In this talk, we discuss the use of randomized optimization methods, including stochastic gradient methods and sketching. Such approaches show amazing promise, not only improving the speed of the methods but also the quality of the solution. We give examples of the intriguing successes as well as notable limitations of these methods. We close with a number of open questions, including important open theoretical challenges.

Semi-Plenary Talk

Wed 10:15–11:00 H 0105

Frauke Liers, Friedrich-Alexander-Universität Erlangen-Nürnberg

Robust Optimization for Energy Applications: Current Challenges and Opportunities

Chair: Wolfram Wiesemann

In this talk, we will give an overview over optimization problems under uncertainty as they appear in energy management, together with global solution approaches. One way of protecting against uncertainties that occur in real-world applications is to apply and to develop methodologies from robust optimization. The latter takes these uncertainties into account already in the mathematical model. The task then is to determine solutions that are feasible for all considered realizations of the uncertain parameters, and among them one with best guaranteed solution value. We will introduce a number of electricity and gas network optimization problems for which robust protection is appropriate. Already for simplified cases, the design of algorithmically tractable robust counterparts and global solution algorithms is challenging. As an example, the stationary case in gas network operations is complex due to non-convex dependencies in the physical state variables pressures and flows. In the robust version, two-stage robust problems with a non-convex second stage are to be solved, and new solution methodologies need to be developed. We will highlight robust optimization approaches and conclude by pointing out some challenges and generalizations in the field.

Semi-Plenary Talk

Wed 10:15–11:00 H 0104

Radu Boţ, University of Vienna

Proximal Algorithms for Nonsmooth Nonconvex Optimization

Chair: Russell Luke

During the last decade many efforts have been made to translate the powerful proximal algorithms for convex optimization problems to the solving of nonconvex optimization problems. In this talk we will review such iterative schemes which posses provable convergence properties and are designed to solve nonsmooth nonconvex optimization problems with structures which range from simple to complex. We will discuss the pillars of the convergence analysis, like the boundedness of the generated iterates, techniques to prove that cluster points of this sequence are stationary points of the optimization problem under investigation, and elements of nonconvex subdifferential calculus. We will also emphasize the role played by the Kurdyka-Lojasiewicz property when proving global convergence, and when deriving convergence rates in terms of the Lojasiewicz exponent.

Semi-Plenary Talk

Wed 17:30–18:15 H 0105

Heinz Bauschke, University of British Columbia

On the Douglas-Rachford algorithm

Chair: Jonathan Eckstein

The Douglas-Rachford algorithm is a popular method for finding minimizers of sums of nonsmooth convex functions; or, more generally, zeros of sums of maximally monotone operators.

In this talk, I will focus on classical and recent results on this method as well as challenges for the future.

Semi-Plenary Talk

Wed 17:30–18:15 H 0104

Lieven Vandenberghe, UCLA

Structured sparsity in semidefinite programming

Chair: Jacek Gondzio

Primal-dual interior-point methods for semidefinite programming, as implemented in widely used solvers, rely on the elegant theory of self-scaled barriers and the property that the dense symmetric positive semidefinite matrices form a symmetric convex cone.

In applications it is very common that the constraints in a semidefinite program are sparse. It is natural to pose such problems as conic optimization problems over cones of sparse positive semidefinite matrices, in order to exploit theory and algorithms from sparse linear algebra. Examples of this approach are the splitting techniques based on decomposition theorems for chordal sparsity patterns, which have been applied successfully in first-order methods and interior-point algorithms. However sparse semidefinite matrix cones are not symmetric, and conic optimization algorithms for these cones lack the extensive theory behind the primal-dual methods for dense semidefinite optimization. The talk will explore new formulations of primal-dual interior-point methods for sparse semidefinite programming. It will mostly focus on the important special case of chordal sparsity patterns that define homogeneous convex cones.

The talk is based on joint work with Levent Tuncel.

Semi-Plenary Talk

Thu 15:15–16:00 H 0105

Frank E. Curtis, Lehigh University

New Quasi-Newton Ideas for (Non)smooth Optimization

Chair: Jorge Nocedal

One of the most important developments in the design of optimization algorithms came with the advent of quasi-Newton methods in the 1960s. These methods have been used to great effect over the past decades, and their heyday is not yet over. In this talk, we introduce a new advance in quasi-Newton methodology that we refer to as displacement aggregation. We also discuss other new advances for extending quasi-Newton ideas for stochastic and nonconvex, nonsmooth optimization.

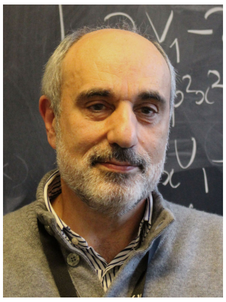
Semi-Plenary Talk

Thu 15:15–16:00 H 0104

Piermarco Cannarsa, University of Rome Tor Vergata

First order mean field games

Chair: Stefan Ulbrich



The theory of mean field games has been developed in the last decade by economists, engineers, and mathematicians in order to study decision making in very large populations of small interacting agents. The approach by Lasry and Lions leads to a system of nonlinear partial differential equations, the solution of which can be used to approximate the limit of an N-player Nash equilibrium as N tends to infinity.

This talk will mainly focus on deterministic models, which are associated with a first order pde system. The main points that will be addressed are the existence and uniqueness of solutions, their regularity in the presence of boundary conditions, and their asymptotic behaviour as time goes to infinity.

Plenary Talk

Thu 16:15–17:15 H 0105

Michael Ulbrich, Technical University of Munich

Nonsmoothness in PDE-Constrained Optimization

Chair: Matthias Heinkenschloss

Nonsmoothness arises in PDE-constrained optimization in multi-faceted ways and is at the core of many recent developments in this field. This talk highlights selected situations where nonsmoothness occurs, either directly or by reformulation, and discusses how it can be handled analytically and numerically.

Projections, proximal maps, and similar techniques provide powerful tools to convert variational inequalities and stationarity conditions into nonsmooth operator equations. These then enable the application of semismooth Newton methods, which belong to the most successful algorithms for inequality constrained problems with PDEs. Nonsmoothness also arises in problems with equilibrium constraints, such as MPECs, or with bilevel structure. This is particularly apparent when reduced problems are generated via solution operators of subsystems. Similarly, nonlinear PDEs, even if looking smooth at first sight, often pose challenges regarding the differentiability of the solution operator with respect to parameters such as control or shape. There are also important applications where nonsmoothness arises naturally in the cost function, for instance in sparse control or when risk measures like the CVaR are used in risk-averse PDE-constrained optimization. Also other approaches for PDE-constrained optimization under uncertainty exhibit nonsmoothness, e.g., (distributionally) robust optimization.

All this shows that PDE-constrained optimization with nonsmooth structures is a broad and highly relevant field. This talk discusses specific examples to highlight the importance of being able to master nonsmoothness in PDE optimization. General patterns are identified and parallels to the finite dimensional case are explored. The infinite dimensional setting of PDEs, however, poses additional challenges and unveils problem characteristics that are still present after discretization but then are much less accessible to a rigorous analysis.

Exhibition

The exhibition is open during the full conference period.

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FBP 2020

FBP 2020 BERLIN

International Conference on Free Boundary Problems: Theory and Applications

The **15th International Conference on Free Boundary Problems: Theory and Applications 2020** (FBP 2020) will take place on the campus of the Humboldt University (HU) of Berlin, **September 7–11, 2020**. The FBP conference is a flagship event that brings together the free boundary/partial differential equation community and is organized every few years.

The Call For Papers is expected to be sent in Fall 2019. More information on https://fbp2020.de

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Posters Abstracts

1 Waleed Alhaddad, King Abdullah University of Science and Technology (KAUST)
Uncertainty Quantification in Wind Power Forecasting

Reliable wind power generation forecasting is crucial to meet energy demand, to trade and invest. We propose a model to simulate and quantify uncertainties in such forecasts. This model is based on Stochastic Differential Equations whose time-dependent parameters are inferred using continuous optimization of an approximate Likelihood function. The result is a skew stochastic process that simulates uncertainty of wind power forecasts accounting for maximum power production limit and other temporal effects. We apply the model to historical Uruguayan data and forecasts.

2 Anas Barakat, LTCI, Télécom Paris, Institut Polytechnique de Paris (joint work with Pascal Bianchi)
Convergence of the ADAM algorithm from a Dynamical System Viewpoint

Adam is a popular variant of the stochastic gradient descent. However, only few information about its convergence is available in the literature. We investigate the dynamical behavior of Adam when the objective function is non-convex and differentiable. We introduce a continuous-time version of Adam, under the form of a non-autonomous ordinary differential equation. Existence, uniqueness and convergence of the solution to the stationary points of the objective function are established. It is also proved that the continuous-time system is a relevant approximation of the Adam iterates.

3 Jo Andrea Brüggemann, Weierstrass Institute for Applied Analysis and Stochastics (WIAS)
Elliptic obstacle-type quasi-variational inequalities (QVIs) with volume constraints motivated by a contact problem in biomedicine

Motivated by a contact model in biomedicine, a compliant obstacle problem arises exemplarily in the situation of two elastic membranes enclosing a region of constant volume, which are subject to external forces. The motivating model enables a reformulation as a obstacle-type quasi-variational inequality (QVI) with volume constraints. We analyse this class of QVIs and present a tailored path-following semismooth Newton method to solve the problem. In view of the numerical performance, adaptive finite elements are used based on a posteriori error estimation.

4 Renzo Caballero, King Abdullah University of science and technology (KAUST) (joint work with Raul Tempone)
Stochastic Optimal Control of Renewable Energy

Uruguay has always been a pioneer in the use of renewable sources of energy. Nowadays, it can usually satisfy its total demand from renewable sources, but half of the installed power, due to wind and solar sources, is non-controllable and has high uncertainty and variability. We deal with non-Markovian dynamics through a Lagrangian relaxation, solving then a sequence of HJB PDEs associated with the system to find time-continuous optimal control and cost function. We introduce a monotone scheme to avoid spurious oscillations. Finally, we study the usefulness of extra system storage capacity.

5 Jongchen Chen, National Yunlin University of Science and Technology (joint work with Chao-Yi Huang)
Towards Perpetual Learning Using a Snake-Like Robot Controlled by a Self-Organizing Neuromolecular System

A robot that works no matter how well designed, the results of its operation in the actual environment are sometimes quite different from the expected results of its design environment. In this study, we train a snake-type robot Snaky with 8 joints and 4 control rotary motors to learn to complete the specified snake mission through an autonomous learning mechanism. The core learning mechanism is the artificial neuromolecular system (ANM) developed by the research team in the early days. The learning continues until the robot achieves the assigned tasks or stopped by the system developer.

6 Sarah Chenche, Guelma University Algeria
A new approach for solving the set covering problem

The paper presents a simple technique to heuristically reduce the column set of set covering problems. The idea consists in discarding all columns that are not selected by the subgradient algorithm used to solve the Lagrangian relaxation. In case the reduction leaves a large number of columns, this filter may be strengthened by discarding all columns that are not selected more than alpha% times.the proposed technique is in the class of "Sifting" techniques. We are evaluating this technique using a Benders algorithm designed for solving real world set covering instances arising from Deutsche Bahn.

7 Maxim Demenkov, Institute of Control Sciences
First-order linear programming over box-constrained polytopes using separation oracle

First-order methods for linear feasibility problems have been known since the Kaczmarz algorithm. According to Naumann and Klee, any polytope is obtainable as a section of higher-dimensional cube. Transformation of linear constraints to such form is very much like the one in simplex method, but instead of non-negativity constraints every variable is constrained to an interval. A solution of LP problem amounts to finding an intersection between a line and an affine transformation of the cube, which iteratively uses calculation of a hyperplane separating a point on the line and that polytope.

8 Simon Funke, Simula Research Laboratory (joint work with Sebastian Mitusch)
Algorithmic differentation for coupled FEniCS and pyTorch models

This poster presents recent advances in dolfin-adjoint, the algorithmic differentiation tool for the finite element framework FEniCS. We will show dolfin-adjoint can be used to differentiated and optimised PDE models in FEniCS that are coupled to neural network models implemented in pyTorch. Our approach allows to compute derivatives with respect to weights in the neural network, and as PDE coefficients such as initial condition, boundary conditions and even the mesh shape.

9 Carmen Gräßle, Universität Hamburg (joint work with Michael Hinze, Alessandro Alla)
Time adaptivity in POD based model predictive control

Within model predictive control (MPC), an infinite time horizon problem is split into a sequence of open-loop finite horizon problems which allows to react to changes in the problem setting due to external influences. In order to find suitable time horizon lengths, we utilize a residual-based time adaptive approach which uses a reformulation of the optimality system of the open-loop problem as a biharmonic equation. In order to achieve an efficient numerical solution, we apply POD based model order reduction.

10 Seyedeh Masoumeh Hosseini Nejad (joint work with Majid Darehmiraki)
Accelerated Bregman proximal gradient methods for the absolute value equation

The absolute value equation plays a outstanding role in optimization. In this paper, we employ proximal gradient method to present a efficient solution for solving it. We use accelerated

Bregman proximal gradient methods that employ the Bregman distance of the reference function as the proximity measure.

11 Tomoyuki Iori, Kyoto University (joint work with Toshiyuki Ohtsuka)

A Symbolic-Numeric Penalty Function Method for Parametric Polynomial Optimizations via Limit Operation in a Projective Space

We propose a symbolic-numeric method to solve a constrained optimization problem with free parameters where all the functions are polynomials. The proposed method is based on the quadratic penalty function method and symbolically performs the limit operation of a penalty parameter by using projective spaces and tangent cones. As its output, we obtain an implicit function representation of optimizers as a function of the free parameters. Some examples show that the exact limit operation enables us to find solutions that do not satisfy the Karush-Kuhn-Tucker (KKT) conditions.

12 Chesoong Kim, Sangji University

Modeling and Optimization for Wireless Communication Networks using Advanced Queueing Model

We consider an advanced queueing model with energy harvesting and multi-threshold control by the service modes. The account of the possibility of error occurrence is very important in modelling wireless sensor networks. This model generalizes a previously considered in the literature by suggestions that the buffer for customers has an infinite capacity and the accumulated energy can leak from the storage. Under the fixed thresholds defining the control strategy, behavior of the system is described by multi-dimensional Markov chain what allows to formulate and solve optimization problems.

13 Elisabeth Köbis, Martin Luther University Halle-Wittenberg (joint work with Markus Arthur Köbis)

An Inequality Approach to Set Relations by Means of a Nonlinear Scalarization Functional

We show how a nonlinear scalarization functional can be used in order to characterize several well-known set relations and which thus plays a key role in set optimization. By means of this functional, we derive characterizations for minimal elements of set-valued optimization problems using a set approach. Our methods do not rely on any convexity assumptions on the considered sets. Furthermore, we introduce a derivative-free descent method for set optimization problems without convexity assumptions to verify the usefulness of our results.

14 Markus Arthur Köbis, Free University Berlin (joint work with Jia-Wei Chen, Elisabeth Köbis, Jen-Chih Yao)

A New Set Relation in Set Optimization

We show the construction of a novel set relation implementing a compromise between the known concepts "upper set less relation" on the one hand and "lower set less relation" on the other. The basis of the construction lies in the characterization of the relation of two sets by means of a single real value that can be computed using nonlinear separation functionals of Tammer-Weidner-type. The new relation can be used for the definition of flexible robustness concepts and the theoretical study of set optimization problems based on this concepts can be based on properties of the other relations.

15 Chul-Hee Lee, INHA University (joint work with Ji-Su Hong, Gwang-Hee Lee)

Optimization and Experimental Validation on the Frame of Resistance Spot Welding Gun

Resistance spot welding gun is generally used to bond parts in the automotive and home appliance industry. The industrial robot is essential because most of the welding process is automated. The weight of the welding gun should be minimized to increase the efficiency of the robot motion. In this study, welding gun frame optimization is performed using genetic algorithm methods. Several parts of frame thickness are specified as variables and the optimization model is validated through both simulation and experiments. The weight is decreased by up to 14% and cost saving is also achieved.

16 Chiao-Wei Li, National Tsing Hua University (joint work with Yong-Ge Yang, Yu-Ching Lee, Po-An Chen, Wen-Ying Huang)

Data-driven equilibrium pricing in a multi-leader-one-follower game

We consider a periodic-review pricing problem. There are firms i=1,...,N competing in the market of a commodity in a stationary demand environment. Each firm can modify the price over discretized time. The firm i's demand at period n consists of the linear model conditional on the selling prices of its own and other firms with an independent and identically distributed random noise. The coefficients of the linear demand model is not known a priori. Each firms' objective is to sequentially set prices to maximize revenues under demand uncertainty and competition.

17 Sebastian Lämmel, Technische Universität Chemnitz (joint work with Vladimir Shikhman)

On Comparison of Experiments due to Shannon

In order to efficiently design experiments, decision makers have to compare them. The comparison of experiments due to Blackwell is based on the notion of garbling. It is well-known that the Blackwell order can be characterized by agents' maximal expected utility. We focus on the comparison of experiments due to Shannon by allowing pre-garbling. We show that for any subset of decision makers the comparison of their maximal expected utilities does not capture the Shannon order. For characterizing the Shannon order, we enable decision makers to redistribute noise, and convexify the garbling.

18 Martin Morin, Lund University (joint work with Pontus Giselsson)

Stochastic Variance Adjusted Gradient Descent

We present SVAG, a variance reduced stochastic gradient method with SAG and SAGA as special cases. A parameter interpolates and extrapolates SAG/SAGA such that the variance the gradient approximation can be continuously adjusted, at the cost of introducing bias. The intuition behind this bias/variance trade-off is explored with numerical examples. The algorithm is analyzed under smoothness and convexity assumptions and convergence is established for all choices of the bias/variance trade-off parameter. This is the first result that simultaneously captures SAG and SAGA.

19 Ketan Rajawat, Indian Institute of Technology Kanpur (joint work with Amrit Singh Bedi, Alec Koppel)

Nonstationary Nonparametric Optimization: Online Kernel Learning against Dynamic Comparators

We are interested in solving an online learning problem when the decision variable is a function f which belongs to reproducing kernel Hilbert space. We present the dynamic regret analysis for an optimally compressed online function learning algorithm. The dynamic regret is bounded in terms of the loss function variation. We also present the dynamic regret analysis in terms of the function space path length. We prove that the learned function via the proposed algorithm has a finite memory requirement. The theoretical results are corroborated through simulation on real data sets.

20 Adrian Redder, Automatic Control Group / Paderborn University (joint work with Arunselvan Ramaswamy, Daniel E. Quevedo)

Learning based optimal control and resource allocation for large-scale cyber-physical systems.

Typical cyber-physical Systems consist of many interconnected heterogeneous entities that share resources such as communication or computation. Here optimal control and resource scheduling go hand in hand. In this work, we consider the problem of simultaneous control and scheduling. Specially, we present DIRA, a Deep Reinforcement Learning based Iterative Resource Allocation algorithm, which is scalable and control sensitive. For the controller, we present three compatible designs based on actor-critic reinforcement learning, adaptive linear quadratic regulation and model predictive control.

21 Olaf Schenk, Università della Svizzera italiana (joint work with Dimosthenis Pasadakis, Drosos Kourounis)

Balanced Graph Partition Refinement in the p-Norm

We present a modified version of spectral partitioning utilizing the graph p-Laplacian, a nonlinear variant of the standard graph Laplacian. The computation of the second eigenvector is achieved with the minimization of the graph p-Laplacian Rayleigh quotient, by means of an accelerated gradient descent approach. A continuation approach reduces the p-norm from a 2-norm towards a 1-norm, thus promoting sparser solution vectors, corresponding to smaller edgecuts. The effectiveness of the method is validated in a variety of complex graphical structures originating from power and social networks.

22 Johanna Schultes, University of Wuppertal (joint work with Kathrin Klamroth, Michael Stiglmayr, Onur Tanil Doganay, Hanno Gottschalk, Camilla Hahn)

Biobjective Shape Optimization of Ceramic Components using Weighted Sums: Reliability versus Cost

We consider a biobjective PDE constrained shape optimization problem maximizing the reliability of a ceramic component under tensile load and minimizing its material consumption. The numerical implementation is based on a finite element discretization with a B-spline representation of the shapes. Using the B-spline coefficients as control variables we combine it with a single objective gradient descent algorithm for solving the weighted sum scalarization and apply it to 2D test cases. While varying the weights we determine different solutions representing different preferences.

23 **[canceled]** Roya Soltani, Khatam University (joint work with Reza Soltani, Soheila Soltani)

Robust optimization for the redundancy allocation problem with choice of component type and price discounting

In this paper, a redundancy allocation problem (RAP) with an active strategy and choice of a component type is considered, in which there are different components with various reliabilities and costs considered as imprecise and varied in an interval uncertainty set. Therefore, a robust model for the RAP is presented to propose a robust design for different realization of uncertain parameters. Finally, uncertainty and price discounting are considered together in a comprehensive model for the RAP and the effects on warranty costs with minimal repair are investigated.

24 Alexander Spivak, HIT - Holon Institute of Technology

Successive Approximations for Optimal Control in Nonlinear Systems with Small Parameter

Bilinear systems are linear on phase coordinates when the control is fixed, and linear on the control when the coordinates are fixed. They describe the dynamic processes of nuclear reactors, kinetics of neutrons, and heat transfer. Further investigations show that many processes in engineering, biology, ecology and other areas can be described by the bilinear systems . The problem is to find optimal control minimizing the quadratic functional for the system driven by white noise with small parameter. Successive approximations are constructed by perturbation theory method/

25 Steven-Marian Stengl, WIAS/HU Berlin

On the Convexity of Optimal Control Problems involving Nonlinear PDEs or VIs

In recent years, generalized Nash equilibrium problems in function spaces involving control of PDEs have gained increasing interest. One of the central issues arising is the question of existence, which requires the topological characterization of the set of minimizers for each player. In this talk, we propose conditions on the operator and the functional, that guarantee the reduced formulation to be a convex minimization problem. Subsequently, we generalize the results of convex analysis to derive optimality systems also for nonsmooth operators. Our findings are illustrated with examples.

26 Adrian Viorel, Tehnical University of Cluj-Napoca

An average vector field approach to second-order nonconvex gradient systems

The average vector field (AVF) discrete gradient, originally designed by Quispel and McLaren as an energy-preserving numerical integrator for Hamiltonian systems has found a variety of applications, including Optimization. In contrast to the very recent work of Ehrhardt et. al. which deals with AVF discretizations of gradient flows, the present contribution aims at deriving discrete versions of second-order gradient systems based on AVF discrete gradients. The obtained optimization algorithms are shown to inherit the asymptotic behavior of their continuous counterparts.

27 Meihua Wang, Xidian University (joint work with Caoyuan Ma, Fengmin Xu)

Application of quasi-norm regularization into robust portfolio optimization problem

This paper concerns robust portfolio optimization problem which is a popular topic in financial engineering. To reach the investor's requirement on asset selection, we build a sparse robust portfolio optimization model by adding a nonconvex penalty item into the objective function instead of the cardinality constraint. A series of models based on different uncertainty sets for expected return rates and covariance are present. The Alternating Quadratic Penalty (AQP) method is applied to solve the relative sparse robust portfolio selection models.

28 Yue Xie, University of Wisconsin-Madison (joint work with Uday Shanbhag, Stephen Wright)

Resolution of nonconvex optimization via ADMM type of schemes

First, we consider a class of nonconvex optimization problems including l0 norm minimization and dictionary learning which can be efficiently solved using ADMM and its variants. In particular, the nonconvex problem is decomposed such that each subproblem is either a tractable convex program or endowed with hidden convexity. Competitive performance is demonstrated through preliminary numerics. Second, we show that for a general class of nonconvex optimization problems, proximal ADMM is able to avoid strict saddle points with probability 1 using random initialization.

29 Peng-Yeng Yin, National Chi Nan University (joint work with Chun-Ying Cheng)

Simulation Optimization of Co-Sited Wind-Solar Farm under Wind Irradiance and Dust Uncertainties

This paper considers a hybrid system deploying both wind and solar photovoltaic (PV) farms at the same site. We propose a simulation optimization approach. The simulation of uncertain wind, sky irradiance, and dust deposition is based on a meteorological dataset. The co-siting constraints which degrade the production are handled by calculating wind-turbine's umbra and penumbra on PVs, planning shortest roads for routing the maintenance vehicles, and minimizing the land usage conflict by an evolutionary algorithm. We propose several models to leverage the production, cost, and uncertainty.

30 Jia-Jie Zhu, Max Planck Institute for Intelligent Systems

A Learning Approach to Warm-Start Mixed-Integer Optimization for Controlling Hybrid Systems

Motivated by practical challenges in controlling hybrid systems (i.e. robot trajectory optimization through contact), we propose a machine learning approach to speed up the mixed-integer optimization (MIO) for numerical optimal control. We learn policies to serve as a form of solution memory by casting the training as learning from suboptimal demonstrations. The resulting policies provide feasible incumbent solutions for the branch-and-bound (-cut) process of MIO. Coupled with other insights developed in this work, the approach speeds up numerical optimal control of hybrid systems.

Conference Dinner: Cruise along the river Spree on the “MS Mark Brandenburg”

The river cruise starts at Gotzkowskybrücke, a bridge in 20 minutes walking distance from the conference venue. You can alternatively take Bus 245 from Ernst-Reuter-Platz to Franklinstr., see maps on page 6, and on the inside-back cover. We will then cruise through the city of Berlin while having dinner from buffet with modern German food.

Important Facts

Time and Date Tuesday, August 6, 19:00–23:00

Venue River Cruise on “MS Mark Brandenburg”, Stern und Kreisschifffahrt GmbH.

Start Gotzkowskybrücke, 10555 Berlin, Stern und Kreisschifffahrt pier
Boarding starts at 18:30, *check-in no later than 19:00*.

End 23:00 at the starting point

Participation fee 65 EUR

Tickets The Conference Dinner is open to attendees and guests who registered and paid in advance for tickets. Tickets are included in your registration envelope. There may be a limited number of tickets available on site — please enquire at the ICCOPT Registration Desk.

Menu Vegetarian options will be available. Please advise, in advance, of any dietary requirements via email to dinner@iccopt2019.berlin

Contact dinner@iccopt2019.berlin

Please note that we assume no liability for damage to property or personal injury.

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Wed.1 H 3013 **Semismoothness for Set-Valued Mappings and Newton Method (Part II)**, Helmut Gfrerer
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Wed.1 H 0107 **Semidefinite Approaches to Combinatorial Optimization**, Renata Sotirov
Hao Hu | Christian Truden | Daniel Brosch | page 110

Wed.1 H 2032 **Polynomial Optimization (Part I)**, Grigoriy Blekherman
Oguzhan Yuruk | João Gouveia | Grigoriy Blekherman | page 110

Wed.1 H 1028 **New Frontiers in Splitting Algorithms for Optimization and Monotone Inclusions (Part I)**, Patrick L. Combettes
Bang Cong Vu | Saverio Salzo | Patrick L. Combettes | page 111

Wed.1 H 1058 **Convex and Nonsmooth Optimization - Contributed Session I**
Igor Konnov | Ali Dorostkar | Vladimir Shikhman | page 111

Wed.1 H 2033 **Emerging Trends in Derivative-Free Optimization (Part II)**, Ana Luisa Custodio, Sébastien Le Digabel, Margherita Porcelli, Francesco Rinaldi, Stefan Wild
Anne Auger | Ludovic Salomon | Ana Luisa Custodio | page 112

Wed.1 H 3002 **Algorithmic Approaches to Multi-Objective Optimization**, Gabriele Eichfelder, Alexandra Schwartz
Yousuke Araya | Christian Günther | Stefan Banholzer | page 112

Wed.1 H 0105 **Geometry in Non-Convex Optimization (Part I)**, Nicolas Boumal, André Uschmajew, Bart Vandereycken
Suvrit Sra | Nick Vannieuwenhoven | Nicolas Boumal | page 113

Wed.1 H 1012 **Nonlinear Optimization Methods and Their Global Rates of Convergence**, Geovani Grapiglia
Oliver Hinder | Philippe L. Toint | Ernesto G. Birgin | page 113

Wed.1 H 1029 **Practical Aspects of Nonlinear Optimization**, Coralia Cartis
Hiroshige Dan | Michael Feldmeier | Tim Mitchell | page 114

Wed.1 H 2013 **New Trends in Optimization Methods and Machine Learning (Part I)**, El houcine Bergou, Aritra Dutta
Vyacheslav Kungurtsev | El houcine Bergou | Xin Li | page 114

Wed.1 H 2053 **Efficient Numerical Solution of Nonconvex Problems**, Serge Gratton, Elisa Riccietti
Serge Gratton | Selime Gurol | Elisa Riccietti | page 115

Wed.1 H 0106 **Optimal Control of Nonsmooth Systems (Part I)**, Constantin Christof, Christian Clason
Daniel Walter | Lukas Hertlein | Sebastian Engel | page 115

Wed.1 H 0111 **Optimal Control and Dynamical Systems (Part V)**, Cristopher Hermosilla, Michele Palladino
Franco Rampazzo | Peter Wolenski | Piernicola Bettiol | page 116

Wed.1 H 0112 **Fractional/Nonlocal PDEs: Applications, Control, and Beyond (Part II)**, Harbir Antil, Carlos Rautenberg, Mahamadii Warma
Deepanshu Verma | Benjamin Manfred Horn | page 116

Wed.1 H 3006 **Statistical Methods for Optimization Under Uncertainty**, Henry Lam
Fengpei Li | Huajie Qian | Yuanlu Bai | page 117

Wed.1 H 3007 **Recent Development in Applications of Distributionally Robust Optimization**, Zhichao Zheng
Zhenzhen Yan | Guanglin Xu [canceled] | Yini Gao | page 117

Wed.1 H 2038 **Complexity of Sparse Optimization for Subspace Identification**, Julien Mairal
Guillaume Garrigos | Yifan Sun | Julien Mairal | page 118

Wed.1 H 3012 **Stochastic Optimization and Its Applications (Part I)**, Fengmin Xu
Xiaojun Chen | Jianming Shi | Fengmin Xu | page 118

Wed.2 14:15–15:30

Wed.2 H 3004 **Structural Design Optimization (Part II)**, Tamás Terlaky
Michael Stingl | Alemseged Gebrehiwot Weldeyesus | Jonas Holley | page 119

Wed.2 H 3025 **Mathematical Optimization in Signal Processing (Part II)**, Ya-Feng Liu, Zhi-Quan Luo
Zhi-Quan Luo | Ya-Feng Liu | page 119

Wed.2 H 0104 **Recent Advancements in Optimization Methods for Machine Learning (Part III)**, Albert Berahas, Martin Takáč
Peter Richtárik | Aaron Defazio [canceled] | Aurelien Lucchi | page 120

Wed.2 H 0110 **Recent Advances in Convex and Non-Convex Optimization and Their Applications in Machine Learning (Part I)**, Qihang Lin, Tianbao Yang
Yiming Ying | Niao He | Javier Pena | page 120

Wed.2 H 3013 **Quasi-Variational Inequalities and Generalized Nash Equilibrium Problems (Part II)**, Amal Alphonse, Carlos Rautenberg
Abhishek Singh | Jo Andrea Brüggemann | Ruchi Sandilya | page 121

Wed.2 H 0107 **Advances in Convex Optimization**, Negar Soheili
Robert Freund | Michael Friedlander | Negar Soheili | page 121

Wed.2 H 2032 **Polynomial Optimization (Part II)**, Grigoriy Blekherman
Etienne de Klerk | Cordian Riener | Victor Magron | page 122

Wed.2 H 1028 **New Frontiers in Splitting Algorithms for Optimization and Monotone Inclusions (Part II)**, Patrick L. Combettes
Calvin Wylie | Isao Yamada | Christian L. Müller | page 122

Wed.2 H 1058 **Algorithms for Large-Scale Convex and Nonsmooth Optimization (Part I)**, Daniel Robinson
Guilherme Franca | Zhihui Zhu | Sergey Guminov | page 123

Wed.2 H 2033 **Model-Based Derivative-Free Optimization Methods**, Ana Luisa Custodio, Sébastien Le Digabel, Margherita Porcelli, Francesco Rinaldi, Stefan Wild
Raghu Pasupathy | Lindon Roberts | Liyuan Cao | page 123

Wed.2 H 3008 **Global Optimization - Contributed Session I**
Kuan Lu | Francesco Romito | Syuuji Yamada | page 124

Wed.2 H 0105 **Geometry in Non-Convex Optimization (Part II)**, Nicolas Boumal, André Uschmajew, Bart Vandereycken
Marco Sutti | Max Pfeffer | Yuqian Zhang | page 124

Wed.2 H 1012 **Developments in Structured Nonconvex Optimization (Part I)**, Jun-ya Gotoh, Yuji Nakatsukasa, Akiko Takeda
Jun-ya Gotoh | Shummin Nakayama | Takayuki Okuno | page 125

Wed.2 H 1029 **Advances in Nonlinear Optimization Algorithms (Part I)**
Johannes Brust | Hardik Tankaria | Mehiddin Al-Baali | page 125

Wed.2 H 2013 **New Trends in Optimization Methods and Machine Learning (Part II)**, El houcine Bergou, Aritra Dutta
Aritra Dutta | Michel Barlaud | Jakub Mareček | page 126

Wed.2 H 2053 **Recent Trends in Large Scale Nonlinear Optimization (Part I)**, Michal Kočvara, Panos Parpas
Derek Driggs | Zhen Shao | Panos Parpas | page 126

Wed.2 H 0106 **Optimal Control of Nonsmooth Systems (Part II)**, Constantin Christof, Christian Clason
Dorothee Knees | Vu Huu Nhu | Livia Betz | page 127

Wed.2 H 0111 **Optimal Control and Dynamical Systems (Part VI)**, Cristopher Hermosilla, Michele Palladino
Paloma Schäfer Aguilar | Laurent Pfeiffer | Caroline Löbhard | page 127

Wed.2 H 0112 **Decomposition-Based Methods for Optimization of Time-Dependent Problems (Part I)**, Matthias Heinkenschloss, Carl Laird
Sebastian Götschel | Stefan Ulbrich | Denis Ridzal | page 128

Wed.2 H 3006 **Recent Advances in Theories of Distributionally Robust Optimization (DRO)**, Zhichao Zheng
Karthyek Murthy | Jingui Xie | Grani A. Hanasusanto | page 128

Wed.2 H 3007 **Decision-Dependent Uncertainty and Bi-Level Optimization**, Chrysanthos Gounaris, Anirudh Subramanyam
Anirudh Subramanyam | Mathieu Besançon | Omid Nohadani | page 129

Wed.2 H 2038 **Primal-Dual Methods for Structured Optimization**, Mathias Staudigl
Robert Ernö Csetnek | Darina Dvinskikh | Kimon Antonakopoulos | page 129

Wed.2 H 3012 **Stochastic Optimization and Its Applications (Part II)**, Fengmin Xu
Sunho Jang | Jussi Lindgren | Luis Espath | page 130

Wed.3 16:00–17:15

Wed.3 H 2053 **Applications in Finance and Real Options**
Daniel Ralph | Peter Schütz | Luis Zuluaga | page 131

Wed.3 H 0104 **Recent Advancements in Optimization Methods for Machine Learning (Part IV)**, Albert Berahas, Martin Takáč
Martin Jaggi | Robert Gower | Ahmet Alacaoglu | page 131

Wed.3 H 0110 **Recent Advances in Convex and Non-Convex Optimization and Their Applications in Machine Learning (Part II)**, Qihang Lin, Tianbao Yang
Yuejie Chi | Praneeth Netrapalli | Raef Bassily | page 132

Wed.3 H 3002 **Recent Advances in Distributed Optimization**, Pavel Dvurechensky, Cesar A Uribe
Alex Olshevsky | Alexander Gasnikov | Jingzhao Zhang | page 132

Wed.3 H 1058 **Complementarity: Extending Modeling and Solution Techniques (Part I)**, Michael Ferris
Olivier Huber | Youngdae Kim | Michael Ferris | page 133

Wed.3 H 0111 **Theoretical Aspects of Conic Optimization**, Roland Hildebrand
Naomi Shaked-Monderer | Takashi Tsuchiya | Roland Hildebrand | page 133

Wed.3 H 2032 **Conic Optimization and Machine Learning**, Amir Ali Ahmadi
Pablo Parrilo [canceled] | Pravesh Kothari | Amir Ali Ahmadi | page 134

Wed.3 H 1028 **New Frontiers in Splitting Algorithms for Optimization and Monotone Inclusions (Part III)**, Patrick L. Combettes
Nimit Nimana | Dang-Khoa Nguyen | Marcel Jacobse | page 134

Wed.3 H 3025 **Algorithms for Large-Scale Convex and Nonsmooth Optimization (Part II)**
Masoud Ahookhosh | Avinash Dixit | Ewa Bednarczuk | page 135

Wed.3 H 2033 **Derivative-Free Optimization Under Uncertainty (Part II)**, Ana Luisa Custodio, Sébastien Le Digabel, Margherita Porcelli, Francesco Rinaldi, Stefan Wild
Fani Boukouvala | Friedrich Menhorn | Morteza Kimiaei | page 135

Wed.3 H 3008 **Generalized Distances and Envelope Functions**, Ting Kei Pong
Scott B. Lindstrom | Andreas Themelis | Ting Kei Pong | page 136

Wed.3 H 0105 **Geometry and Optimization**, Coralia Cartis
Florentin Goyens | Erlend Skaldehaug Riis | Mario Lezcano Casado | page 136

Wed.3 H 1012 **Developments in Structured Nonconvex Optimization (Part II)**, Jun-ya Gotoh, Yuji Nakatsukasa, Akiko Takeda
Nikitas Rontsis | André Uschmajew | Tianxiang Liu | page 137

Wed.3 H 1029 **Advances in Nonlinear Optimization Algorithms (Part II)**
Erik Berglund | Wenwen Zhou | Hao Wang | page 137

Wed.3 H 2013 **New Trends in Optimization Methods and Machine Learning (Part III)**
Saeed Ghadimi | Hien Le | page 138

Wed.3 H 3007 **Recent Trends in Large Scale Nonlinear Optimization (Part II)**, Michal Kočvara, Panos Parpas
Filippo Pecci | Michal Kočvara | Man Shun Ang | page 138

Wed.3 H 0106 **Optimal Control of Nonsmooth Systems (Part III)**, Constantin Christof, Christian Clason
Gerd Wachsmuth | Anne-Therese Rauls | Georg Müller | page 139

Wed.3 H 0107 **Optimal Control and Dynamical Systems (Part VII)**, Cristopher Hermosilla, Michele Palladino
Emilio Vilches | Cristopher Hermosilla | Fernando Lobo Pereira | page 139

Wed.3 H 0112 **Decomposition-Based Methods for Optimization of Time-Dependent Problems (Part II)**, Matthias Heinkenschloss, Carl Laird
Nicolas Gauger | Alexander Engelmann | Carl Laird | page 140

Wed.3 H 3004 **Robust Nonlinear Optimization**, Frans de Ruiter
Oleg Kelis | Jianzhe (Trevor) Zhen | Frans de Ruiter | page 140

Wed.3 H 3006 **Algorithms and Applications of Robust Optimization**, William Haskell
Napat Rujeerapaiboon | Wolfram Wiesemann | William Haskell | page 141

Wed.3 H 2038 **Block Alternating Schemes for Nonsmooth Optimization at a Large Scale**, Emilie Chouzenoux
Krzysztof Rutkowski | Marco Prato | Jean-Christophe Pesquet | page 141

Wed.3 H 3012 **Stochastic Optimization and Its Applications (Part III)**, Fengmin Xu
Christian Bayer | Xiaobo Li | page 142

Thu.1 09:00–10:15

Thu.1 H 3004 **Applications in Logistics and Supply Chain Management**
Okan Ozener · Mingyu Li · Ali Ekici · page 143

Thu.1 H 0105 **Distributed and Decentralized Optimization: Learning, Lower-Complexity Bounds, and Communication-Efficiency**, Andy Sun, Wotao Yin
Qing Ling · Mingyi Hong · Wotao Yin · page 143

Thu.1 H 3006 **Large-Scale Optimization for Statistical Learning**, Paul Grigas
Rahul Mazumder [canceled] · Hussein Hazimeh [canceled] · page 144

Thu.1 H 3007 **Big Data and Machine Learning - Contributed Session I**
Scindhiya Laxmi · Robert Ravier · Guozhi Dong · page 144

Thu.1 H 3013 **Complementarity: Extending Modeling and Solution Techniques (Part II)**, Michael Ferris
Francesco Caruso · David Stewart · page 145

Thu.1 H 2032 **Methods and Applications in Mixed Integer Semidefinite Programming**, Christoph Helmberg
Angelika Wiegele · Julie Sliwak · Felix Lieder · page 145

Thu.1 H 2033 **Matrix Analysis and Conic Programming**, Etienne de Klerk
Cécile Hautecoeur · Fei Wang · page 146

Thu.1 H 2038 **Second and Higher Order Cone Programming and Trust Region Methods**, Etienne de Klerk
Mirai Tanaka · Walter Gomez · Lijun Ding [canceled] · page 146

Thu.1 H 1028 **Splitting Methods and Applications (Part I)**, Pontus Giselsson, Ernest Ryu, Adrien Taylor
Francisco Javier Aragón Artacho · Sorin-Mihai Grad · Xiaoqun Zhang · page 147

Thu.1 H 3025 **Emerging Trends in Derivative-Free Optimization (Part III)**, Ana Luisa Custodio, Sébastien Le Digabel, Margherita Porcelli, Francesco Rinaldi, Stefan Wild
Susan Hunter · Mauro Passacantando · Evgeniya Vorontsova · page 147

Thu.1 H 1029 **Global Optimization - Contributed Session II**
Majid Darehmiraki · José Fernández · Ozan Evkaya · page 148

Thu.1 H 0111 **Uncertainty in Multi-Objective Optimization**, Gabriele Eichfelder, Alexandra Schwartz
Fabian Chlumsky-Harttmann · Patrick Groetzner · page 148

Thu.1 H 0104 **Recent Advances of First-Order Methods for Nonlinear Problems (Part I)**, Shiqian Ma, Yangyang Xu
Haihao Lu · Tianbao Yang · N. Serhat Aybat · page 149

Thu.1 H 0106 **Optimality Conditions in Nonlinear Optimization (Part I)**, Gabriel Haeser
Alexey Tret'yakov · Bruno Figueira Lourenço · Paulo J. S. Silva · page 149

Thu.1 H 0107 **Methods of Optimization in Riemannian Manifolds (Part I)**, Orizon Pereira Ferreira
João Xavier da Cruz Neto · João Carlos Souza · Maurício Louzeiro · page 150

Thu.1 H 2053 **Mixed-Integer Optimal Control and PDE Constrained Optimization (Part III)**, Falk Hante, Christian Kirches, Sven Leyffer
Clemens Zeile · Bart van Bloemen Waanders · Sven Leyffer · page 150

Thu.1 H 0112 **Geometric Methods in Optimization of Variational Problems (Part I)**, Roland Herzog, Anton Schiela
Ronny Bergmann · Robin Richter · Dominik Stöger · page 151

Thu.1 H 2013 **PDE-constrained Optimization Under Uncertainty (Part I)**, Harbir Antil, Drew Philip Kouri, Thomas Michael Surowiec, Michael Ulbrich, Stefan Ulbrich
René Henrion · Harbir Antil · Philipp Guth · page 151

Thu.1 H 1058 **Robust Optimization: New Advances in Methodology and Applications**, Nikos Trichakis
Lukáš Adam [canceled] · Phebe Vayanos · Nikos Trichakis · page 152

Thu.1 H 1012 **Sparse Optimization and Information Processing - Contributed Session II**, Shoham Sabach
Radu-Alexandru Dragomir · Yue Xie · Mustafa C. Pinar · page 152

Thu.1 H 3012 **Advances in Probabilistic/Chance Constrained Problems**
Yassine Laguel · Pedro Pérez-Aros · page 153

Thu.2 10:45–12:00

Thu.2 H 3004 **Applications in Economics**
Benteng Zou | Asiye Aydilek | Po-An Chen | page 154

Thu.2 H 3012 **Applications in Engineering**
Dimitrios Nerantzis | Manuel Radons | page 154

Thu.2 H 0105 **Nonconvex Optimization in Machine Learning (Part I)**, Ethan Fang
Yuxin Chen | Zhuoran Yang | Alfonso Lobos | page 155

Thu.2 H 0110 **Recent Advances in Optimization Techniques for Large-Scale Structured Problems**, Akiko Takeda
Zirui Zhou | Michael R. Metel | Pierre-Louis Poirion | page 155

Thu.2 H 3007 **Big Data and Machine Learning - Contributed Session II**
Lei Zhao | Sarit Khirirat | Rachael Tappenden | page 156

Thu.2 H 3013 **Numerical Methods for Bilevel Optimization and Applications (Part I)**, Alain Zemkoho
Anthony Dunn | Andrey Tin | Alain Zemkoho | page 156

Thu.2 H 2032 **Advances in Algorithms for Conic Optimization**, Julio C Goez
Joachim Dahl | Alex Wang | Julio C Goez [canceled] | page 157

Thu.2 H 2033 **Polynomial Optimization Algorithms, Software, and Applications**, Etienne de Klerk
Brais González Rodríguez | Yi-Shuai Niu | Anders Eltved | page 157

Thu.2 H 2038 **Algorithms for Conic Programming**, Etienne de Klerk
Chee Khian Sim | Kresimir Mihic | Konrad Schrempf | page 158

Thu.2 H 1028 **Splitting Methods and Applications (Part II)**, Francisco Javier Aragón Artacho, Matthew K. Tam
C.H. Jeffrey Pang | Pontus Giselsson | Adrien Taylor | page 158

Thu.2 H 1029 **Convex and Nonsmooth Optimization - Contributed Session II**
Nima Rabiei | Maryam Yashtini | Jose Vidal-Nunez | page 159

Thu.2 H 3025 **Recent Advances in Derivative-Free Optimization (Part III)**
Tyler Chang | Alexander Matei | Douglas Vieira | page 159

Thu.2 H 0104 **Recent Advances of First-Order Methods for Nonlinear Problems (Part II)**, Shiqian Ma, Ion Necoara, Quoc Tran-Dinh, Yangyang Xu
Hao Yu | Runchao Ma | Yuyuan Ouyang | page 160

Thu.2 H 0106 **Optimality Conditions in Nonlinear Optimization (Part II)**
Olga Brezhneva | Maria Daniela Sanchez | S. K. Gupta | page 160

Thu.2 H 2053 **Methods of Optimization in Riemannian Manifolds (Part II)**, Orizon Pereira Ferreira
Josua Sassen | Orizon Pereira Ferreira | page 161

Thu.2 H 0112 **Geometric Methods in Optimization of Variational Problems (Part II)**, Roland Herzog, Anton Schiela
Andreas Weinmann | Thomas Vogt | Gladyston de Carvalho Bento | page 161

Thu.2 H 2013 **PDE-constrained Optimization Under Uncertainty (Part II)**, Harbir Antil, Drew Philip Kouri, Thomas Michael Surowiec, Michael Ulbrich, Stefan Ulbrich
Thomas Michael Surowiec | Ekaterina Kostina | Andreas Van Barel | page 162

Thu.2 H 3006 **A Mixed Bag of Decision Problems**, Peyman Mohajerin Esfahani
Man-Chung Yue | Bart P.G. Van Parys | Zhi Chen | page 162

Thu.2 H 1012 **Continuous Systems in Information Processing (Part II)**, Martin Benning
Jan Lellmann | Noémie Debroux | Daniel Tenbrinck | page 163

Thu.3 13:30–14:45

Thu.3 H 3004 **Other Applications**
Sugandima Mihirani Vidanagamachchi | Yidiat Omolade Aderinto | Jean-Paul Arnaout | page 164

Thu.3 H 0105 **Canceled! Nonconvex Optimization in Machine Learning (Part II)**, Ethan Fang
Stephane Chretien [canceled] | Ke Wei [canceled] | page 164

Thu.3 H 3007 **Big Data and Machine Learning - Contributed Session III**
Qing Qu | Cheolmin Kim | Dimosthenis Pasadakis | page 165

Thu.3 H 3013 **Numerical Methods for Bilevel Optimization and Applications (Part II)**, Alain Zemkoho
Thomas Kleinert | Tangi Migot | Jie Jiang | page 165

Thu.3 H 2033 **Miscellaneous Topics in Conic Programming**, Etienne de Klerk
Antonios Varvitsiotis | Lucas Slot | Sandra S. Y. Tan | page 166

Thu.3 H 2038 **Conic Optimization Approaches to Discrete Optimization Problems**, Etienne de Klerk
Fatima Ezzahra Khalloufi | Timotej Hrga | Enrico Bettiol | page 166

Thu.3 H 1028 **Splitting Methods and Applications (Part III)**, Pontus Giselsson, Ernest Ryu, Adrien Taylor
Puya Latafat | Matthew K. Tam | Ernest Ryu | page 167

Thu.3 H 1029 **Convex and Nonsmooth Optimization - Contributed Session III**
Ching-pei Lee | Yan Gu | Andrew Eberhard | page 167

Thu.3 H 0104 **Advances in Nonlinear Optimization With Applications (Part II)**, Yu-Hong Dai, Deren Han
Xingju Cai | Caihua Chen | Deren Han [canceled] | page 168

Thu.3 H 0106 **Nonlinear Optimization - Contributed Session III**
Gulcin Dinc Yalcin | Rafael Durbano Lobato | Refail Kasimbeyli | page 168

Thu.3 H 0107 **Variational Inequalities, Minimax Problems and GANs (Part II)**, Konstantin Mishchenko
Daoli Zhu | Sarath Pattathil | Georgios Piliouras | page 169

Thu.3 H 2032 **Nonlinear Optimization - Contributed Session II**
Simone Rebegoldi | Andrea Cristofari | Jourdain Lamperski | page 169

Thu.3 H 2053 **Nonlinear Optimization - Contributed Session I**
Truc-Dao Nguyen | Adrian Hauswirth | Raul Tempone | page 170

Thu.3 H 0112 **Geometric Methods in Optimization of Variational Problems (Part III)**, Roland Herzog, Anton Schiela
Anton Schiela | Silvio Fanzon | Hanne Hardering | page 170

Thu.3 H 2013 **PDE-constrained Optimization Under Uncertainty (Part III)**, Harbir Antil, Drew Philip Kouri, Thomas Michael Surowiec, Michael Ulbrich, Stefan Ulbrich
Sergio Rodrigues | Johannes Milz | page 171

Thu.3 H 1058 **Distributionally Robust Optimization: Advances in Methodology and Applications**, Aurelie Thiele
Sanjay Mehrotra | Tito Homem-de-Mello | Aurelie Thiele | page 171

Thu.3 H 3006 **Dynamic Optimization Under Data Uncertainty**, Omid Nohadani
Sebastian Pokutta | Eojin Han | Dan Iancu | page 172

Thu.3 H 1012 **Sparse Optimization and Information Processing - Contributed Session III**, Shoham Sabach
Ryan Cory-Wright | Bolin Pan | Bogdan Toader | page 172

Thu.3 H 3012 **Solution and Analysis of Stochastic Programming and Stochastic Equilibria**
Pedro Borges | Shu Lu | page 173

Mon.1 11:00–12:15

APP

Mon.1 H 0107

Optimization in Healthcare (Part I)

Organizers: Felix Jost, Christina Schenk
Chair: Felix Jost

Marta Sauter, University of Heidelberg (joint work with Hans Georg Bock, Kathrin Hatz, Ekaterina Kostina, Katja Mombaur, Johannes P. Schlöder, Sebastian Wolf)

Simultaneous Direct Approaches for Inverse Optimal Control Problems and Their Application to Model-Based Analysis of Cerebral Palsy Gait

Inverse optimal control problems arise in the field of modeling, simulation and optimization of the human gait. For our studies we consider a bilevel optimization problem. The lower optimal control model includes unknown parameters that have to be determined by fitting the model to measurements, which is done in the upper level. We present mathematical and numerical methods using a simultaneous direct approach for inverse optimal control problems and derive optimal control models for the gait of patients with cerebral palsy from real-world motion capture data.

Leonard Wirsching, Heidelberg University (joint work with Hans Georg Bock, Ekaterina Kostina, Johannes P. Schlöder, Andreas Sommer)

Solution and Sensitivity Generation for Differential Equations with State-Dependent Switches – an Application-Oriented Approach

For ODEs with switched or non-smooth dynamics, modelers often provide code containing conditionals like IF, ABS, MIN, and MAX. Standard black-box integrators, in general, show poor performance or may compute wrong dynamics without notice. Transformation into model descriptions suitable for state-of-the-art methods is often cumbersome or infeasible. In this talk, we present a new approach that works on the dynamic model equations as provided by the modeler and allows to treat switched and non-smooth large-scale dynamics efficiently and accurately for both integration and sensitivity generation.

Christina Schenk, Carnegie Mellon University (joint work with Lorenz Biegler, Lu Han, Jason Mustakis)

Kinetic Parameter Estimation Based on Spectroscopic Data and Its Application to Drug Manufacturing Processes

The development of drug manufacturing processes involves dealing with spectroscopic data. In many cases kinetic parameter estimation from spectra has to be performed without knowing the absorbing species in advance, such that they have to be estimated as well. That is why we take a closer look at the development of optimization-based procedures in order to estimate the variances of system and measurement noise and thus determine the concentration and absorbance profiles, and parameters simultaneously. The further investigations related to the application specific challenges are presented.

BIG

Mon.1 H 0104

Optimization for Data Science (Part I)

Organizers: Ying Cui, Jong-Shi Pang
Chair: Jong-Shi Pang

Jong-Shi Pang, University of Southern California (joint work with Ying Cui, Ziyu He)

Multi-composite Nonconvex Optimization for Learning Deep Neural Network

We present in this paper a novel deterministic algorithmic framework that enables the computation of a directional stationary solution of the empirical deep neural network training problem formulated as a multi-composite optimization problem with coupled nonconvexity and nondifferentiability. This is the first time to our knowledge that such a sharp kind of stationary solutions is provably computable for a nonsmooth deep neural network. Numerical results from a matlab implementation demonstrate the effectiveness of the framework for solving reasonably sized networks.

Defeng Sun, The Hong Kong Polytechnic University

A majorized proximal point dual Newton algorithm for nonconvex statistical optimization problems

We consider high-dimensional nonconvex statistical optimization problems such as the regularized square-root Lasso problem, where in the objective the loss terms are possibly nonsmooth or non-Lipschitzian and the regularization terms are the difference of convex functions. We introduce a majorized proximal point dual Newton algorithm (mPPDNA) for solving these large scale problems. We construct proper majorized proximal terms that are conducive to the design of an efficient dual based semismooth Newton method of low computational complexities. Extensive numerical results are provided.

Gesualdo Scutari, Purdue University (joint work with Guang Cheng, Ying Sun, Ye Tian)

Distributed inference over networks: geometrically convergent algorithms and statistical guarantees

We study distributed high-dimensional M-estimation problems over networks, modeled as arbitrary graphs (with no centralized node). We design the first class of distributed algorithms with convergence guarantees for such a class of Empirical Risk Minimization (ERM) problems. We prove that, under mild technical assumptions, the proposed algorithm converges at a linear rate to a solution of the ERM that is statistically optimal. Furthermore, for a fixed network topology, such a linear rate is invariant when the problem dimension scales properly with respect to the sample size.

BIG

Mon.1 H 3004

Non-Convex Optimization for Neural Networks

Organizers: Mingyi Hong, Ruoyu Sun
Chair: Mingyi Hong

Ruoyu Sun, UIUC
Landscape of Over-parameterized Networks

Non-convexity of neural networks may cause bad local minima, but the recent guess is that over-parameterization can smooth the landscape. We prove that for any continuous activation functions, the loss function has no bad strict local minimum, both in the regular sense and in the sense of sets. This result holds for any convex and continuous loss function, and the data samples are only required to be distinct in at least one dimension. Furthermore, we show that bad local minima do exist for a class of activation functions.

Sijia Liu, MIT-IBM Watson AI Lab, IBM Research (joint work with Mingyi Hong)
On the convergence of a class of adam-type algorithms for non-convex optimization

We study a class of adaptive gradient based momentum algorithms, called "Adam-type" algorithm, that update search directions and learning rate simultaneously using past gradients. The convergence of these algorithms for nonconvex problems remains an open question. We provide a set of mild sufficient conditions that guarantee the convergence of the Adam-type methods. We prove that under our derived conditions, these methods can achieve convergence rate $O(\log(T)/\operatorname{sqrt}(T))$ for nonconvex optimization. We show the conditions are essential in the sense that violating them may cause divergence.

Alex Schwing, University of Illinois at Urbana-Champaign
Optimization for GANs via Sliced Distance

In the Wasserstein GAN, the Wasserstein distance is commonly transformed to its dual via the Kantorovich-Rubinstein Duality and then optimized. However, the dual problem requires a Lipschitz condition which is hard to impose. One idea is to solve the primal problem directly, but this is computationally expensive and has an exponential sample complexity. We propose to solve the problem using the sliced and max-sliced Wasserstein distance, which enjoy polynomial sample complexity. Analysis shows that this approach is easy to train, requires little tuning, and generates appealing results.

VIS

Mon.1 H 3002

Linear Complementarity Problem (Part I)

Organizers: Tibor Illés, Janez Povh
Chair: Janez Povh

Marianna E.-Nagy, Budapest University of Technology and Economics
Constructing and analyzing sufficient matrices

The sufficient matrix class was defined related to Linear complementarity problems. This is the widest class for which the criss-cross and the interior point algorithms (IPM) for solving LCPs are efficient in some sence. It is an NP-complete problem to decide whether a matrix belongs to this class. Therefore, we build a library of sufficient matrices to provide a test set for algorithms solving such LCPs. We show different techniques to generate such matrices. Furthermore, we present results about the handicap, which matrix parameter is important for the theoretical complexity of the IPM.

Tibor Illés, Budapest University of Technology and Economics, Budapest, Hungary
Interior point algorithms for general linear complementarity problems

Linear Complementarity Problems (LCP) belong to the class of NP-complete problems. Darvay et al. (2018) showed that predictor-corrector (PC) interior point algorithms (IPA) using algebraic equivalent transformation (AET) solves sufficient LCPs in polynomial time. Our aim is to construct new PC IPAs based on AETs which in polynomial time either give an ϵ-optimal solution of the general LCP or detect the lack of sufficiency property. In the latter case, the algorithms give a polynomial size certificate depending on parameter κ, the initial interior point and the input size of the (LCP).

Janez Žerovnik, University of Ljubljana (joint work with Tibor Illés, Janez Povh)
On sufficient properties for sufficient matrices

In this talk we present new necessary and sufficient conditions for testing matrix sufficiency, which is an NP-hard problem. We discuss methods for testing matrix sufficiency based on the new characterizations and propose an algorithm with exponential complexity which in its kernel solves many simple instances of linear programming problems. Numerical results confirm relevance of this algorithm.

VIS

Mon.1 H 3007

Nash Equilibrium Problems and Extensions (Part I)
Organizer: Anna Thünen
Chair: Anna Thünen

Jan Becker, TU Darmstadt (joint work with Alexandra Schwartz)
Linear-quadratic multi-leader-follower games in Hilbert spaces

Multi-leader-follower games (MLFGs) can be seen as an hierarchical extension of Nash equilibrium problems. By now, the analysis of the latter is well-known and well-understood even in infinite dimensions. While the analysis of MLFGs in finite dimensions is restricted to special cases, the analysis in function spaces is still in its infancy. Therefore, the talk focuses on linear-quadratic MLFGs in Hilbert spaces and their corresponding equilibrium problems with complementarity constraints (EPCCs). By considering relaxed equilibrium problems, we derive a novel equilibrium concept for MLFGs.

Giancarlo Bigi, Università di Pisa (joint work with Simone Sagratella)
Algorithms for generalized Nash games in semi-infinite programming

Semi-infinite programs (SIPs) can be formulated as generalized Nash games (GNEPs) with a peculiar structure under mild assumptions. Pairing this structure with a penalization scheme for GNEPs leads to methods for SIPs. A projected subgradient method for nonsmooth optimization and a subgradient method for saddlepoints are adapted to our framework, providing two kinds of the basic iteration for the penalty scheme. Beyond comparing the two algorithms, these results and algorithms are exploited to deal with uncertainty and analyse robustness in portfolio selection and production planning.

CON

Mon.1 H 0111

Conic Approaches to Infinite Dimensional Optimization (Part I)
Organizer: Juan Pablo Vielma
Chair: Juan Pablo Vielma

Marcelo Forets, Universidad de la República
Algorithms for Flowpipe Approximation using Sum-of-Squares

Exhaustive coverage of all possible behaviours is important when we model safety-critical or mission-critical systems, either embedded or cyber-physical, since uncertain inputs, disturbances or noise can have an adverse effect in performance and reliability. In this talk we survey methods that have emerged recently to soundly verify properties of systems using sum-of-squares optimisation methods. The study is conducted with our software tool JuliaReach that gives a unified user interface implementing different reachability approaches while not sacrificing features or performance.

Benoît Legat, UCLouvain (joint work with Raphaël Jungers, Paulo Tabuada)
Computing polynomial controlled invariant sets using Sum-of-Squares Programming

We develop a method for computing controlled invariant sets of discrete-time affine systems using Sum-of-Squares programming. We apply our method to the controller design problem for switching affine systems with polytopic safe sets but our work also improves the state of the art for the particular case of LTI systems. The task is reduced to a Sum-of-Squares programming problem by enforcing an invariance relation in the dual space of the geometric problem.

Chris Coey, MIT OR Center (joint work with Lea Kapelevich, Juan Pablo Vielma)
Nonsymmetric conic optimization algorithms and applications

Hypatia is an open-source optimization solver in Julia for primal-dual conic problems involving general convex cones. Hypatia makes it easy to define and model with any closed convex conic set for which an appropriate primal or dual barrier function is known. Using novel nonsymmetric cones, we model control applications with smaller, more natural formulations, and demonstrate Hypatia's superior performance (relative to other state-of-the-art conic interior point solvers) on several large problems.

CON

Mon.1 H 0112

Recent Advances in Applications of Conic Programming

Organizers: Mituhiro Fukuda, Masakazu Muramatsu, Makoto Yamashita, Akiko Yoshise
Chair: Makoto Yamashita

Yuzhu Wang, University of Tsukuba (joint work with Akihiro Tanaka, Akiko Yoshise)

Polyhedral Approximations of the Semidefinite Cone and Their Applications

Large and sparse polyhedral approximations of the semidefinite cone have been showed important for solving hard conic optimization problems. We propose new approximations that contain the diagonally dominant cone and are contained in the scaled diagonally dominant cone, by devising a simple expansion of the semidefinite bases. As their applications, we propose 1. methods for identifying elements in certain cones, 2. cutting plane methods for conic optimization and 3. a Lagrangian-DNN method for some quadratic optimization problems. Numerical results showed the efficiency of these methods.

Shinichi Kanoh, University of Tsukuba (joint work with Akiko Yoshise)

A centering ADMM for SDP and its application to QAP

We propose a new method for solving SDP problems based on primal dual interior point method and ADMM, called Centering ADMM (CADMM). CADMM is an ADMM but it has the feature of updating the variables toward the central path. We conduct numerical experiments with SDP relaxation problems of QAP and compare CADMM with ADMM. The results demonstrate that which of two methods is favorable depends on instances.

Sena Safarina, Tokyo Institute of Technology (joint work with Tim J. Mullin, Makoto Yamashita)

A Cone Decomposition Method with Sparse Matrix for Mixed-Integer SOCP problem

Our research is focused on an optimal contribution selection (OCS) problem in equal deployment, which is one of the optimization problems that aims to maximize the total benefit under a genetic diversity constraint. The constraint allows the OCS problem to be modeled as mixed-integer second-order cone programming (MI-SOCP). We proposed a cone decomposition method (CDM) that is based on a geometric cut in combination with a Lagrangian multiplier method. We also utilized the sparsity found in OCS, into a sparse linear approximation, that can strongly enhance the performance of CDM.

CON

Mon.1 H 2053

Optimization and Quantum Information

Organizers: Hamza Fawzi, James Saunderson
Chair: Hamza Fawzi

Sander Gribling, CWI, Amsterdam (joint work with Monique Laurent, David de Laat)

Quantum graph parameters and noncommutative polynomial optimization

Graph parameters such as the chromatic number can be formulated in several ways. E.g., as polynomial optimization problems or using nonlocal games (in which two separated parties must convince a referee that they have a valid coloring of the graph of a certain size). We show how these formulations lead to quantum analogues of graph parameters, which can be used in quantum information theory to study the power of entanglement. We apply techniques from the theory of noncommutative polynomial optimization to obtain hierarchies of semidefinite programming bounds, unifying existing bounds.

Andreas Bluhm, Technical University of Munich (joint work with Ion Nechita)

Compatibility of quantum measurements and inclusion constants for free spectrahedra

One of the defining properties of quantum mechanics is the existence of incompatible observables such as position and momentum. We will connect the problem of determining whether a given set of measurements is compatible to the inclusion of free spectrahedra, which arise in convex optimization. We show how results from algebraic convexity can be used to quantify the degree of incompatibility of binary quantum measurements. In particular, this new connection allows us to completely characterize the case in which the dimension of the quantum system is exponential in the number of measurements.

Kun Fang, University of Cambridge (joint work with Hamza Fawzi)

Polynomial optimization on the sphere and entanglement testing

We consider the problem of maximizing a homogeneous polynomial over the unit sphere and its Sum-of-Square (SOS) hierarchy relaxations. Exploiting the polynomial kernel technique, we show that the convergence rate of the hierarchy is no worse than $O(d^2/l^2)$, where d is the dimension of the sphere and l is the level of the hierarchy. Moreover, we explore the duality relation between the SOS polynomials and the quantum extendable states in details, and further explain the connection of our result with the one by Navascues, Owari & Plenio from quantum information perspective.

CNV

Mon.1 H 1028

Convex-Composite Optimization (Part I)

Organizer: Tim Hoheisel
Chair: Tim Hoheisel

Andre Milzarek, The Chinese University of Hong Kong, Shenzhen (joint work with Michael Ulbrich)

A globalized semismooth Newton method for nonsmooth nonconvex optimization

We propose a globalized semismooth Newton framework for solving convex-composite optimization problems involving smooth nonconvex and nonsmooth convex terms in the objective function. A prox-type fixed point equation representing the stationarity conditions forms the basis of the approach. The proposed algorithm utilizes semismooth Newton steps for the fixed point equation to accelerate an underlying globally convergent descent method. We present both global and local convergence results and provide numerical experiments illustrating the efficiency of the semismooth Newton method.

James Burke, University of Washington (joint work with Abraham Engle)

Quadratic convergence of SQP-like methods for convex-composite optimzation

We discuss the local convergence theory of Newton and quasi-Newton methods for convex-composite optimization: minimize $f(x) = h(c(x))$, where h is an infinite-valued closed proper convex function and c is smooth. The focus is on the case where h is infinite-valued convex piecewise linear-quadratic. The optimality conditions are embedded into a generalized equation, and we show the strong metric subregularity and strong metric regularity of the corresponding set-valued mappings. The classical convergence of Newton-type methods is extended to this class of problems

Tim Hoheisel, McGill University, Montréal

On the Fenchel conjugate of convex-composite functions

We study conjugacy results of compositions of a convex function g and a nonlinear mapping F (possibly extended-valued in a generalized sense) such that the composition $g \circ F$ is still convex. This composite structure which preserves convexity models a myriad of applications comprising e.g. conic programming, convex additive composite minimization, variational Gram functions or vector optimization. Our methodology is largely based on infimal convolution combined with cone-induced convexity.

CNV

Mon.1 H 1029

Recent Advances in First-Order Methods for Constrained Optimization and Related Problems (Part I)

Organizers: Ion Necoara, Quoc Tran-Dinh
Chair: Quoc Tran-Dinh

Dirk Lorenz, TU Braunschweig

Extensions of the randomized Kaczmarz method: sparsity and mismatched adjoints

The randomized Kaczmarz method is an incremental method to solve linear equations. It uses only a single row of the system in each step and hence, only needs very little storage. The standard Kaczmarz method approximates (in the underdetermined case) the minimum norm solution. In this talk we will study two extensions of the method: First, we will show how to adapt the method to produce sparse solutions of underdetermined and second, we investigate how a mismatch in the adjoint matrix does affect the convergence.

Angelia Nedich, Arizona State University

A Smooth Inexact Penalty Reformulation of Convex Problems with Linear Constraints

We consider a constrained convex problem with linear inequalities and provide an inexact penalty reformulation. The novelty is in the choice of the penalty functions, which are smooth and can induce a non-zero penalty over some points in feasible region of the original problem. For problems with a large number of constraints, a particular advantage of such a smooth penalty-based reformulation is that it renders a penalized problem suitable for the implementation of fast incremental gradient methods, which require only one sample from the inequality constraints at each iteration (such as SAGA).

Ion Necoara, University Politehnica Bucharest (UPB)

Minibatch stochastic first order methods for convex optimization

We present convergence rates for minibatch stochastic first order methods with constant or variable stepsize for convex optimization problems, expressed in terms of expectation operator. We show that these methods can achieve linear convergence rate up to a constant proportional to stepsize and under some strong stochastic bounded gradient condition even pure linear convergence. Moreover, when variable stepsize is chosen we derive sublinear convergence rates that show an explicit dependence on minibatch size. Applications of these results to convex feasibility problems will be also discussed.

DER

Mon.1 H 2038

Recent Advances in Derivative-Free Optimization (Part I)

Organizers: Ana Luisa Custodio, Sébastien Le Digabel, Margherita Porcelli, Francesco Rinaldi, Stefan Wild
Chair: Francesco Rinaldi

Coralia Cartis, Oxford University (joint work with Adilet Otemissov)

Dimensionality reduction techniques for global optimization

We show that the scalability challenges of Global Optimisation (GO) algorithms can be overcome for functions with low effective dimensionality, which are constant along certain subspaces. We propose the use of random subspace embeddings within a(ny) global optimization algorithm, extending Wang et al (2013). Using tools from random matrix theory and conic integral geometry, we investigate the success rates of our low-dimensional embeddings of the original problem, in both a static and adaptive formulation. We illustrate our algorithmic proposals and theoretical findings numerically.

Jeffrey Larson, Argonne National Laboratory (joint work with Kamil Khan, Matt Menickelly, Stefan Wild)

Manifold Sampling for Composite Nonconvex Nonsmooth Optimization

We present and analyze a manifold sampling method for minimizing $f(x) = h(F(x))$ when h is nonsmooth, nonconvex, and has a known structure and F is smooth, expensive to evaluate, and has a relatively unknown structure. Manifold sampling seeks to take advantage of knowledge of h in order to efficiently use past evaluations of F.

Florian Jarre, Heinrich-Heine Universität Düsseldorf (joint work with Felix Lieder)

The use of second order cone programs in constrained derivative-free optimization

We discuss a derivative-free solver for nonlinear programs with nonlinear equality and inequality constraints. The algorithm aims at finding a local minimizer by using finite differences and sequential quadratic programming (SQP). As approximations of the derivatives are expensive compared to the numerical computations that usually dominate the computational effort of NLP solvers a somewhat effortful trust-region SQP-subproblem is solved at each iteration by second order cone programs. The public domain implementation in Matlab or Octave is suitable for small to medium size problems.

MUL

Mon.1 H 3013

Applications of Multi-Objective Optimization (Part I)

Organizers: Gabriele Eichfelder, Alexandra Schwartz
Chair: Alexandra Schwartz

Arun Pankajakshan, University College London (joint work with Federico Galvanin)

A multi-objective optimal design of experiments framework for online model identification platforms

In many real world applications, sequential model-based design of experiments (MBDoE) methods employed in online model-based optimization platforms may involve more than one objective in order to drive the real process towards optimal targets, while guaranteeing the satisfaction of quality, cost and operational constraints. In this work, a flexible multi-objective optimal design of experiments framework suitable for online modelling platforms is proposed. The proposed framework is integrated in an online model identification platform for studying the kinetics of chemical reaction systems.

Bennet Gebken, Paderborn University (joint work with Sebastian Peitz)

Inverse multiobjective optimization: Inferring decision criteria from data

It is a very challenging task to identify the objectives on which a certain decision was based, in particular if several, potentially conflicting criteria are equally important and a continuous set of optimal compromise decisions exists. This task can be understood as the inverse problem of multiobjective optimization, where the goal is to find the objective vector of a given Pareto set. To this end, we present a method to construct the objective vector of a multiobjective optimization problem (MOP) such that the Pareto critical set contains a given set of data points.

Alexandra Schwartz, TU Darmstadt (joint work with Daniel Nowak)

A Generalized Nash Game for Computation Offloading

The number of tasks performed on wireless devices is steadily increasing. Due to limited resources on these devices computation offloading became a relevant concept. In order to minimize their own task completion time, users can offload parts of their computation task to a cloudlet with limited power. We investigate the resulting nonconvex generalized Nash game, where the time restriction from offloading is formulated as a vanishing constraint. We show that a unique Nash exists and that the price of anarchy is one, i.e. the equilibrium coincides with a centralized solution.

NON

Mon.1 H 0105

Nonlinear and Stochastic Optimization (Part I)
Organizers: Albert Berahas, Geovani Grapiglia
Chair: Albert Berahas

Jorge Nocedal, Northwestern University (joint work with Richard Byrd, Yuchen Xie)
Analysis of the BFGS Method with Errors

The classical convergence analysis of quasi-Newton methods assumes that the function and gradients employed at each iteration are exact. Here we consider the case when there are (bounded) errors in both computations and study the complex interaction between the Hessian update and step computation. We establish convergence guarantees for a line search BFGS method.

Fred Roosta, University of Queensland (joint work with Yang Liu, Michael Mahoney, Peng Xu)
Newton-MR: Newton's Method Without Smoothness or Convexity

Establishing global convergence of the classical Newton's method has long been limited to making restrictive assumptions on (strong) convexity as well as Lipschitz continuity of the gradient/Hessian. We show that two simple modifications of the classical Newton's method result in an algorithm, called Newton-MR, which is almost indistinguishable from its classical counterpart but it can readily be applied to invex problems. By introducing a weaker notion of joint regularity of Hessian and gradient, we show that Newton-MR converges even in the absence of the traditional smoothness assumptions.

Frank E. Curtis, Lehigh University
NonOpt: Nonsmooth Optimization Solver

We discuss NonOpt, an open source C++ solver for nonconvex, nonsmooth minimization problems. The code has methods based on both gradient sampling and bundle method approaches, all incorporating self-correcting BFGS inverse Hessian approximations. The code comes equipped with its own specialized QP solver for solving the arising subproblems. It is also extensible, intended to allow users to add their own step computation strategies, line search routines, etc. Numerical experiments show that the software is competitive with other available codes.

NON

Mon.1 H 2032

Smooth Optimization (Part I)
Organizers: Dominique Orban, Michael Saunders
Chair: Dominique Orban

Elizabeth Wong, UC San Diego (joint work with Anders Forsgren, Philip Gill)
A method for degenerate convex quadratic programming

We consider the formulation and analysis of an active-set method for convex quadratic programming that is guaranteed not to cycle. Numerical experiments are presented that illustrate the behavior of the method on some highly degenerate quadratic programs.

David Ek, KTH Royal Institute of Technology (joint work with Anders Forsgren)
Newton-like approaches for approximately solving systems of nonlinear equations arising in interior-point methods

We discuss Newton-like methods for approximately solving systems of nonlinear equations. Equivalence is shown between a Newton-like method with linearization of gradients to one with inverse Hessian approximations. We also discuss the relationship of these methods to other Newton-like methods as well as their potential use in higher-order methods. Finally we specialize to systems of nonlinear equations arising in interior-point methods.

Michael Saunders, Stanford University (joint work with Ding Ma, Dominique Orban)
Experimental results with Algorithm NCL for constrained optimization

We reimplement the LANCELOT augmented Lagrangian method as a short sequence of nonlinearly constrained subproblems that can be solved efficiently by IPOPT and KNITRO, with warm starts on each subproblem. NCL succeeds on degenerate tax policy models that can't be solved directly. These models (and algorithm NCL) are coded in AMPL. A Julia implementation of NCL gives results for standard test problems.

NON

Mon.1 H 3006

Mixed-Integer Optimal Control and PDE Constrained Optimization (Part I)

Organizers: Falk Hante, Christian Kirches, Sven Leyffer
Chair: Sven Leyffer

Christian Clason, Universität Duisburg-Essen

Discrete material optimization for the wave equation

This talk is concerned with optimizing the spatially variable wave speed in a scalar wave equation whose values are assumed to be taken pointwise from a known finite set. Such a property can be included in optimal control by a so-called "multibang" penalty that is nonsmooth but convex. Well-posedness as well as the numerical solution of the regularized problem are discussed.

Richard Krug, Friedrich-Alexander-Universität Erlangen-Nürnberg (joint work with Günter Leugering, Alexander Martin, Martin Schmidt)

Domain decomposition of systems of hyperbolic equations

We develop a decomposition method in space and time for optimal control problems on networks governed by systems of hyperbolic PDEs. The optimality system of the optimal control problem can be iteratively decomposed such that the resulting subsystems are defined on small time intervals and (possibly) single edges of the network graph. Then, virtual control problems are introduced, which have optimality systems that coincide with the decomposed subsystems. Finally, we prove the convergence of this iterative method to the solution of the original control problem.

Falk Hante, FAU Erlangen-Nürnberg (joint work with Simone Göttlich, Andreas Potschka, Lars Schewe)

Penalty-approaches for partial minima in mixed-integer optimal control

We consider mixed-integer optimal control problems with combinatorial constraints that couple over time such as minimum dwell times. A lifting allows a decomposition into a mixed-integer optimal control problem without combinatorial constraints and a mixed-integer problem for the combinatorial constraints in the control space. The coupling is handled using a penalty-approach. We present an exactness result for the penalty which yields a solution approach that convergences to partial-epsilon-minima. The quality of these dedicated points can be controlled using the penalty parameter.

PLA

Mon.1 H 3012

Optimization of Biological Systems (Part I)

Organizer: Pedro Gajardo
Chair: Pedro Gajardo

Anna Desilles, ENSTA ParisTech

HJB approach to optimal control problems with free initial conditions

This talk will fucus on some recent results about HJB approach to solve optimal control problems of Mayer's type with free initial state. First, wi show that such problems can be solved by using the associated value function as function of the initial state. Then, some sensitivity relations can be established to link the subdifferential of the value function and the adjoint state of the problem, coming from the Pontryagin's maximum principle. These theoretic results will be illustrated by practical examples from optimal control of bio-processes.

Victor Riquelme, Universidad Tecnica Federico Santa Maria

Optimal control of diseases in jailed populations

We study the control of a communicable disease in a prison. Its time evolution is modeled by a SIS model, typically used for illnesses that do not confer immunity after recovery. To control the disease, we consider an strategy that consists on performing a screening to a proportion (control variable) of the new prisoners, followed by a treatment. We determine the optimal strategies that minimize a tradeoff between the treatment cost and the number of infective prisoners, in a predetermined time horizon, and characterize qualitatively different behaviors depending on the model parameters

Pedro Gajardo, Universidad Tecnica Federico Santa Maria

Links between sustainability standards, maximin, and viability: methods and applications

The maximin criterion, as the highest performance that can be sustained over time, promotes intergenerational equity, a pivotal issue for sustainability. The viable control approach, by investigating trajectories and actions complying over time with various standards and constraints, provides major insights into strong sustainability. In this presentation we address the links between maximin and viability approaches in a multi-criteria context, showing practical methods for computing sustainability standards based in dynamic programming principle and level-set approach.

PDE

Mon.1 H 0106

Bilevel Optimization in Image Processing (Part I)

Organizers: Michael Hintermüller, Kostas Papafitsoros
Chair: Kostas Papafitsoros

Juan Carlos De los Reyes, Escuela Politécnica Nacional
Bilevel Optimal Parameters Selection in Nonlocal Image Denoising

We propose a bilevel learning approach for the determination of optimal weights in nonlocal image denoising. We consider both spatial weights in front of the nonlocal regularizer, as well as weights within the kernel of the nonlocal operator. In both cases we investigate the differentiability of the solution operator in function spaces and derive a first order optimality system that characterizes local minima. For the numerical solution of the problems, we propose a second- order optimization algorithm in combination with a suitable finite element discretization of the nonlocal denoising models.

Michael Hintermüller, Weierstrass Institute for Applied Analysis and Stochastics
Several Applications of Bilevel Programming in Image Processing

Opportunities and challenges of bilevel optimization for applications in image processing are addressed. On the mathematical side, analytical and algorithmic difficulties as well as solution concepts are highlighted. Concerning imaging applications, statistics based automated regularization function choice rules, and blind deconvolution problems are in the focus.

Kostas Papafitsoros, Weierstrass Institute for Applied Analysis and Stochastics
Generating structure non-smooth priors for image reconstruction

We will bind together and extend some recent developments regarding data-driven non-smooth regularization techniques in image processing through the means of bilevel minimization schemes. The schemes, considered in function space, take advantage of dualization frameworks and they are designed to produce spatially varying regularization parameters adapted to the data for well-known regularizers, e.g. Total Variation and Total Generalized Variation, leading to automated (monolithic), image reconstruction workflows.

PDE

Mon.1 H 2013

Infinite-Dimensional Optimization of Nonlinear Systems (Part I)

Organizers: Fredi Tröltzsch, Irwin Yousept
Chair: Irwin Yousept

Fredi Tröltzsch, Technische Universität Berlin (joint work with Eduardo Casas Rentería)
Sparse optimal control for a nonlinear parabolic equation with mixed control-state constraints

A problem of sparse optimal control for a semilinear parabolic equation is considered, where pointwise bounds on the control and mixed pointwise control-state constraints are given. A quadratic objective functional is to be minimized that includes a Tikhonov regularization term and the L^1-norm of the control that accounts for sparsity. Special emphasis is laid on existence and regularity of Lagrange multipliers associated with the mixed control-state constraints. Since the interior of the underlying non-negative cone is empty, the duality theory for linear programming problems in Hilbert spaces is applied in a special way to prove the existence of Lagrange multipliers. First-order necessary optimality conditions are established and discussed up to the sparsity of optimal controls.

Yifeng Xu, Shanghai Normal University (joint work with Irwin Yousept, Jun Zou)
AFEM for quasilinear magnetostatic phenomena

In this talk, I introduce an adaptive edge element method for a quasilinear H(curl)-elliptic problem in magnetostatics, based on a residual-type a posteriori error estimator and general marking strategies. The error estimator is shown to be reliable and efficient, and its resulting sequence of adaptively generated solutions converges strongly to the exact solution of the original quasilinear system. Numerical experiments are provided to verify the validity of the theoretical results.

Irwin Yousept, University of Duisburg-Essen
Hyperbolic Maxwell variational inequalities of the second kind

Physical phenomena in electromagnetism can lead to hyperbolic variational inequalities with a Maxwell structure. They include electromagnetic processes arising in polarizable media, nonlinear Ohm's law, and high-temperature superconductivity (HTS). In this talk, we present well-posedness and regularity results for a class of hyperbolic Maxwell variational inequalities of the second kind, under different assumptions.

ROB

Mon.1 H 1058

Advances in Robust Optimization (Part I)

Organizer: Shimrit Shtern
Chair: Shimrit Shtern

Krzysztof Postek, Erasmus University Rotterdam (joint work with Shimrit Shtern)

First-order methods for solving robust optimization problems

We show how robust optimization problems where each onstraints is convex in the decision variables and concave in the uncertain parameters, can be solved using a first-order saddle-point algorithm. Importantly, the computations of proximal operators involving the uncertain parameters ("pessimization") are parallelizable over the problem's constraints. The scheme has an $O(1/T)$ convergence rate with known both optimality and feasibility guarantees.

Dick den Hertog, Tilburg University, The Netherlands

Solving hard non-robust optimization problems by Robust Optimization

We discuss several hard classes of optimization problems that contain no uncertainty, and that can be reformulated to (adaptive) robust optimization (RO) problems. We start with several geometrical problems that can be modeled as RO problems. Then, we show that disjoint bilinear and concave minimization problems with linear constraints can be efficiently solved by reformulating these problems as adaptive linear RO problems. This talk summarizes several (recent) papers and is joint work with many other researchers. We expect that more hard classes of problems can be treated in this way.

Shimrit Shtern, Technion-Israel Institute of Tecnology (joint work with Dimitris Bertsimas, Bradley Sturt)

Data-Driven Two-Stage Linear Optimization: Feasibility and Approximation Guarantees

In this talk, we focus on two-stage linear optimization problems wherein the information about uncertainty is given by historical data. We present a method that employs a simple robustification of the data combined with a multi-policy approximation in order to solve this problem, and prove is combines (i) strong out-of-sample finite-sample guarantees and (ii) asymptotic optimality. A key contribution of this work is the development of novel geometric insights, which we use to show our approximation is asymptotically optimal.

ROB

Mon.1 H 3025

Advances in Optimization Under Uncertainty

Organizer: Fatma Kilinc-Karzan
Chair: Fatma Kilinc-Karzan

Paul Grigas, University of California, Berkeley

New Results for Contextual Stochastic Optimization

We consider a class of stochastic optimization problems where the distribution defining the objective function can be estimated based on a contextual feature vector. We propose an estimation framework that leverages the structure of the underlying optimization problem that will be solved given an observed feature vector. We provide theoretical, algorithmic, and computational results to demonstrate the validity and practicality of our framework.

Anirudh Subramanyam, Argonne National Laboratory (joint work with Kibaek Kim)

Wasserstein distributionally robust two-stage convex optimization with discrete uncertainty

We study two-stage distributionally robust convex programs over Wasserstein balls centered at the empirical distribution. Under this setting, recent works have studied single-stage convex programs and two-stage linear programs with continuous parameters. We study two-stage convex conic programs where the uncertain parameters are supported on mixed-integer programming representable sets. We show that these problems also admit equivalent reformulations as finite convex programs and propose an exact algorithm for their solution that is scalable with respect to the size of the training dataset.

Prateek R Srivastava, University of Texas at Austin (joint work with Grani A. Hanasusanto, Purnamrita Sarkar)

A Semidefinite Programming Based Kernel Clustering Algorithm for Gaussian Mixture Models with Outliers

We consider the problem of clustering data points generated from a mixture of Gaussians in the presence of outliers. We propose a semidefinite programming based algorithm that takes the original data as input in the form of a Gaussian kernel matrix, uses the SDP formulation to denoise the data and applies spectral clustering to recover the true cluster labels. We show that under a reasonable separation condition our algorithm is weakly consistent. We compare the performance of our algorithm with existing algorithms like k-means, vanilla spectral clustering and other SDP-based formulations.

SPA

Mon.1 H 1012

Recent Advances in First-Order Methods
Organizer: Shoham Sabach
Chair: Shoham Sabach

Russell Luke, Georg-August-University of Göttingen
Inconsistent Nonconvex Feasibility: algorithms and quantitative convergence results

Feasibility models can be found everywhere in optimization and involve finding a point in the intersection of a collection (possibly infinite) of sets. The focus of most of the theory for feasibility models is on the case where the intersection is nonempty. But in applications, one encounters infeasible problems more often than might be expected. We examine a few high-profile instances of inconsistent feasibility and demonstrate the application of a recently established theoretical framework for proving convergence, with rates, of some elementary algorithms for inconsistent feasibility.

Yakov Vaisbourd, Tel Aviv University (joint work with Marc Teboulle)
Novel Proximal Gradient Methods for Sparsity Constrained Nonnegative Matrix Factorization

In this talk we consider the nonnegative matrix factorization (NMF) problem with a particular focus on its sparsity constrained variant (SNMF). Of the wide variety of methods proposed for NMF, only few are applicable for SNMF and guarantee global convergence to a stationary point. We propose several additional, globally convergent methods, which are applicable to SNMF. Some are extensions of existing state of the art methods, while others are genuine proximal methods that tackle non standard decompositions of NMF, leading to subproblems lacking a Lipschitz continuous gradient objective.

Shoham Sabach, Technion-Israel Institute of Technology
Recent Advances in Proximal Methods for Composite Minimization

Proximal based methods are nowadays starring in optimization algorithms, and are effectively used in a wide spectrum of applications. This talk will present some recent work on the impact of the proximal framework for composite minimization, with a particular focus on convergence analysis and applications.

STO

Mon.1 H 0110

Stochastic Approximation and Reinforcement Learning (Part I)
Organizer: Alec Koppel
Chair: Alec Koppel

Sean Meyn, University of Florida (joint work with Andrey Bernstein, Yue Chen, Marcello Colombino, Emiliano Dall'Anese, Prashant Mehta)
Quasi-Stochastic Approximation and Off-Policy Reinforcement Learning

The talk will survey new results in the area of "quasi-stochastic approximation" in which all of the processes under consideration are deterministic, much like quasi-Monte-Carlo for variance reduction in simulation. Variance reduction can be substantial, but only if the parameters in the algorithm are chosen with attention to constraints. These results yield a new class of reinforcement learning algorithms for deterministic state space models. Specifically, we propose a class of algorithms for policy evaluation, using a different policy designed to introduce "exploration".

Huizhen Yu, University of Alberta (joint work with Rupam Mahmood, Richard Sutton)
On Generalized Bellman Equations and Temporal-Difference (TD) Learning for Policy Evaluation in MDPs

We introduce a new class of TD(lambda) algorithms for policy evaluation, based on the idea of randomized stopping times and generalized Bellman equations. The key innovation is a dynamic scheme to judiciously set the lambda-parameters in eligibility trace iterates, which is especially useful for balancing the bias-variance tradeoff in off-policy learning. We prove weak convergence and almost sure convergence results for several gradient-type algorithms, including saddle-point and mirror-descent TD variants, by using ergodic theory for weak Feller Markov chains and mean-ODE based proof methods.

Alec Koppel, U.S. Army Research Laboratory (joint work with Tamer Başar, Kaiqing Zhang, Hao Zhu)
Global Convergence of Policy Gradient Methods: A Nonconvex Optimization Perspective

We propose a new variant for infinite-horizon problems that uses a random rollout horizon to estimate the Q function. Doing so yields unbiased gradient estimates, which yields an alternative method to recover existing convergence results. We then modify the proposed PG method by introducing a periodically enlarged stepsize rule, which under the correlated negative curvature condition (which holds when the reward is strictly positive or negative), converges to a second-order stationarity, i.e., approximate local maxima. Intriguingly, we substantiate reward-reshaping from nonconvex optimization.

Mon.2 13:45–15:00

APP

Mon.2 H 0107

Optimization in Healthcare (Part II)
Organizers: Felix Jost, Christina Schenk
Chair: Christina Schenk

Corinna Maier, University of Potsdam (joint work with Niklas Hartung, Wilhelm Huisinga, Charlotte Kloft, Jana de Wiljes)
Reinforcement Learning for Individualized Dosing Policies in Oncology

For cytotoxic anticancer drugs, the combination of a narrow therapeutic window and a high variability between patients complicates dosing policies, as strict adherence to standard protocols may expose some patients to life-threatening toxicity and others to ineffective treatment. Therefore, individualisation is required for safe and effective treatments. We present a reinforcement learning framework for individualised dosing policies that not only takes into account prior knowledge from clinical studies, but also enables continued learning during ongoing treatment.

Patrick-Marcel Lilienthal, Otto-von-Guericke-Universität Magdeburg (joint work with Sebastian Sager, Manuel Tetschke)
Mathematical Modeling of Erythropoiesis and Treatment Optimization in the Context of Polycythemia Vera

The disease Polycythemia Vera (PV) leads to patients, which suffer from an uncontrolled production of red blood cells (RBC). If untreated, this might be fatal. Initial treatment is done by phlebotomy in certain regular intervals. Until now it is not known, how to find an individual optimal timing of the treatment schedule, w.r.t. side effects. We extend our published model of RBC dynamics to PV and verify it using simulations. Different approaches for the computation of optimal treatment schedules are formulated and discussed. We illustrate our conclusions with numerical results

Felix Jost, Otto-von-Guericke University Magdeburg (joint work with Hartmut Döhner, Thomas Fischer, Sebastian Sager, Enrico Schalk, Daniela Weber)
Optimal Treatment Schedules for Acute Myeloid Leukemia Patients During Consolidation Therapy

In this talk we present a pharmacokinetic-pharmacodynamic model describing the dynamics of healthy white blood cells (WBCs) and leukemic cells during chemotherapy for acute myeloid leukemia patients. Despite the primary treatment goal of killing cancer cells, a further clinically relevant event is the cytarabine-derived and lenograstim-reduced low number of WBCs increasing the risk of infections and delayed or stopped therapy. We present optimal treatment schedules derived by optimization problems considering terms for disease progression, healthiness and therapy costs.

BIG

Mon.2 H 0104

The Interface of Generalization and Optimization in Machine Learning (Part I)
Organizers: Benjamin Recht, Mahdi Soltanolkotabi
Chair: Mahdi Soltanolkotabi

Benjamin Recht, University of California, Berkeley
Training on the Test Set and Other Heresies

Conventional wisdom in machine learning taboos training on the test set, interpolating the training data, and optimizing to high precision. This talk will present evidence demonstrating that this conventional wisdom is wrong. I will additionally highlight commonly overlooked phenomena imperil the reliability of current learning systems: surprising sensitivity to how data is generated and significant diminishing returns in model accuracies given increased compute resources. New best practices to mitigate these effects are critical for truly robust and reliable machine learning.

Suriya Gunasekar, Toyota Technological Institute at Chicago
Characterizing optimization bias in terms of optimization geometry [canceled]

In the modern practice of machine learning, especially deep learning, many successful models have far more trainable parameters compared to the number of training examples. Consequently, the optimization objective for such models have multiple minimizers that perfectly fit the training data, but most such minimizers will simply overfit or memorize the training data and will perform poorly on new examples. When minimizing the training objective for such ill posed problems, the implicit inductive bias from optimization algorithms like (S)GD plays a crucial role in learning. In this talk, I will specifically focus on how the characterization of this optimization bias depends on the update geometry of two families of local search algorithms – mirror descent w.r.t. strongly convex potentials and steepest descent w.r.t general norms.

Tengyuan Liang, University of Chicago
New Thoughts on Adaptivity, Generalization and Interpolation

In the absence of explicit regularization, Neural Networks (NN) and Kernel Ridgeless Regression (KRR) have the potential to fit the training data perfectly. It has been observed empirically, however, that such interpolated solutions can still generalize well on test data. We show training NN with gradient flow learns an adaptive RKHS representation, and performs the global least squares projection onto the adaptive RKHS, simultaneously. We then isolate a phenomenon of implicit regularization for minimum-norm interpolated solutions for KRR which could generalize well in the high dim setting.

BIG

Mon.2 H 3004

Optimization Methods for Machine Learning and Data Science

Organizer: Shuzhong Zhang

Chair: Shuzhong Zhang

Yin Zhang, The Chinese University of Hong Kong, Shenzhen

Data clustering: a subspace-matching point of view and K-scalable algorithms

Data clustering is a fundamental unsupervised learning strategy. The most popular clustering method is arguably the K-means algorithm (K being the number of clusters), albeit it is usually applied not directly to a dataset given, but to its image in a processed "feature space" (such as the case in spectral clustering). The K-means algorithm, however, has been observed to have a deteriorating performance as K increases. In this talk, we will examine some clustering models from a subspace-matching viewpoint and promote a so-called K-indicators model. We apply a partial convex-relaxation scheme to this model and construct an "essentially deterministic" algorithm requiring no randomized initialization. We will present theoretical results to justify the proposed algorithm and give extensive numerical results to show its superior scalability over K-means as the number of clusters grows.

Shuzhong Zhang, University of Minnesota, joint appointment with Institute of Data and Decision Analytics, The Chinese University of Hong Kong, Shenzhen (joint work with Bo Jiang, Tianyi Lin)

Optimization Methods for Learning Models: Adaptation, Acceleration, and Subsampling

In this talk we present a suite of algorithms for solving optimization models arising from applications in machine learning and statistics. Popular optimization methods for solving such problems include the high-order tensor approximation approach, which requires the knowledge on some problem parameters. To make such methods practical, one will need to find ways of implementation without such knowledge. We discuss methods that exhibit an accelerated iteration bound while maintaining the traits of being adaptive.

Bo Jiang, Shanghai University of Finance and Economics (joint work with Haoyue Wang, Shuzhong Zhang)

An Optimal High-Order Tensor Method for Convex Optimization

Optimization algorithms using up to the d-th order derivative information of the iterative solutions are called high-order tensor methods. In this talk, we propose a new high-order tensor algorithm for the general composite case, with the iteration complexity of $O(1/k^{(3d+1)/2})$, which matches the lower bound for the d-th order tensor methods, hence is optimal. Our approach is based on the so-called Accelerated Hybrid Proximal Extragradient (A-HPE) framework.

VIS

Mon.2 H 3002

Linear Complementarity Problem (Part II)

Organizers: Tibor Illés, Janez Povh

Chair: Tibor Illés

Zsolt Darvay, Babes-Bolyai University (joint work with Tibor Illés, Janez Povh, Petra Renáta Rigó)

Predictor-corrector interior-point algorithm for sufficient linear complementarity problems based on a new search direction

We introduce a new predictor-corrector (PC) interior-point algorithm (IPA), which is suitable for solving linear complementarity problem (LCP) with P*(K)-matrices. We use the method of algebraically equivalent transformation (AET) of the nonlinear equation of the system which defines the central path. We show the complexity of this algorithm and implement it in C++ programming language. We demonstrate its performance on two families of LCPs: LCP with matrices, which have positive handicap and on instances of LCP related to the copositivity test.

Janez Povh, University of Ljubljana

Multi-type symmetric non-negative matrix factorization

Multi-type symmetric non-negative matrix factorization problem is a strong model to approach data fusion e.g. in bioinformatics. It can be formulated as a non-convex optimization problem with the objective function being polynomial of degree 6 and the feasible set being defined by sign and complementarity constraints. In the talk we will present how to obtain good solutions, often local extreme points, by the fixed point method, the projected gradient method, the Alternating Direction Method of Multipliers and ADAM. We also demonstrate the application of this approach in cancer research.

VIS

Mon.2 H 3007

Nash Equilibrium Problems and Extensions (Part II)

Organizer: Anna Thünen
Chair: Anna Thünen

Mathias Staudigl, Maastricht University (joint work with Panayotis Mertikopoulos)
Stochastic Dual Averaging in Games and Variational Inequalities

We examine the convergence of a broad class of distributed learning dynamics for games with continuous action sets. The dynamics comprise a multi-agent generalization of Nesterov's dual averaging method, a primal-dual mirror descent method that has seen a major resurgence in large-scale optimization and machine learning. To account for settings with high temporal variability we adopt a continuous-time formulation of dual averaging and we investigate the dynamics' behavior when players have noiseless or noisy information. Asymptotic and non-asymptotic converegence results are presented.

Matt Barker, Imperial College London
A Comparison of Stationary Solutions to Mean Field Games and the Best Reply Strategy

In this talk I will briefly discuss the Best Reply Strategy (BRS) – an instantaneous response to a cost function – and how it can be related to a Mean Field Game (MFG) through a short-time rescaling. I will then focus on stationary solutions to linear-quadratic MFGs and the BRS, describing a proof for existence and uniqueness of such MFGs and comparing existence between the two models. I will highlight some specific examples of MFGs and BRS that show typical differences between the two models. Finally, I will explain the importance of these differences and their modelling consequences.

Anna Thünen, Institut für Geometrie und Praktische Mathematik (IGPM), RWTH Aachen University (joint work with Michael Herty, Sonja Steffensen)
Multi-Level Mean Field Games

We discuss an application motivated two level game with a large amount of players. To overcome the challenge of high dimensionality due to the number of players, we derive the mean field limit of infinitely many players. We discuss the relation between optimization and mean field limit for different settings and establish conditions for consistency.

CON

Mon.2 H 0111

Conic Approaches to Infinite Dimensional Optimization (Part II)

Organizer: Juan Pablo Vielma
Chair: Juan Pablo Vielma

Lea Kapelevich, MIT Operations Research Center (joint work with Chris Coey, Juan Pablo Vielma)
Sum-of-Squares Programming with New Cones

We discuss the modeling capabilities of our new conic interior point solver, Hypatia.jl. We focus on problems that can be naturally formulated using nonsymmetric cones, such as the weighted sum of squares cone. The standard approach to solve these problems involves utilizing semidefinite programming reformulations, which unnecessarily increases the dimensionality of the optimization problem. We show the advantages of being able to optimize directly over known nonsymmetric cones and newly defined cones.

Sascha Timme, Technische Universität Berlin (joint work with Paul Breiding)
Solving systems of polynomials by homotopy continuation

Homotopy continuation methods allow to compute all isolated solutions of polynomial systems as well as representatives for positive dimensional solution sets using techniques from algebraic geometry. After a short introduction to the fundamental constructions of the homotopy continuation approach, I will continue with describing an efficient approach to the solution of polynomial systems with parametric coefficients by using the monodromy action induced by the fundamental group of the regular locus of the parameter space. This is demonstrated using the Julia package HomotopyContinuation.jl.

Tillmann Weisser, Los Alamos National Laboratory (joint work with Carleton Coffrin)
GMP.jl: Modeling Conic Relaxations for the Generalized Moment Problem

The generalized moment problem (GMP) is an infinite dimensional linear optimization problem on measures. Relaxations based on LP, SOCP, SDP and other cones are known to approximate its solution. Since implementation of the different algorithms are spread over all platforms of mathematical computing and not necessarily able to take into account new algorithmic ideas or additional use of structure, it is difficult to compare known and newly emerging approaches in practice and to decide which hierarchy works best for a particular problem. With GMP.jl we provide a unified framework.

CON

Mon.2 H 0112

Recent Advances and Applications of Conic Optimization

Organizer: Anthony Man-Cho So
Chair: Anthony Man-Cho So

Hamza Fawzi, University of Cambrige

On polyhedral approximations of the positive semidefinite cone

Let D be the set of density matrices, i.e., the set of positive definite matrices of unit trace. We show that any polytope P that is sandwiched between $(1-\epsilon)D$ and D (where the origin is taken to be the scaled identity matrix) must have linear programming extension complexity at least $\exp(c\,\mathrm{sqrt}(n))$ where $c > 0$ is a constant that depends only on ϵ. The main ingredient of our proof is hypercontractivity of the noise operator on the hypercube.

Huikang Liu, The Chinese University of Hong Kong (joint work with Rujun Jiang, Anthony Man-Cho So, Peng Wang)

Fast First-Order Methods for Quadratically Constrained Quadratic Optimization Problems in Signal Processing

Large-scale quadratically constrained quadratic programming (QCQP) finds many applications in signal processing. Traditional methods, like semidefinite relaxation (SDR) and successive convex approximation (SCA), become inefficient because they are sensitive to the problem dimension. Thus, we are motivated to design a fast fisrt-order method, called linear programming-assisted subgradient decent (LPA-SD), to tackle it. For LPA-SD, we only solve a dimension-free linear programming in each iterate. Numerical results demonstrate its potential in both computational efficiency and solution quality.

Anthony Man-Cho So, The Chinese University of Hong Kong (joint work with K-F Cheung, Sherry Ni)

Mixed-Integer Conic Relaxation for TOA-Based Multiple Source Localizaton

Source localization is among the most fundamental and studied problems in signal processing. In this talk, we consider the problem of localizing multiple sources based on noisy distance measurements between the sources and the sensors, in which the source-measurement association is unknown. We develop a mixed-integer conic relaxation of the problem and propose a second-order cone-based outer approximation algorithm for solving it. We show that the proposed algorithm enjoys finite convergence and present numerical results to demonstrate its viability.

CNV

Mon.2 H 1028

Convex-Composite Optimization (Part II)

Organizer: Tim Hoheisel
Chair: Tim Hoheisel

Dmitry Kamzolov, Moscow Institute of Physics and Technology, MIPT (joint work with Pavel Dvurechensky, Alexander Gasnikov)

Composite High-Order Method for Convex Optimization

In this paper, we propose a new class of convex optimization problem with the objective function formed as a sum of $m+1$ functions with the different order of smoothness: non-smooth but simple with known structure, with Lipschitz-continuous gradient, with Lipschitz-continuous second-order derivative, ..., with Lipschitz-continuous m-order derivative. To solve this problem, we propose a high-order optimization method, that takes into account information about all functions. We prove the convergence rate of this method. We obtain faster convergence rates than the ones known in the literature.

Pedro Merino, Escuela Politécnica Nacional (joint work with Juan Carlos De los Reyes)

A Second-order method with enriched hessian information for composite sparse optimization problems

In this talk we present a second order method for solving composite sparse optimization problems, which consist in minimizing the sum of a differentiable, possibly nonconvex function and a nondifferentiable convex term. The composite nondifferentiable convex penalization is given by ℓ_1-norm of a matrix times the coefficient vector. Our proposed method generalizes the previous OESOM algorithm in its three main ingredients to the case of the generalized composite optimization: outhant directions, the projection step and, in particular, the full second-order information.

CNV

Mon.2 H 1029

Recent Advances in First-Order Methods for Constrained Optimization and Related Problems (Part II)

Organizers: Shiqian Ma, Ion Necoara, Quoc Tran-Dinh, Yangyang Xu
Chair: Ion Necoara

Nam Ho-Nguyen, (joint work with Fatma Kilinc-Karzan)

A dynamic primal-dual first-order framework for convex optimization under uncertainty

Many optimization problems in practice must be solved under uncertainty, i.e., only with noisy estimates of input parameters. We present a unified primal-dual framework for deriving first-order algorithms for two paradigms of optimization under uncertainty: robust optimization (RO) where constraint parameters are uncertain, and joint estimation-optimization (JEO) where objective parameters are uncertain. The key step is to study a related 'dynamic saddle point' problem, and we show how RO and JEO are covered by our framework through choosing the dynamic parameters in a particular manner.

Guanghui Lan, Georgia Institute of Technology (joint work with Digvijay Boob, Qi Deng)

Proximal point methods for constrained nonconvex optimization

We present novel proximal-point methods for solving a class of nonconvex optimization problems with nonconvex constraints and establish its computational complexity for both deterministic and stochastic problems. We will also illustrate the effectiveness of this algorithm when solving some application problems in machine learning.

Quoc Tran-Dinh, University of North Carolina at Chapel Hill

Adaptive Primal-Dual Methods for Convex Optimization with Faster Rates

We discuss a new class of primal-dual methods for solving nonsmooth convex optimization problem ranging from unconstrained to constrained settings. The proposed methods achieve optimal convergence rates and faster rates in the last iterates instead of taking averaging sequence, and essentially maintain the same per-iteration complexity as in existing methods. Our approach relies on two different frameworks: quadratic penalty and augmented Lagrangian functions. In addition, it combines with other techniques such as alternating, linearizing, accelerated, and adaptive strategies in one

DER

Mon.2 H 2038

Challenging Applications in Derivative-Free Optimization (Part I)

Organizers: Ana Luisa Custodio, Sébastien Le Digabel, Margherita Porcelli, Francesco Rinaldi, Stefan Wild
Chair: Margherita Porcelli

Yves Lucet, University of British Columbia (joint work with Mahdi Aziz, Warren Hare, Majid Jaberipour)

Multi-fidelity derivative-free algorithms for road design

We model the road design problem as a bilevel problem. The top level calculates the road path from a satellite's viewpoint while the lower level is a mixed-integer linear problem (solving the vertical alignment i.e. where to cut and fill the ground to design the road and the earthwork i.e. what material to move to minimize costs) for which we build a variable-fidelity surrogate using quantile regression. We compare two variable-fidelity algorithms from the literature (a generalized pattern search with adaptive precision vs. a trust-region with controlled error) and report significant speedups.

Miguel Diago, Polytechnique Montréal (joint work with Peter R. Armstrong, Nicolas Calvet)

Net power maximization in a beam-down solar concentrator

The reflectors of a beam-down solar concentrator are adjusted to maximize the net power collected at the receiver. The performance of the solar plant is predicted with a Monte Carlo ray-tracing model as a function of a feasible reflector geometry. Optimization is carried out with NOMAD, an instance of the mesh-adaptive direct search (MADS) blackbox algorithm. Challenges include reducing the number of optimization variables, dealing with the stochastic aspect of the blackbox, and the selection of effective MADS optimization parameters.

Sébastien Le Digabel, Polytechnique Montréal (joint work with Dounia Lakhmiri, Christophe Tribes)

HYPERNOMAD: Hyper-parameter optimization of deep neural networks using mesh adaptive direct search

The performance of deep neural networks is highly sensitive to the choice of the hyper-parameters that define the structure of the network and the learning process. Tuning a deep neural network is a tedious and time consuming process that is often described as a "dark art". This work introduces the HYPERNOMAD package based on the MADS derivative-free algorithm to solve this hyper-parameter optimization problem including the handling of categorical variables. This approach is tested on the MNIST and CIFAR-10 datasets and achieves results comparable to the current state of the art.

MUL

Mon.2 H 3013

Applications of Multi-Objective Optimization (Part II)

Organizers: Gabriele Eichfelder, Alexandra Schwartz
Chair: Alberto De Marchi

Floriane Mefo Kue, University of Siegen (joint work with Thorsten Raasch)

Semismooth Newton methods in discrete TV and TGV regularization

We consider the numerical minimization of Tikhonov-type functionals with discrete total generalized variation (TGV) penalties. The minimization of the Tikhonov functional can be interpreted as a bilevel optimization problem. The upper level problem is unconstrained, and the lower level problem is a mixed ℓ_1-TV separation problem. By exploiting the structure of the lower level problem, we can reformulate the first-order optimality conditions as an equivalent piecewise smooth system of equations which can then be treated by semismooth Newton methods.

Zahra Forouzandeh, Faculdade de Engenharia da Universidade do Porto (joint work with Mostafa Shamsi, Maria do Rosário de Pinho)

Multi-objective optimal control problems: A new method based on the Pascoletti-Serafini scalarization method

A common approach to determine efficient solutions of a Multi-Objective Optimization Problems is to reformulate it as a parameter dependent Single-Objective Optimization: this is the scalarization method. Here, we consider the well-known Pascoletti-Serafini Scalarization approach to solve the nonconvex Multi-Objective Optimal Control Problems (MOOCPs). We show that by restricting the parameter sets of the Pascoletti-Serafini Scalarization method, we overcome some of the difficulties. We illustrate the efficiency of the method for two MOOCPs comprising both two and three different costs.

Alberto De Marchi, Bundeswehr University Munich (joint work with Matthias Gerdts)

Mixed-Integer Linear-Quadratic Optimal Control with Switching Costs

We discuss the linear-quadratic optimal control of continuous-time dynamical systems via continuous and discrete-valued control variables, also considering state-independent switching costs. This is interpreted as a bilevel problem, involving switching times optimization, for a given mode sequence, and continuous optimal control. Switching costs are formulated in terms of cardinality, via the L^0 “norm”. An efficient routine for the simplex-constrained L^0 proximal operator is devised and adopted to solve some numerical examples through an accelerated proximal gradient method.

NON

Mon.2 H 0105

Nonlinear and Stochastic Optimization (Part II)

Organizers: Albert Berahas, Geovani Grapiglia
Chair: Albert Berahas

Alejandra Peña-Ordieres, Northwestern University, Evanston (joint work with James Luedtke, Andreas Wächter)

A Nonlinear Programming Reformulation of Chance Constraints

In this talk, we introduce a method for solving nonlinear continuous optimization problems with chance constraints. Our method is based on a reformulation of the probabilistic constraint as a smooth sample-based quantile function. We provide theoretical statistical guarantees of the approximation. Furthermore, we propose an Sl1QP-type trust-region method to solve instances with joint chance constraints. We show that the method scales well in the number of samples and that the smoothing can be used to counteract the bias in the chance constraint approximation induced by the sample.

Stefan Wild, Argonne National Laboratory (joint work with Matt Menickelly)

Manifold Sampling for Robust Calibration

We adapt a manifold sampling algorithm for the composite nonsmooth, nonconvex optimization formulations of model calibration that arise when imposing robustness to outliers present in training data. We demonstrate the approach on objectives based on trimmed loss and highlight the challenges resulting from the nonsmooth, nonconvex paradigm needed for robust learning. Initial results demonstrate that the method has favorable scaling properties. Savings in time on large-scale problems arise at the expense of not certifying global optimality in empirical studies, but the method also extends to cases where the loss is determined by a black-box oracle.

Nikita Doikov, UCLouvain

Complexity of cubically regularized Newton method for minimizing uniformly convex functions

In this talk we discuss iteration complexity of cubically regularized proximal Newton method for solving composite minimization problems with uniformly convex objective. We introduce the notion of second-order condition number of a certain degree and present the linear rate of convergence in a nondegenerate case. The algorithm automatically achieves the best possible global complexity bound among different problem classes of functions with Holder continuous Hessian of the smooth part. This research was supported by ERC Advanced Grant 788368.

NON

Mon.2 H 2032

Smooth Optimization (Part II)

Organizers: Dominique Orban, Michael Saunders
Chair: Michael Saunders

Dominique Orban, GERAD & Polytechnique (joint work with Ron Estrin, Michael Friedlander, Michael Saunders)

Implementing a smooth exact penalty function for constrained nonlinear optimization

We develop a general constrained optimization algorithm based on a smooth penalty function proposed by Fletcher. The main computational kernel is solving structured linear systems. We show how to solve these systems efficiently by storing a single factorization per iteration when the matrices are available explicitly. We also give a factorization-free implementation. The penalty function shows particular promise when such linear systems can be solved efficiently, e.g., for PDE-constrained optimization problems where efficient preconditioners exist.

Marie-Ange Dahito, PSA Group / École Polytechnique (joint work with Dominique Orban)

The Conjugate Residual Method in Linesearch and Trust-Region Methods

Like the conjugate gradient method (CG), the conjugate residual method (CR), proposed by Hestenes and Stiefel, has properties that are desirable in both linesearch and trust-region contexts for optimization, but is only defined for symmetric positive-definite operators. We investigate modifications that make CR suitable, even in the presence of negative curvature, and perform comparisons on convex and nonconvex problems with CG. We give an extension suitable for nonlinear least-squares problems. CR performs as well as or better than CG, and yields savings in operator-vector products.

Douglas Gonçalves, UFSC Federal University of Santa Catarina (joint work with Fermin Bazan, Juliano Francisco, Lila Paredes)

Nonmonotone inexact restoration method for minimization with orthogonality constraints

We consider the problem of minimizing a differentiable functional restricted to the set of $n \times p$ matrices with orthonormal columns. We present a nonmonotone line search variant of the inexact restoration method along with implementation details. The restoration phase employs the Cayley transform, which leads to an SVD-free scheme. By exploiting the Sherman-Morrison-Woodburry formula this strategy proved to be quite efficient when p is much smaller than n. Numerical experiments validate the reliability of our approach on a wide class of problems against a well established algorithm.

NON

Mon.2 H 2053

Variational Inequalities, Minimax Problems and GANs (Part I)

Organizer: Konstantin Mishchenko
Chair: Konstantin Mishchenko

Simon Lacoste-Julien, University of Montreal & Mila & SAIL Montreal

Negative Momentum for Improved Game Dynamics

Games generalize the single-objective optimization paradigm by introducing different objective functions for different players. Differentiable games often proceed by simultaneous or alternating gradient updates. In machine learning, games are gaining new importance through formulations like generative adversarial networks (GANs) and actor-critic systems. However, compared to single-objective optimization, game dynamics is more complex and less understood. In this work, we analyze gradient-based methods with negative momentum on simple games and show stability of alternating updates.

Dmitry Kovalev, King Abdullah University of Science and Technology (KAUST)

Revisiting Stochastic Extragradient Method.

We revisit stochastic extragradient methods for variational inequalities. We propose a new scheme which uses the same stochastic realization of the operator to perform an extragradient step. We prove convergence under the assumption that variance is bounded only at the optimal point and generalize method to proximal setting. We improve state-of-the-art results for bilinear problems and analyze convergence of the method for non-convex minimization.

Gauthier Gidel, Université de Montréal

New Optimization Perspectives on Generative Adversarial Networks

Generative adversarial networks (GANs) form a generative modeling approach known for producing appealing samples, but they are notably difficult to train. One common way to tackle this issue has been to propose new formulations of the GAN objective. Yet, surprisingly few studies have looked at optimization methods designed for this adversarial training. In this work, we cast GAN optimization problems in the general variational inequality framework and investigate the effect of the noise in this context.

NON

Mon.2 H 3006

Mixed-Integer Optimal Control and PDE Constrained Optimization (Part II)

Organizers: Falk Hante, Christian Kirches, Sven Leyffer
Chair: Falk Hante

Sebastian Peitz, Paderborn University (joint work with Stefan Klus)

Feedback control of nonlinear PDEs using Koopman-Operator-based switched systems

We present a framework for feedback control of PDEs using Koopman operator-based reduced order models (K-ROMs). The Koopman operator is a linear but infinite-dimensional operator describing the dynamics of observables. By introducing a finite number of constant controls, a dynamic control system is transformed into a set of autonomous systems and the corresponding optimal control problem into a switching time optimization problem, which can be solved efficiently when replacing the PDE constraint of the autonomous systems by K-ROMs. The approach is applied to examples of varying complexity.

Mirko Hahn, Otto-von-Guericke University Magdeburg (joint work with Sven Leyffer, Sebastian Sager)

Set-based Approaches for Mixed-Integer PDE Constrained Optimization

We present a gradient descent method for optimal control problems with ordinary or partial differential equations and integer-valued distributed controls. Our method is based on a derivative concept similar to topological gradients. We formulate first-order necessary optimality conditions, briefly sketch a proof of approximate stationarity, and address issues with second derivatives and sufficient optimality conditions. We give numerical results for two test problems based on the Lotka-Volterra equations and the Laplace equation, respectively.

Paul Manns, TU Braunschweig (joint work with Christian Kirches)

A continuous perspective on Mixed-Integer Optimal Control

PDE-constrained control problems with distributed integer controls can be relaxed by means of partial outer convexification. Algorithms exist that allow to approximate optimal relaxed controls with feasible integer controls. These algorithms approximate relaxed controls in the weak* topology of L^∞ and can be interpreted as a constructive transfer of the Lyapunov convexity theorem to mixed-integer optimal control, which yields state vector approximation in norm for compact solution operators of the underlying process. The chain of arguments is demonstrated numerically.

PLA

Mon.2 H 3012

Optimization of Biological Systems (Part II)

Organizer: Pedro Gajardo
Chair: Pedro Gajardo

Kenza Boumaza, INRA (joint work with Nesrine Kalboussi, Alain Rapaport, Roux Sébastien)

About optimal crop irrigation planing under water scarcity

We study theoretically on a simple crop model the problem of optimizing the crop biomass at harvesting date, choosing the temporal distribution of water under the constraint of a total water volume available for the season. We show with the tools of the optimal control theory that the optimal solution may present a singular arc, under a lower water availability, which leads to a bang-singular-bang solution. This differs from the usual irrigation policies under water scarcity, which are bang-bang.

Ilya Dikariev, University BTU Cottbus-Senftenberg (joint work with Ingrid M. Cholo, Gerard Olivar Tost)

Optimal public and private investments in a model of sustainable development

In this paper, we analyze the existence of an optimal resource control problem with an infinite time horizon of a system of differential equations with nonlinear dynamics and linear control. Our system of differential equations corresponds to a model of sustainable development. The variables in the state space are related to economics, ecosystems and social dimensions. We deal with the problem of non-convexity, and we prove the existence of optimal solutions, which are interpreted in the sustainable and economic environment.

PDE

Mon.2 H 0106

Bilevel Optimization in Image Processing (Part II)

Organizers: Michael Hintermüller, Kostas Papafitsoros
Chair: Michael Hintermüller

Elisa Davoli, University of Vienna (joint work with Irene Fonseca, Pan Liu)

Adaptive image processing: first order PDE constraint regularizers and a bilevel training scheme

In this talk we will introduce a novel class of regularizers, providing a unified approach to standard regularizers such as TV and TGV^2. By means of a bilevel training scheme we will simultaneously identify optimal parameters and regularizers for any given class of training imaging data. Existence of solutions to the training scheme will be shown via Gamma-convergence. Finally, we will provide some explicit examples and numerical results. This is joint work with Irene Fonseca (Carnegie Mellon University) and Pan Liu (University of Cambridge).

Gernot Holler, University of Graz (joint work with Karl Kunisch)

Learning regularization operators using bilevel optimization

We address a learning approach for choosing regularization operators from given families of operators for the regularization of ill-posed inverse problems. Assuming that some ground truth data is given, the basic idea is to learn regularization operators by solving a bilevel optimization problem. Thereby, the lower level problem, which is depending on the regularization operators, is a Tikhonov-type regularized problem. As concrete examples we consider families of operators arising in multi-penalty Tikhonov regularization and a family of operators inspired by nonlocal energy semi-norms.

Jyrki Jauhiainen, University of Eastern Finland (joint work with Petri Kuusela, Aku Seppänen, Tuomo Valkonen)

An inexact relaxed Gauss–Newton applied to electrical impedance tomography

Partial differential equations (PDE)-based inverse problems-such as image reconstruction in electrical impedance tomography (EIT)-often lead to non-convex optimization problems. These problems are also non-smooth when total variation (TV) type regularization is employed. To improve upon current optimization methods, such as (semi-smooth) Newton's method and non-linear primal dual proximal splitting (NL-PDPS), we propose a new alternative: an inexact relaxed Gauss-Newton method. We investigate its convergence both theoretically and numerically with experimental EIT studies.

PDE

Mon.2 H 2013

Infinite-Dimensional Optimization of Nonlinear Systems (Part II)

Organizers: Fredi Tröltzsch, Irwin Yousept
Chair: Fredi Tröltzsch

Antoine Laurain, Instituto de Matemática e Estatística

Nonsmooth shape optimization and application to inverse problems

The distributed expression of the shape derivative, also known as volumetric form or weak form of the shape derivative, allows to study shape calculus and optimization of nonsmooth geometries such as Lipschitz domains and polygons. The distributed shape derivative has witnessed a surge of interest recently, in particular due to new ideas for numerical applications. We will discuss some recent theoretical developments for distributed shape derivatives, and their application to level set methods in numerical shape optimization. We will then show some applications to inverse problems.

De-Han Chen, Central China Normal University

Variational source condition for the reconstruction of distributed fluxes

This talk is devoted to the inverse problem of recovering the unknown distributed flux on an inaccessible part of boundary using measurement data on the accessible part. We establish and verify a variational source condition for this inverse problem, leading to a logarithmic-type convergence rate for the corresponding Tikhonov regularization method under a low Sobolev regularity assumption on the distributed flux. Our proof is based on the conditional stability and Carleman estimates together with the complex interpolation theory on a proper Gelfand triplet

Malte Winckler, University of Duisburg-Essen

Shape optimization subject to H(curl)-elliptic variational inequalities in superconductivity

We discuss a shape optimization problem subject to an elliptic curl-curl VI of the second kind. By employing a Moreau-Yosida-type regularization to its dual formulation, we obtain the sufficient differentiablity property to apply the averaged adjoint method. By means of this, we compute the shape derivative of the regularized problem. After presenting a stability estimate for the shape derivative w.r.t. the regularization parameter, we prove the strong convergence of the optimal shapes and the solutions. Finally, we apply the numerical algorithm to a problem from the (HTS) superconductivity.

PDE

Mon.2 H 2033

Optimal Control of Phase Field Models

Organizers: Carmen Gräßle, Tobias Keil
Chair: Carmen Gräßle

Tobias Keil, WIAS Berlin

Optimal control of a coupled Cahn–Hilliard–Navier–Stokes system with variable fluid densities

This talk is concerned with the optimal control of two immiscible fluids. For the mathematical formulation we use a coupled Cahn–Hilliard/Navier–Stokes system which involves a variational inequality of 4th order. We discuss the differentiability properties of the control-to-state operator and the corresponding stationarity concepts for the control problem. We present strong stationarity conditions and provide a numerical solution algorithm based on a bundle-free implicit programming approach which terminates at an at least C-stationary point which, in the best case, is even strongly stationary

Masoumeh Mohammadi, TU Darmstadt (joint work with Winnifried Wollner)

A priori error estimates for optimal control of a phase-field fracture model

An optimal control problem for a time-discrete fracture propagation process is considered. The nonlinear fracture model is treated once as a linearized one, while the original nonlinear model is dealt with afterwards. The discretization of the problem in both cases is done using a conforming finite element method. Regarding the linearized case, a priori error estimates for the control, state, and adjoint variables will be derived. The discretized nonlinear fracture model will be analyzed as well, which leads to a quantitative error estimate, while we avoid unrealistic regularity assumptions.

Henning Bonart, Technische Universität Berlin (joint work with Christian Kahle, Jens-Uwe Repke)

Controlling Sliding Droplets with Optimal Contact Angle Distributions

In lab-on-a-chip devices liquid drops move over solid surfaces. A specific contact angle distribution can be utilized to influence both speed and path of each drop. In previous works, we improved and implemented a phase field model for energy-consistent simulations of moving contact lines. Building on this, we present first results for the optimal control of droplets on solid surfaces. The static contact angle distribution acts as the control variable and the phase field model is used to calculate the drop dynamics. As optimization problems, desired drop shapes and positions are considered.

ROB

Mon.2 H 1058

New Advances in Robust Optimization

Organizer: Angelos Georghiou
Chair: Angelos Georghiou

Han Yu, University of Southern California (joint work with Angelos Georghiou, Phebe Vayanos)

Robust Optimization with Decision-Dependent Information Discovery

We consider two-stage robust optimization problems in which the first stage variables decide on the uncertain parameters that will be observed between the first and the second decision stages. The information available in the second stage is thus decision-dependent and can be discovered by making strategic exploratory investments in the first stage. We propose a novel min-max-min-max formulation of the problem. We prove the correctness of this formulation and leverage this new model to provide a solution method inspired from the K-adaptability approximation approach.

Viet Anh Nguyen, EPFL (joint work with Daniel Kuhn, Peyman Mohajerin Esfahani)

Distributionally Robust Inverse Covariance Estimation: The Wasserstein Shrinkage Estimator;

We introduce a distributionally robust maximum likelihood estimation model with a Wasserstein ambiguity set to infer the inverse covariance matrix of a p-dimensional Gaussian random vector from n independent samples. We show that the estimation problem has an analytical solution that is interpreted as a nonlinear shrinkage estimator. Besides being invertible and well-conditioned, the new shrinkage estimator is rotation-equivariant and preserves the order of the eigenvalues of the sample covariance matrix.

Angelos Georghiou, McGill University, Montréal (joint work with Angelos Tsoukalas, Wolfram Wiesemann)

A Primal-Dual Lifting Scheme for Two-Stage Robust Optimization

In this talk, we discuss convergent hierarchies of primal (conservative) and dual (progressive) bounds for two-stage robust optimization problems that trade off the competing goals of tractability and optimality: While the coarsest bounds recover a tractable but suboptimal affine decision rule of the two-stage robust optimization problem, the refined bounds lift extreme points of the uncertainty set until an exact but intractable extreme point reformulation of the problem is obtained.

ROB

Mon.2 H 3025

Advances in Robust Optimization (Part II)

Organizer: Krzysztof Postek
Chair: Krzysztof Postek

Ahmadreza Marandi, Eindhoven University of Technology (joint work with Geert-Jan van Houtum)

Robust location-transportation problems for integer low-demand items

We analyze robust location-transportation problems with uncertain integer demand. The goal is to select locations of the warehouses and determine their stock levels while considering the optimal policy to satisfy the demand of customers. In this presentation, we consider the integer transshipments between customers and local warehouses. We provide theoretical and numerical results on how to solve or approximate a multi-stage robust location-transportation problem. The numerical experiments will show the efficiency of our methods.

Ernst Roos, Tilburg University (joint work with Ruud Brekelmans, Dick den Hertog)

Uncertainty Quantification for Mean-MAD Ambiguity

The Chebyshev inequality and its variants provide upper bounds on the tail probability of a random variable. While it is tight, it has been criticized for only being attained by pathological distributions that abuse the unboundedness of the support. We provide an alternative tight lower and upper bound on the tail probability given a bounded support, mean and mean absolute deviation. This fundamental result allows us to find convex reformulations of single and joint ambiguous chance constraints with right-hand side uncertainty and left-hand side uncertainty with specific structural properties.

Stefan ten Eikelder, Tilburg University, The Netherlands (joint work with Ali Ajdari, Thomas Bortfeld, Dick den Hertog)

Adjustable robust treatment-length optimization in radiation therapy

Technological advancements in radiation therapy (RT) allow for the collection of biomarker data on individual patient response during treatment, and subsequent RT plan adaptations. We present a mathematical framework that optimally adapts the treatment-length of an RT plan, focusing on the inexactness of acquired biomarker data. We formulate the adaptive treatment-length optimization problem as a 2-stage problem in terms of Biological Effective Dose (BED). Using Adjustable Robust Optimization (ARO) techniques we derive explicit stage-2 decision rules and solve the optimization problem.

SPA

Mon.2 H 1012

Nonlinear Optimization Algorithms and Applications in Data Analysis (Part I)

Organizers: Xin Liu, Cong Sun
Chair: Xin Liu

Yaxiang Yuan, State Key Laboratory of Scientific/Engineering Computing, Institute of Computational Mathematics and Scientific/Engineering Computing, Academy of Mathematics and Systems Science, Chinese Academy of Sciences (joint work with Xin Liu, Zaiwen Wen)

Efficient Optimization Algorithms For Large-scale Data Analysis

This talk first reviews two efficient Newton type methods based on problem structures: 1) semi-smooth Newton methods for composite convex programs and its application to large-scale semi-definite program problems and machine learning; 2) an adaptive regularized Newton method for Riemannian Optimization. Next, a few parallel optimization approaches are discussed: 1) parallel subspace correction method for a class of composite convex program; 2) parallelizable approach for linear eigenvalue problems; 3) parallelizable approach for optimization problems with orthogonality constraint.

Liping Wang, Nanjing University of Aeronautics and Astronautics

Robust ordinal regression induced by l_p-centroid

We propose a novel type of class centroid derived from the l_p-norm (coined as l_p-centroid) to overcome the drawbacks above, and provide an optimization algorithm and corresponding convergence analysis for computing the l_p-centroid. To evaluate the effectiveness of l_p-centroid in Ordinal regression (OR) context against noises, we then combine the l_p-centroid with two representative class-center-induced ORs. Finally, extensive OR experiments on synthetic and real-world datasets demonstrate the effectiveness and superiority of the proposed methods to related existing methods.

Cong Sun, Beijing University of Posts and Telecommunications (joint work with Jinpeng Liu, Yaxiang Yuan)

New gradient method with adaptive stepsize update strategy

In this work, a new stepsize update strategy for the gradient method are proposed. On one hand, the stepsizes are updated in a cyclic way, where the Cauchy steps are combined with fixed step lengths; on the other hand, the iteration number in one cycle is adjusted adaptively according to the gradient residue. Theorecially, the new method terminates in 7 iterations for 3 dimensional convex quadratic function minimization problem; for general high dimensional problems, it converges R-linearly. Numerical results show the superior performance of the proposed method over the states of the art.

STO

Mon.2 H 0110

Stochastic Approximation and Reinforcement Learning (Part II)

Organizer: Alec Koppel
Chair: Alec Koppel

Stephen Tu, UC Berkeley (joint work with Benjamin Recht)
The Gap Between Model-Based and Model-Free Methods on the Linear Quadratic Regulator: An Asymptotic Viewpoint

We study the sample complexity of popular model-based and model-free algorithms on the Linear Quadratic Regulator (LQR). For policy evaluation, we show that a simple model-based plugin method requires asymptotically less samples than least-squares temporal difference (LSTD) to reach similar performance; the sample complexity gap between the two methods is at least a factor of state dimension. For simple problem instances, nominal (certainty equivalence principle) control requires several factors of state and input dimension fewer samples than policy gradient method for similar performance.

Hoi-To Wai, CUHK (joint work with Belhal Karimi, Błażej Miasojedow, Eric Moulines)
Non-asymptotic Rate for Biased Stochastic Approximation Scheme

In this talk, we analyze a general stochastic approximation scheme to minimize a non-convex, smooth objective function. We consider an update procedure whose drift term depends on a state-dependent Markov chain and the mean field is not necessarily of gradient type, therefore it is a biased SA scheme. Importantly, we provide the first non-asymptotic convergence rate under such dynamical setting. We illustrate these settings with the policy-gradient method for average reward maximization, highlighting its tradeoff in performance between the bias and variance.

Tue.1 10:30–11:45

APP

Tue.1 H 1012

Applications in Energy (Part I)
Chair: Bartosz Filipecki

Sauleh Siddiqui, Johns Hopkins University
Solving Problems with Equilibrium Constraints Applied to Energy Markets

We provide a method to obtain stationary points for mathematical and equilibrium problems with equilibrium constraints (MPECs and EPECs). The MPECs and EPECs considered have linear complementarity constraints at the lower level. Our approach is to express the MPEC and EPEC as a complementarity problem by decomposing the dual variables associated with the bilinear constraints, and using a nonlinear optimization over a polytope to find stationary points. We apply this method to the generic setting of energy markets that have operational and infrastructure decisions among many players.

Paolo Pisciella, NTNU-The Norwegian University of Science and Technology
A CGE model for analyzing the economic impacts of the Norwegian energy transition

We introduce a multi-regional dynamic Computable General Equilibrium model representing the Norwegian Economy with a particular focus on the energy system. The model is used to study the effects of macroeconomic policies aimed at decarbonizing the Norwegian economy, such as the reduction of the size of the oil industry, the introduction of carbon capture and storage in the gas industry as well as the introduction of a hydrogen industry and the transition of the transport sector to the usage of hydrogen and electricity to substitute conventional fossil fuels.

Bartosz Filipecki, TU Chemnitz (joint work with Christoph Helmberg)
Semidefinite programming approach to Optimal Power Flow with FACTS devices

Producing accurate and secure solutions to the Optimal Power Flow problem (OPF) becomes increasingly important due to rising demand and share of renewable energy sources. To this end, we consider an OPF model with additional decision variables associated with FACTS devices, such as phase-shifting transformers (PSTs) or thyristor-controlled series capacitors (TCSCs). We show, how a Lasserre hierarchy can be applied to this model. Finally, we provide results of numerical experiments on the resulting semidefinite programming (SDP) relaxation.

BIG

Tue.1 H 2013

The Interface of Generalization and Optimization in Machine Learning (Part II)
Organizers: Benjamin Recht, Mahdi Soltanolkotabi
Chair: Benjamin Recht

Lorenzo Rosasco, Universita' di Genova and MIT
Optimization for machine learning: from training to test error

The focus on optimization is a major trend in modern machine learning. In turn, a number of optimization solutions have been recently developed and motivated by machine learning applications. However, most optimization guarantees focus on the training error, ignoring the performance at test time which is the real goal in machine learning. In this talk, take steps to fill this gap in the context of least squares learning. We analyze the learning (test) performance of accelerated and stochastic gradient methods. In particular, we discuss the influence different learning assumptions.

Mahdi Soltanolkotabi, University of Southern California
Towards demystifying over-parameterization in deep learning

Many neural nets are trained in a regime where the parameters of the model exceed the size of the training dataset. Due to their over-parameterized nature these models have the capacity to (over)fit any set of labels including pure noise. Despite this high fitting capacity, somewhat paradoxically, models trained via first-order methods continue to predict well on yet unseen test data. In this talk I will discuss some results aimed at demystifying such phenomena by demonstrating that gradient methods achieve (1) global optima, (2) are robust to corruption, and (3) generalize to new test data.

Mikhail Belkin, Ohio State University
Interpolation and its implications

Classical statistics teaches the dangers of overfitting. Yet, in modern practice, deep networks that interpolate the data (have near zero training loss) show excellent test performance. In this talk I will show how classical and modern models can be reconciled within a single "double descent" risk curve, which extends the usual U-shaped bias-variance trade-off curve beyond the point of interpolation. This understanding of model performance delineates the limits of classical analyses and opens new lines of inquiry into generalization and optimization properties of models.

BIG

Tue.1 H 3004

Optimization Methods for Graph Analytics

Organizers: Kimon Fountoulakis, Di Wang
Chair: Kimon Fountoulakis

Nate Veldt, Cornell University
Metric-Constrained Linear Program Solvers for Graph Clustering Relaxations

We present a new approach for solving a class of convex relaxations for graph clustering objectives which involve triangle-inequality constraints. Many approximation algorithms for graph clustering rely on solving these metric-constrained optimization problems, but these are rarely implemented in practice due to extremely high memory requirements. We present a memory-efficient approach for solving these problems based on iterative projections methods. In practice we use our approach to address relaxations involving up to 2.9 trillion metric constraints.

Rasmus Kyng, ETH Zürich
Linear equations and optimization on graphs

Optimization on graphs is a powerful tool for understanding networks, for example we can use it to plan flows of good or data, or to understand network clusters. Second order methods are a powerful tool in optimization, but they require solving linear equations, making them slow. However, second order methods for graph optimization lead to structured linear equations, and we can use this structure to solve the linear equations much faster. We will see how to solve such linear equations, known as Laplacians, quickly both in theory and in practice.

Kimon Fountoulakis, University of Waterloo
Local Graph Clustering

Large-scale graphs consist of interesting small or medium-scale clusters. Existing approaches require touching the whole graph to find large clusters and they often fail to locate small and medium-scale clusters. In this talk we will analyze the performance of a local graph clustering approach, i.e., the ℓ_1-regularized PageRank model, on large-scale graphs with many small or medium-scale clusters. We will demonstrate average-case results for the ℓ_1-regularized PageRank model and we will show that proximal gradient descent finds the optimal number of non-zeros without touching the whole graph.

CON

Tue.1 H 0110

Hyperbolicity Cones and Spectrahedra (Part I)

Organizer: Markus Schweighofer
Chair: Markus Schweighofer

Daniel Plaumann, TU Dortmund University
Hyperbolicity cones and spectrahedra: Introduction

Spectrahedra are the domains of semidefinite programs, contained in the a priori larger class of hyperbolicity regions and hyperbolic programs. In recent years, a lot of research in optimization and real algebraic geometry has been devoted to understanding the relation between these concepts. We will give an overview, focussing on algebraic techniques and on duality.

Simone Naldi, Université de Limoges (joint work with Mario Kummer, Daniel Plaumann)
Spectrahedral representations of plane hyperbolic curves

We describe a new method for constructing a spectrahedral representation of the hyperbolicity region of a hyperbolic curve in the real projective plane. As a consequence, we show that if the curve is smooth and defined over the rational numbers, then there is a spectrahedral representation with rational matrices. This generalizes a classical construction for determinantal representations of plane curves due to Dixon and relies on the special properties of real hyperbolic curves that interlace the given curve.

Mario Kummer, TU Berlin (joint work with Rainer Sinn)
When is the conic hull of a curve a hyperbolicity cone?

Let C be a semi-algebraic curve in n-dimensional space. We will present obstructions and constructions for the conic hull of C to be a hyperbolicity cone. The tools we use are methods from complex and real algebraic geometry.

CON

Tue.1 H 2032

Methods for Sparse Polynomial Optimization

Organizers: Venkat Chandrasekaran, Riley Murray
Chair: Riley Murray

Henning Seidler, TU Berlin (joint work with Helena Müller, Timo de Wolff)

Improved Lower Bounds for Global Polynomial Optimization

In this article, we describe a new way to obtain a candidate for the global minimum of a multivariate polynomial, based on its SONC decomposition. Furthermore, we present a branch-and-bound algorithm to improve the lower bounds obtained by SONC/SAGE. Applying this approach to thousands of test cases, we mostly obtain small duality gaps. In particular, we optimally solve the global minimization problem in about 75% of the investigated cases.

Venkat Chandrasekaran, California Institute of Technology (Caltech)

Generalized SAGE Certificates for Constrained Polynomial Optimization

We describe a generalization of the SAGE polynomial cone for obtaining bounds on constrained polynomial optimization problems. Our approach leverages the fact that the SAGE signomial cone conveniently and transparently blends with convex duality. This result is extended to polynomials by the notion of a "signomial representative." Key properties of the original SAGE polynomial cone (e.g. sparsity preservation) are retained by this more general approach. We illustrate the utility of this methodology with a range of examples from the global polynomial optimization literature.

Jie Wang, Peking University (joint work with Haokun Li, Bican Xia)

Exploiting Term Sparsity in SOS Programming and Sparse Polynomial Optimization

We consider a new pattern of sparsity for SOS programming named cross sparsity patterns. A new sparse SOS algorithm is proposed by exploiting cross sparsity patterns, and is applied to unconstrained polynomial optimization problems. It is proved that the SOS decomposition obtained by the new algorithm is always a refinement of the block-diagonalization obtained by the sign-symmetry method. Various experiments show that the new algorithm dramatically saves the computational cost compared with existing tools and can handle some really huge polynomials.

CON

Tue.1 H 3006

Theoretical Aspects of Conic Programming

Organizers: Mituhiro Fukuda, Masakazu Muramatsu, Makoto Yamashita, Akiko Yoshise
Chair: Akiko Yoshise

Sunyoung Kim, Ewha Womans University (joint work with Masakazu Kojima, Kim-Chuan Toh)

Doubly nonnegative programs equivalent to completely positive reformulations of quadratic optimization problems with block clique structure

We exploit sparsity of the doubly nonnegative (DNN) relaxation and the completely positive (CPP) reformulation via the CPP and DNN matrix completion. The equivalence between the CPP and DNN relaxation is established under the assumption that the sparsity of the CPP relaxation is represented with block clique graphs with the maximal clique size at most 4. We also show that a block diagonal QOP with the maximal clique of size 3 over the standard simplex can be reduced to a QOP whose optimal value can be exactly computed by the DNN relaxation.

Natsuki Okamura, The University of Electro-Communications (joint work with Bruno Figueira Lourenço, Masakazu Muramatsu)

Solving SDP by projection and rescaling algorithms

Recently, Lourenco et al. proposed an extension of Chubanov's projection and rescaling algorithm for symmetric cone programming. Muramatsu et al. also proposed an oracle-based projection and rescaling algorithm for semi-infinite programming. Both projection and rescaling algorithms can naturally deal with semidefinite programming. We implemented both algorithms in MATLAB and numerically compare them.

Makoto Yamashita, Tokyo Institute of Technology (joint work with Mituhiro Fukuda, Sunyoung Kim, Takashi Nakagaki)

A dual spectral projected gradient method for log-determinant semidefinite problems

In this talk, we discuss a spectral projected gradient (SPG) method designed for the dual problem of a log-determinant semidefinite problems (SDPs) with general linear constraints. The feasible region of the dual problem is an intersection of a box-constrained set and a linear matrix inequality. In contrast to a simple SPG that employs a single projection onto the intersection, the proposed method utilizes the structure of two projections for the two sets. Numerical results on randomly generated synthetic/deterministic data and gene expression data show the efficacy of the proposed method.

CNV

Tue.1 H 1028

Recent Advances of Nonsmooth Optimization
Organizer: Guoyin Li
Chair: Guoyin Li

Boris Mordukhovich, Department of Mathematics, Wayne State University (joint work with Ebrahim Sarabi)
Superlinear Convergence of SQP Methods in Conic Programming

In this talk we present applications of second-order variational analysis and generalized differentiation to establish the superlinear convergence of SQP methods for general problems of conic programming. For the basic SQP method, the primal-dual superlinear convergence is derived under an appropriate second-order condition and some stability/calmness property, which automatically holds for nonlinear programs. For the quasi-Newton SQP methods, the primal superlinear convergence is obtained under the Dennis-More condition for constrained optimization.

Jingwei Liang, University of Cambridge (joint work with Clarice Poon)
Geometry Based Acceleration for Non-smooth Optimisation

In this talk, we will present a geometry based adaptive acceleration framework for speeding up first-order methods when applied to non-smooth optimisation. Such a framework can render algorithms which are able to automatically adjust themselves to the underlying geometry of the optimisation problems and the structure of the first-order methods. State-of-the-art performances are obtained on various non-smooth optimisation problems and first-order methods, particularly the non-descent type methods.

Guoyin Li, University of New South Wales, Australia
Splitting methods for convex and nonconvex feasibility problems

Splitting methods is a class of important and widely used approach for solving feasibility problems. The behaviour of these methods has been reasonably understood in the convex setting. They have been further successfully applied to various nonconvex instances recently; while the theoretical justification in this latter setting is far from complete. We will examine global convergence of several popular splitting methods (including Douglas-Rachford and Peaceman Rachford splitting method) for general nonconvex nonsmooth optimization problems.

CNV

Tue.1 H 1029

Recent Advances in First-Order Methods for Constrained Optimization and Related Problems (Part III)
Organizers: Ion Necoara, Quoc Tran-Dinh
Chair: Quoc Tran-Dinh

Masaru Ito, Nihon University (joint work with Mituhiro Fukuda)
Nearly optimal first-order method under Hölderian error bound: An adaptive proximal point approach

We develop a first-order method for convex composite optimization problem under the Hölderian Error Bound (HEB) condition which is closely related to the Kurdyka-Łojasiewicz inequality and arises in many applications. The proposed method does not require the prior knowledge on the HEB condition, due to an adaptive proximal point approach. We prove the near optimality of the proposed method in view of the iteration complexity with respect to two kinds of approximation error: the objective function value and the norm of the (generalized) gradient.

Vien Van Mai, KTH Royal Institue of Technology (joint work with Mikael Johansson)
Anderson Acceleration for Constrained Convex Optimization

This paper introduces a novel technique for nonlinear acceleration of 1st-order methods for constrained convex optimization. Previous studies of nonlinear acceleration have only been able to provide convergence guarantees for unconstrained problems. We focus on Anderson acceleration of the projected gradient descent method, but our techniques can easily be extended to more sophisticated algorithms, such as mirror descent. We show that the convergence results for Anderson acceleration of smooth fixed-point iterations can be extended to the non-smooth case under certain technical conditions.

Tuomo Valkonen, Escuela Politécnica Nacional (joint work with Christian Clason, Stanislav Mazurenko)
Primal-dual proximal splitting and generalized conjugation in non-smooth non-convex optimization

We demonstrate that difficult non-convex non-smooth optimization problems, including Nash equilibrium problems and Potts segmentation, can be written using generalized conjugates of convex functionals. We then show through detailed convergence analysis that a conceptually straightforward extension of the primal-dual method of Chambolle and Pock is applicable to such problems. Under sufficient growth conditions we even demonstrate local linear convergence of the method. We illustrate these theoretical results numerically on the aforementioned example problems. (arXiv:1901.02746)

DER

Tue.1 H 2038

Derivative-Free Optimization Under Uncertainty (Part I)

Organizers: Ana Luisa Custodio, Sébastien Le Digabel, Margherita Porcelli, Francesco Rinaldi, Stefan Wild
Chair: Stefan Wild

Matt Menickelly, Argonne National Laboratory (joint work with Stefan Wild)

Formulations and Methods for Derivative-Free Optimization Under Uncertainty

In this talk, we will discuss progress made in the incorporation of derivative-free techniques into various paradigms of optimization under uncertainty. In particular, we will consider a novel outer approximations method for derivative-free robust optimization with particular application to so-called implementation error problems. We will also investigate the application of a particular derivative-free method for nonsmooth optimization (manifold sampling) to robust data-fitting of least trimmed estimators, as well to a feasibility restoration procedure for chance-constrained optimization.

Zaikun Zhang, Hong Kong Polytechnic University (joint work with Serge Gratton, Luis Nunes Vicente)

Trust region methods based on inexact gradient information

We discuss the behavior of trust-region method assuming the objective function is smooth yet the gradient information available is inaccurate. We show trust-region method is quite robust with respect to gradient inaccuracy. It converges even if the gradient is evaluated with only one correct significant digit and encounters random failures with a positive probability. The worst case complexity of the method is essentially the same as when the gradient evaluation is accurate.

Morteza Kimiaei, University of Vienna (joint work with Arnold Neumaier)

Efficient black box optimization with complexity guarantees

I'll report on recent joint work with Morteza Kimiaei on derivative-free unconstrained optimization algorithms that both have high quality complexity guarantees for finding a local minimizer and perform highly competitive with state-of-the-art derivative-free solvers.

MUL

Tue.1 H 3013

Recent Developments in Set Optimization (Part I)

Organizers: Akhtar A. Khan, Elisabeth Köbis, Christiane Tammer
Chair: Akhtar A. Khan

Niklas Hebestreit, Martin-Luther-University Halle-Wittenberg (joint work with Akhtar A. Khan, Elisabeth Köbis, Christiane Tammer)

Existence Theorems and Regularization Methods for Non-coercive Vector Variational and Vector Quasi-Variational Inequalities

In this talk, we present a novel existence result for vector variational inequalities. Since these problems are ill-posed in general, we propose a regularization technique for non-coercive problems which allows to derive existence statements even when the common coercivity conditions in the literature do not hold. For this purpose, we replace our original problem by a family of well-behaving problems and study their relationships. Moreover, we apply our results to generalized vector variational inequalities, multi-objective optimization problems and vector quasi-variational inequalities.

Baasansuren Jadamba, Rochester Institute of Technology

Optimization Based Approaches for the Inverse Problem of Identifying Tumors

This talk focuses on the inverse problem of parameter identification in an incompressible linear elasticity system. Optimization formulations for the inverse problem, a stable identification process using regularization, as well as optimality conditions, will be presented. Results of numerical simulations using synthetic data will be shown.

Ernest Quintana, Martin Luther University Halle-Wittenberg (joint work with Gemayqzel Bouza, Christiane Tammer, Anh Tuan Vu)

Fermat's Rule for Set Optimization with Set Relations

In this talk, we consider Set Optimization problems with respect to the set approach. Specifically, we deal with the lower less and the upper less relations. Under convexity and Lipschitz properties of the set valued objective map, we derive corresponding properties for suitable scalarizing functionals. We then obtain upper estimates for Clarke's subdifferential of these functionals. As a consequence of the scalarization approach, we show a Fermat's rule for this class of problems. Ideas for a descent method are also discussed.

NON

Tue.1 H 0105

Nonlinear and Stochastic Optimization (Part III)

Organizers: Albert Berahas, Geovani Grapiglia
Chair: Albert Berahas

Clément Royer, University of Wisconsin-Madison (joint work with Michael O'Neill, Stephen Wright)

Complexity guarantees for practical second-order algorithms

We discuss methods for smooth unconstrained optimization that converge to approximate second-order necessary points with guaranteed complexity. These methods perform line searches along two different types of directions, approximate Newton directions and negative curvature directions for the Hessian. They require evaluations of functions, gradients, and products of the Hessian with an arbitrary vector. The methods have good practical performance on general problems as well as best-in-class complexity guarantees.

Katya Scheinberg, Cornell University

New effective nonconvex approximations to expected risk minimization

In this talk we will present novel approach to empirical risk minimization. We will show that in the case of linear predictors, the expected error and the expected ranking loss can be effectively approximated by smooth functions whose closed form expressions and those of their first (and second) order derivatives depend on the first and second moments of the data distribution, which can be precomputed. This results in a surprisingly effective approach to linear classification. We compare our method to the state-of-the-art approaches such as logistic regression.

Daniel Robinson, Lehigh University

Accelerated Methods for Problems with Group Sparsity

I discuss an optimization framework for solving problems with sparsity inducing regularization. Such regularizers include Lasso (L^1), group Lasso, and latent group Lasso. The framework computes iterates by optimizing over small dimensional subspaces, thus keeping the cost per iteration relatively low. Theoretical convergence results and numerical tests on various learning problems will be presented.

NON

Tue.1 H 2053

Nonconvex Optimization

Organizers: Asuman Ozdaglar, Nuri Vanli
Chair: Nuri Vanli

Adel Javanmard, University of Southern California

Analysis of a Two-Layer Neural Network via Displacement Convexity

We consider the problem of learning a concave function defined on a compact set, using linear combinations of "bump-like" components. The resulting empirical risk minimization problem is highly non-convex. We prove that, in the limit in which the number of neurons diverges, the evolution of gradient descent converges to a Wasserstein gradient flow in the space of probability distributions. Also, the behavior of this gradient flow can be described by a viscous porous medium equation. Using Displacement Convexity property, we get exponential dimension-free convergence rate for gradient descent.

Murat Erdogdu, University of Toronto

Global Non-convex Optimization with Discretized Diffusions

An Euler discretization of the Langevin diffusion is known to converge to the global minimizers of certain convex and non-convex optimization problems. We show that this property holds for any suitably smooth diffusion and that different diffusions are suitable for optimizing different classes of convex and non-convex functions. This allows us to design diffusions suitable for globally optimizing convex and non-convex functions not covered by the existing Langevin theory. Our non-asymptotic analysis delivers computable optimization and integration error bounds.

Nuri Vanli, Massachusetts Institute of Technology (joint work with Murat Erdogdu, Asuman Ozdaglar, Pablo Parrilo)

Block-Coordinate Maximization Algorithm to Solve Large SDPs with Burer-Monteiro Factorization

Semidefinite programming (SDP) with diagonal constraints arise in many optimization and machine learning problems, such as Max-Cut, community detection and group synchronization. Although SDPs can be solved to arbitrary precision in polynomial time, generic convex solvers do not scale well with the dimension of the problem. In order to address this issue, Burer and Monteiro proposed to reduce the dimension of the problem by appealing to a low-rank factorization, and solve the subsequent non-convex problem instead. In this paper, we present coordinate ascent based methods to solve this non-convex problem with provable convergence guarantees. In particular, we prove that the block-coordinate maximization algorithm applied to the non-convex Burer-Monteiro approach globally converges to a first-order stationary point with a sublinear rate without any assumptions on the problem. We also show that the block-coordinate maximization algorithm is locally linearly convergent to a local maximum under local weak strong concavity assumption. We establish that this assumption generically holds when the rank of the factorization is sufficiently large. Furthermore, we propose an algorithm based on the block-coordinate maximization and Lanczos methods that is guaranteed to return a solution that provide $1-O(1/r)$ approximation to the original SDP, where r is the rank of the factorization, and we quantify the number of iterations to obtain such a solution. This approximation ratio is known to be optimal under the unique games conjecture.

NON

Tue.1 H 3025

Advances in Nonlinear Optimization With Applications (Part I)

Organizers: Yu-Hong Dai, Deren Han
Chair: Yu-Hong Dai

Zhi-Long Dong, Xi'an Jiaotong University (joint work with Yu-Hong Dai, Fengmin Xu)

Fast algorithms for large scale portfolio selection considering industries and investment styles

In this talk, we consider a large scale portfolio selection problem with and without a sparsity constraint. Neutral constraints on industries are included as well as investment styles. To develop fast algorithms for the use in the real financial market, we shall expose the special structure of the problem, whose Hessian is the summation of a diagonal matrix and a low rank modification. Complexity of the algorithms are analyzed. Extensive numerical experiments are conducted, which demonstrate the efficiency of the proposed algorithms compared with some state-of-the-art solvers.

Xinxin Li, Jilin University (joint work with Ting Kei Pong, Hao Sun, Henry Wolkowicz)

A Strictly Contractive Peaceman-Rachford Splitting Method for the Doubly Nonnegative Relaxation of the Minimum Cut Problem

The minimum cut problem, MC, consists in partitioning the set of nodes of a graph G into k subsets of given sizes in order to minimize the number of edges cut after removing the k-th set. Previous work on this topic uses eigenvalue, semidefinite programming, SDP, and doubly non-negative bounds, DNN, with the latter giving very good, but expensive, bounds. We propose a method based on the strictly contractive Peaceman-Rachford splitting method, which can obtain the DNN bound efficiently when used in combination with regularization from facial reduction, FR. The FR allows for a natural splitting of variables in order to apply inexpensive constraints and include redundant constraints. Numerical results on random data sets and vertex separator problems show efficiency and robustness of the proposed method.

Yu-Hong Dai, Chinese Academy of Sciences

Training GANs with Centripetal Acceleration

The training of generative adversarial networks suffers from cyclic behaviours. In this paper, from the simple intuition that the direction of ventripetal acceletation of an object moving in uniform circular motion is toward the center of the circle, we present simultaneous and alternating centripetal acceleration methods to alleviate the cyclic behaviours. We conduct nymerical simulations to test the effectivenes and efficiency compared with several other methods.

PLA

Tue.1 H 3002

Optimization Applications in Mathematics of Planet Earth - Contributed Session

Chair: Maha H. Kaouri

Sophy Oliver, University of Oxford (joint work with Coralia Cartis, Samar Khatiwala)

Ocean Biogeochemical Optimization in Earth System Models

Ocean biogeochemical models used in climate change predictions are very computationally expensive and heavily parameterised. With derivatives too costly to compute, we optimise the parameters within one such model using derivative-free algorithms with the aim of finding a good optimum in the fewest possible function evaluations. We compare the performance of the evolutionary algorithm CMA-ES which is a stochastic global optimization method requiring more function evaluations, to the Py-BOBYQA and DFO-LS algorithms which are local derivative-free solvers requiring fewer evaluations.

Maha H. Kaouri, University of Reading (joint work with Coralia Cartis, Amos S. Lawless, Nancy K. Nichols)

Globally convergent least-squares optimisation methods for variational data assimilation

The variational data assimilation (VarDA) problem is usually solved using a method equivalent to Gauss-Newton (GN) to obtain the initial conditions for a numerical weather forecast. However, GN is not globally convergent and if poorly initialised, may diverge such as when a long time window is used in VarDA; a desirable feature that allows the use of more satellite data. To overcome this, we apply two globally convergent GN variants (line search & regularisation) to the long window VarDA problem and show when they locate a more accurate solution versus GN within the time and cost available.

PDE

Tue.1 H 0106

Computational Design Optimization (Part I)
Organizers: Martin Siebenborn, Kathrin Welker
Chair: Kathrin Welker

Eddie Wadbro, Umeå University (joint work with Bin Niu)
Multi-scale design of coated structures with periodic infill

We apply a multi-scale topology optimization method to design an infill structure, which has a solid outer shell, or coating, and a periodic infill pattern. Harmonic-mean based non-linear filters realize length scale control on both the overall macrostructure and the infill design on the microscale. The design optimization of the infill lattice is performed simultaneously with the optimization of the macroscale structure, which also includes the coating.

Johannes Haubner, (joint work with Michael Ulbrich)
Numerical realization of shape optimization for unsteady fluid-structure interaction

We consider shape optimization for unsteady fluid-structure interaction problems that couple the Navier–Stokes equations with non-linear elasticity equations. We focus on the monolithic approach in the ALE framework. Shape optimization by the method of mappings approach yields an optimal control setting and therefore can be used to drive an optimization algorithm with adjoint based gradient computation. The continuous formulation of the problem and the numerical realization are discussed. Numerical results for our implementation, which builds on FEniCS, dolfin-adjoint and IPOPT are presented.

Kevin Sturm, TU Wien, Institut für Analysis and Scientific Computing (joint work with Peter Gangl)
Shape and Topology Optimization subject to 3D Nonlinear Magnetostatics – Part I: Sensitivity Analysis

We present shape and topological sensitivities for a 3D nonlinear magnetostatic model of an electric motor. In order to derive the sensitivities, we use a Lagrangian approach, which allows us to simplify the derivation under realistic physical assumptions. The topological derivative for this quasilinear problem involves the solution of two transmission problems on the unbounded domain for each point of evaluation.

PDE

Tue.1 H 0107

Optimal Control and Dynamical Systems (Part I)
Organizers: Cristopher Hermosilla, Michele Palladino
Chair: Cristopher Hermosilla

Teresa Scarinci, University of Vienna
Primal-dual forward-backward methods for PDE-constrained optimization

In this talk we investigate some direct methods to solve a class of optimization problems in a Hilbert space framework. In particular, we discuss some methods based on proximal splitting techinques and propose some applications to PDE-constrained optimization. We conclude the talk with a discussion about stochastic methods for problems with random data, numerical simulations, and some future research directions. The talk is based on a joint work with Caroline Geiersbach.

Karla Cortez, Faculdade de Engenharia da Universidade do Porto (joint work with Maria do Rosário de Pinho)
Applications for Multiprocesses to Optimal path planning of AUVs under currents

We formulate the path planning of AUVs under currents as a free end time multiprocess optimal control problem with state constraints. Reformulating it as a fixed time problem, we derive first order necessary conditions in the form of a maximum principle. The notable feature of this result is that it covers the case when the time spent in an intermediate system is reduced to zero. It also provides us with the tools to design codes to solve the problem numerically and extract information on the optimal solution and its multipliers to partially validate the numerical findings.

Dante Kalise, University of Nottingham
Robust optimal feedback control through high-dimensional Hamilton-Jacobi-Isaacs equations

We propose a numerical scheme for the approximation of high-dimensional, nonlinear Isaacs PDEs arising in robust optimal feedback control of nonlinear dynamics. The numerical method consists of a global polynomial ansatz together separability assumptions for the calculation of high-dimensional integrals. The resulting Galerkin residual equation is solved by means of an alternating Newton-type/policy iteration method for differential games. We present numerical experiments illustrating the applicability of our approach in robust optimal control of nonlinear parabolic PDEs.

PDE

Tue.1 H 0112

Infinite-Dimensional Optimization of Nonlinear Systems (Part III)

Organizers: Fredi Tröltzsch, Irwin Yousept
Chair: Irwin Yousept

Matthias Heinkenschloss, Rice University
ADMM based preconditioners for time-dependent optimization problems

The Alternating Direction Method of Multipliers (ADMM) can be applied to time-decomposition formulations of optimal control problems to exploit parallelism. However, ADMM alone converges slowly and the subproblem solves, while done in parallel, are relatively expensive. Instead ADMM is used as a preconditioner. This approach inherits parallelism, but reduces the number of iterations and allows coarser subproblems solves. Approach, theoretical and numerical results will be presented.

Moritz Ebeling-Rump, Weierstrass Institute for Applied Analysis and Stochastics (WIAS)
Topology Optimization subject to Additive Manufacturing Constraints

In Topology Optimization the goal is to find the ideal material distribution in a domain subject to external forces. The structure is optimal if it has the highest possible stiffness. A volume constraint ensures filigree structures, which are controlled via a Ginzburg-Landau term. During 3D Printing overhangs lead to instabilities, which have only been tackled unsatisfactorily. The novel idea is to incorporate an Additive Manufacturing Constraint into the phase field method. Stability during 3D Printing is assured, which solves a common additive manufacturing problem.

Dietmar Hömberg, Weierstrass Institute (joint work with Manuel Arenas, Robert Lasarzik)
Optimal pre-heating strategies for the flame cutting of steel plates

We consider a mathematical model for the flame cutting of steel. It is known that for high-strength steel grades this technology is prone to develop cracks at the cutting surface. To mitigate this effect new strategies for inductive pre-heating have been investigated within the European Industrial Doctorate project "MIMESIS – Mathematics and Materials Science for Steel Production and Manufacturing". In the talk we formulate a quasi-stationary optimal control problem for this problem, derive the optimality system and discuss preliminary numerical results.

ROB

Tue.1 H 1058

Models and Algorithms for Dynamic Decision Making Under Uncertainty

Organizer: Man-Chung Yue
Chair: Man-Chung Yue

Kilian Schindler, EPFL (joint work with Daniel Kuhn, Napat Rujeerapaiboon, Wolfram Wiesemann)
A Day-Ahead Decision Rule Method for Multi-Market Multi-Reservoir Management

Peak/off-peak spreads in European electricity spot markets are eroding due to the nuclear phaseout and the recent growth in photovoltaic capacity. The reduced profitability of peak/off-peak arbitrage forces hydropower producers to participate in the reserve markets. We propose a two-layer stochastic programming framework for the optimal operation of a multi-reservoir hydropower plant which sells energy on both the spot and the reserve markets. The backbone of this approach is a combination of decomposition and decision rule techniques. Numerical experiments demonstrate its effectiveness.

Cagil Kocyigit, École polytechnique fédérale de Lausanne (joint work with Daniel Kuhn, Napat Rujeerapaiboon)
A Two-Layer Multi-Armed Bandit Approach for Online Multi-Item Pricing

The revenue-maximizing mechanism for selling I items to a buyer with additive and independent values is unknown, but the better of separate item pricing and grand-bundle pricing extracts a constant fraction of the optimal revenue. We study an online version of this pricing problem, where the items are sold to (each of) T identical and independent buyers arriving sequentially. We propose a two-layer multi-armed bandit algorithm that is reminiscent of the UCB algorithm and offers an asymptotic constant-factor approximation guarantee relative to the (unknown) best offline mechanism.

Daniel Kuhn, EPFL (joint work with Peyman Mohajerin Esfahani, Viet Anh Nguyen, Soroosh Shafieezadeh Abadeh)
On the Connection between Chebyshev and Wasserstein Ambiguity Sets in Distributionally Robust Optimization

Existing tractability results for distributionally robust optimization problems with Wasserstein ambiguity sets require the nominal distribution to be discrete. In this talk we derive tractable conservative approximations for problems with continuous nominal distributions by embedding Wasserstein ambiguity sets into larger Chebyshev ambiguity sets. We identify interesting situations in which these approximations are exact.

ROB

Tue.1 H 3012

Advances in Modeling Uncertainty via Budget-Constrained Uncertainty Sets in Robust and Distributionally Robust Optimization

Organizer: Karthyek Murthy
Chair: Karthyek Murthy

Bradley Sturt, Massachusetts Institute of Technology (joint work with Dimitris Bertsimas, Shimrit Shtern)

A Data-Driven Approach for Multi-Stage Linear Optimization

We propose a novel data-driven framework for multi-stage stochastic linear optimization where uncertainty is correlated across stages. The proposed framework optimizes decision rules by averaging over historical sample paths, and to avoid overfitting, each sample path is slightly perturbed by an adversary. We show that this new framework is asymptotically optimal (even if uncertainty is arbitrarily correlated across stages) and can be tractably approximated using techniques from robust optimization. We also present new results and limitations of possible Wasserstein alternatives.

Omar El Housni, Columbia University (joint work with Vineet Goyal)

On the Optimality of Affine Policies for Budgeted Uncertainty Sets

We study the performance of affine policies for two-stage adjustable robust optimization problem under budget of uncertainty sets. This problem is hard to approximate within a factor better than $\Omega(\log n/\log\log n)$ where n is the number of decision variables. We show that surprisingly affine policies provide the optimal approximation for this class of uncertainty sets that matches the hardness of approximation; thereby, further confirming the power of affine policies. Our analysis also gives a significantly faster algorithm to compute near-optimal affine policies.

Rui Gao, University of Texas at Austin

Wasserstein distributionally robust optimization and statistical learning

In this talk, we consider a framework, called Wasserstein distributionally robust optimization, that aims to find a solution that hedges against a set of distributions that are close to some nominal distribution in Wasserstein metric. We will discuss the connection between this framework and regularization problems in statistical learning, and study its generalization error bound.

SPA

Tue.1 H 3007

Methods and Theory for Nonconvex Optimization

Organizer: Nadav Hallak
Chair: Nadav Hallak

Armin Eftekhari, EPFL

Non-Convex Augmented Lagrangian Method for Learning and Inference

We present efficient ALM and ADMM variants for solving nonconvex optimization problems, with local sublinear convergence rates. We show how the ubiquitous Slater's condition in convex optimization gives its place to a geometric condition, reminiscent of the Mangasarian-Fromovitz constraint qualification. We apply these new algorithms to a variety of applications, including clustering, generalized eigenvalue decomposition, and even robustness in deep nets. We will also show improved linear rates can be obtained using the concepts of restricted strong convexity and smoothness.

Peter Ochs, Saarland University

Model Function Based Conditional Gradient Method with Armijo-like Line Search

The Conditional Gradient Method is generalized to a class of non-smooth non-convex optimization problems with many applications in machine learning. The proposed algorithm iterates by minimizing so-called model functions over the constraint set. As special cases of the abstract framework, for example, we develop an algorithm for additive composite problems and an algorithm for non-linear composite problems which leads to a Gauss-Newton-type algorithm. Moreover, the framework yields a hybrid version of Conditional Gradient and Proximal Minimization schemes for free.

Nadav Hallak, Tel Aviv University (joint work with Marc Teboulle)

Convergence to Second-Order Stationary Points: A Feasible Direction Approach

We focus on nonconvex problems minimizing a smooth nonconvex objective over a closed convex set. Finding second-order stationary points for this class of problems is usually a hard task. Relying on basic and fundamental feasible descent ideas, this talk presents a surprisingly simple second order feasible directions scheme for computing such points, with proven theoretical convergence guarantees (to second order stationarity) under mild assumptions. (Numerical examples illustrate the practicability of the proposed method for nonconvex problems.)

STO

Tue.1 H 0104

Stochastic Approximation and Reinforcement Learning (Part III)

Organizer: Alec Koppel
Chair: Alec Koppel

Andrzej Ruszczynski, Rutgers University (joint work with Saeed Ghadimi, Mengdi Wang)

A Single Time-scale Stochastic Approximation Method for Nested Stochastic Optimization

We propose a new stochastic approximation algorithm to find an approximate stationary point of a constrained nested stochastic optimization. The algorithm has two auxiliary averaged sequences (filters) which estimate the gradient of the composite objective function and the inner function value. By using a special Lyapunov function, we show the sample complexity of $O(1/\epsilon^2)$ for finding an ϵ-approximate stationary point, thus outperforming all extant methods for nested stochastic approximation. We discuss applications to stochastic equilibria and learning in dynamical systems

Vivak Patel, University of Wisconsin-Madison

Using Statistical Filters for Stochastic Optimization

Stochastic optimization methods fall into three general paradigms: the Monte-Carlo (MC)/Sample Average Approximation (SAA) approach, the Bayesian Optimization (BO) approach, and the Stochastic Approximation (SA) approach. While these paradigms enjoy strong theoretical support, these methods are often not always practical for well-documented reasons. In this talk, we introduce a fourth paradigm for solving such optimization problems using statistical filters.

Angeliki Kamoutsi, ETH Zürich (joint work with John Lygeros, Tobias Sutter)

Randomized methods and PAC bounds for data-driven inverse stochastic optimal control

This work studies discrete-time Markov decision processes (MDPs) with continuous state and action spaces and addresses the inverse problem of inferring a cost function from observed optimal behavior. We propose a method that avoids solving repeatedly the forward problem and at the same time provides probabilistic performance guarantees on the quality of the recovered solution. Our approach is based on the LP formulation of MDPs, complementary slackness optimality conditions, recent developments in convex randomized optimization and uniform finite sample bounds from statistical learning theory.

Tue.2 13:15–14:30

Tue.2 13:15–14:30

APP

Tue.2 H 1012

Applications in Energy (Part II)
Chair: Kristina Janzen

Felipe Atenas, University of Chile (joint work with Claudia Sagastizábal)
Planning Energy Investment under Uncertainty

We consider risk-averse stochastic programming models for the Generation and Expansion Planning problem for energy systems with here-and-now investment decisions and generation variables of recourse. The resulting problem is coupled both along scenarios and along power plants. To achieve decomposition, we combine the Progressive Hedging algorithm to deal with scenario separability, and an inexact proximal bundle method to handle separability for different power plants in each scenario subproblem. By suitably combining these approaches, a solution to the original problem is obtained.

Gopika Geetha Jayadev, University of Texas at Austin (joint work with Erhan Kutanoglu, Benjamin Leibowicz)
U.S. Energy Infrastructure Of The Future: Electricity Capacity Planning Through 2050

We develop a large-scale linear programming framework that optimizes long-term capacity investment decisions and operational schedules for energy supply and end-use technologies. Our methodology extends an energy-economic modeling framework that simultaneously optimizes generation investments, the locations of these investments as well as the underlying transmission network linking generation facilities to different demand regions. We study the evolution of technology mix and transmission infrastructure for the US electricity market over the span of 2016-2050.

Kristina Janzen, TU Darmstadt (joint work with Stefan Ulbrich)
Cost-optimal design of decentralized energy networks with coupling of electricity, gas and heat networks including renewable energies

The optimal design of energy networks is a decisive prerequisite for the realization of future decentralized supply structures including renewable energy. The different energy carriers must be planned simultaneously with regard to generation and load conditions. Our aim is to minimize the costs of the various acquisition opportunities, while satisfying the heat and power demands. The design decisions and the detailed description of the flow dynamics within each network result in a mixed integer nonconvex optimization problem. Furthermore numerical results for different instances are presented.

BIG

Tue.2 H 2013

Optimization for Data Science (Part II)
Organizers: Ying Cui, Jong-Shi Pang
Chair: Jong-Shi Pang

Kim-Chuan Toh, National University of Singapore (joint work with Xudong Li, Defeng Sun)
An asymptotically superlinear convergent semismooth Newton augmented Lagrangian method for LP

Powerful interior-point methods (IPM) based commercial solvers have been hugely successful in solving large-scale linear programming problems. Unfortunately, the natural remedy, although can avoid the explicit computation of the coefficient matrix and its factorization, are not practically viable due to the inherent extreme ill-conditioning of the large scale normal equation arising in each interior-point iteration. To provide a better alternative choice for solving large scale LPs with dense data, we propose a semismooth Newton based inexact proximal augmented Lagrangian method.

Zhengling Qi, The George Washington University (joint work with Yufeng Liu, Jong-Shi Pang)
Learning Optimal Individualized Decision Rules with Risk Control

With the emergence of precision medicine, estimation of optimal individualized decision rules (IDRs) has attracted tremendous attentions in many scientific areas. Motivated by complex decision making procedures and the popular conditional value at risk, we propose a robust criterion to evaluate IDRs to control the lower tails of each subject's outcome. The resulting optimal IDRs are robust in controlling adverse events. The related nonconvex optimization algorithm will be discussed. Finally, I will present some optimization challenges about learning optimal IDRs in the observational studies.

Meisam Razaviyayn, University of Southern California
First and Second Order Nash Equilibria of Non-Convex Min-Max Games: Existence and Computation

Recent applications that arise in machine learning have surged significant interest in solving min-max saddle point games. While this problem has been extensively studied in the convex-concave regime, our understanding of non-convex case is very limited. In this talk, we discuss existence and computation of first and second order Nash Equilibria of such games in the non-convex regime. Then, we see applications of our theory in training Generative Adversarial Networks.

BIG

Tue.2 H 3004

Recent Advances in Algorithms for Large-Scale Structured Nonsmooth Optimization (Part I)

Organizer: Xudong Li
Chair: Xudong Li

Yangjing Zhang, National University of Singapore (joint work with Defeng Sun, Kim-Chuan Toh, Ning Zhang)

An Efficient Linearly Convergent Regularized Proximal Point Algorithm for Fused Multiple Graphical Lasso Problems

This paper focuses on the fused multiple graphical Lasso model. For solving the model, we develop an efficient regularized proximal point algorithm, where the subproblem in each iteration of the algorithm is solved by a superlinearly convergent semismooth Newton method. To implement the method, we derive an explicit expression for the generalized Jacobian of the proximal mapping of the fused multiple graphical Lasso regularizer. Our approach has exploited the underlying second order information. The efficiency and robustness of our proposed algorithm are shown by numerical experiments.

Xin-Yee Lam, National University of Singapore (joint work with Defeng Sun, Kim-Chuan Toh)

A semi-proximal augmented Lagrangian based decomposition method for primal block angular convex composite quadratic conic programming problems

We propose a semi-proximal augmented Lagrangian based decomposition method for convex composite quadratic conic programming problems with primal block angular structures. Using our algorithmic framework, we are able to naturally derive several well-known augmented Lagrangian based decomposition methods for stochastic programming such as the diagonal quadratic approximation method of Mulvey and Ruszczynski. We also propose a semi-proximal symmetric Gauss-Seidel based alternating direction method of multipliers for solving the corresponding dual problem.

Lei Yang, National University of Singapore (joint work with Jia Li, Defeng Sun, Kim-Chuan Toh)

A Fast Globally Linearly Convergent Algorithm for the Computation of Wasserstein Barycenters

In this talk, we consider the problem of computing a Wasserstein barycenter for a set of discrete distributions with finite supports. When the supports in the barycenter are prespecified, this problem is essentially a large-scale linear programming (LP). To handle this LP, we derive its dual problem and adapt a symmetric Gauss-Seidel based ADMM. The global linear convergence rate is also given without any condition. All subproblems involved can be solved exactly and efficiently. Numerical experiments show that our method is more efficient than two existing representative methods and Gurobi.

CON

Tue.2 H 0110

Hyperbolicity Cones and Spectrahedra (Part II)

Organizer: Markus Schweighofer
Chair: Markus Schweighofer

Rainer Sinn, Freie Universität Berlin (joint work with Daniel Plaumann, Stephan Weis)

Kippenhahn's Theorem in higher dimensions

Kippenhahn's Theorem relates the numerical range of a complex square matrix to a hyperbolic plane curve via convex duality. We will discuss this result and its generalization to higher dimensions (which goes by the name of joint numerical ranges of a sequence of hermitian matrices) from the point of view of convex algebraic geometry.

Markus Schweighofer, Universität Konstanz

Spectrahedral relaxations of hyperbolicity cones

We present a new small spectrahedral relaxation of hyperbolicity cones that relies on the Helton-Vinnikov theorem and exhibit certain cases where it is exact.

CON

Tue.2 H 2032

Signomial Optimization and Log-Log Convexity

Organizers: Venkat Chandrasekaran, Riley Murray
Chair: Venkat Chandrasekaran

Berk Ozturk, Massachusetts Institute of Technology
Methods and applications for signomial programming in engineering design

In this talk we motivate further research in signomial programming (SP) for the solution of conceptual engineering design problems. We use examples from aerospace engineering, from aircraft design to network design and control, to demonstrate the modeling capabilities and solution quality of SPs, and identify areas for future work. We introduce GPkit, a toolkit that provides abstractions, modeling tools and solution methods to use SPs to explore complex tradespaces. Additionally, we present methods to solve SPs under uncertainty, called robust SPs, to trade off risk and performance.

Riley Murray, Caltech (joint work with Venkat Chandrasekaran, Adam Wierman)
Solving Signomial Programs with SAGE Certificates and Partial Dualization

We show how SAGE nonnegativity certificates are compatible with a technique known as partial dualization, whereby computationally tractable constraints are incorporated into a dual problem without being moved to the Lagrangian. We consider the resulting "generalized SAGE cone" as it pertains to signomial programming (SP). Matters such as coordinate system invariance, sparsity preservation, and error bounds are addressed. Our provided implementation shows that this approach can solve many SPs from the literature to global optimality, without resorting to cutting planes, or branch-and-bound.

Akshay Agrawal, Stanford University (joint work with Stephen Boyd, Steven Diamond)
Log-Log Convexity

We introduce log-log convex programs (LLCPs): optimization problems with positive variables that become convex when the variables, objective functions, and constraint functions are replaced with their logs. LLCPs strictly generalize geometric programming, and include interesting problems involving nonnegative matrices, and integral inequalities. We discuss the basic calculus for this class of functions, and show when a given LLCP can be cast to a format that is acceptable by modern conic solvers. Illustrative examples are provided with CVXPY's new "disciplined geometric programming" feature.

CON

Tue.2 H 3006

Solving Saddle-Point Problems via First-Order Methods

Organizer: Robert Freund
Chair: Robert Freund

Renbo Zhao, Massachusetts Institute of Technology
Optimal Algorithms for Stochastic Three-Composite Convex-Concave Saddle Point Problems [canceled]

We develop stochastic first-order primal-dual algorithms to solve stochastic three-composite convex-concave saddle point problems. When the saddle function is non-strongly convex in the primal variable, we design an algorithm based on the PDHG framework, that achieves the state-of-the-art oracle complexity. Using this algorithm as subroutine, when the saddle function is strongly convex in the primal variable, we develop a novel stochastic restart scheme, whose oracle complexity is strictly better than any of the existing ones, even in the deterministic case.

Panayotis Mertikopoulos, CNRS
Going the extra (gradient) mile in saddle-point problems

Novel theoretical inroads on saddle-point problems involve moving beyond the convex-concave framework. Here we analyze the behavior of mirror descent (MD) in a class of non-monotone problems whose solutions coincide with those of a naturally associated variational inequality – a property which we call "coherence." We show that "vanilla" MD converges under a strict version of coherence (but not otherwise) and that this deficiency is mitigated by taking an "extra-gradient" step which leads to convergence in all coherent problems. We validate our analysis by numerical experiments in GANs.

Yangyang Xu, Rensselaer Poly. Institute (joint work with Yuyuan Ouyang)
Lower complexity bounds of first-order methods for bilinear saddle-point problems

There have been many works studying the upper complexity bounds of first-order methods for solving the convex-concave bilinear saddle-point problem (SPP). In this talk I will show the opposite direction by deriving lower complexity bounds for first-order methods for SPPs. For convex-concave SPP, I show that the lower complexity bound is $O(1/\epsilon)$ to obtain an ϵ-solution, and is $O(1/\sqrt{\epsilon})$ under primal strong convexity. These established bounds are tight in terms of the dependence on ϵ, and they imply the optimality of several existing first-order methods.

CNV

Tue.2 H 1028

Disjunctive Structures in Mathematical Programming

Organizer: Matúš Benko
Chair: Matúš Benko

Patrick Mehlitz, Brandenburgische Technische Universität Cottbus-Senftenberg (joint work with Christian Kanzow, Daniel Steck)

Switching-constrained mathematical programs: Applications, optimality conditions, and a relaxation method

Mathematical programs with switching constraints are characterized by restrictions requiring the product of two functions to be zero. Switching structures appear frequently in the context of optimal control and can be used to reformulate semi-continuity conditions on variables or logical or-constraints. In this talk, these applications of switching-constrained optimization are highlighted. Moreover, first-and second-order optimality conditions for this problem class will be investigated. Finally, a relaxation method is suggested and results of computational experiments are presented.

Matúš Benko, Johannes Kepler University Linz

New verifiable sufficient conditions for metric subregularity of constraint systems with application to disjunctive programs and pseudo-normality

In this talk, we present a directional version of pseudo-normality for very general constraints. This condition implies the prominent error bound property/MSCQ. Moreover, it is naturally milder than its standard (non-directional) counterpart, in particular GMFCQ, as well as the directional FOSCMS. We apply the obtained results to the disjunctive programs, where pseudo-normality assumes a simplified form, resulting in verifiable point-based sufficient conditions for this property and hence also for MSCQ. In particular, we recover SOSCMS and the Robinson's result on polyhedral multifunctions.

Michal Červinka, Czech Academy of Sciences (joint work with Matúš Benko, Tim Hoheisel)

Ortho-disjunctive programs: constraint qualifications and stationarity conditions

We introduce a class of ortho-disjunctive programs (ODPs), which includes MPCCs, MPVCs and several further recently introduced examples of disjunctive programs. We present a tailored directional version of quasi-normality introduced for general constraint systems which implies error bound property/metric subregularity CQ. Thus, we effectively recover or improve some previously established results. Additionally, we introduce tailored OD-versions of stationarity concepts and strong CQs (LICQ, MFCQ etc) and provide a unifying framework for further results on stationarity conditions for all ODPs.

CNV

Tue.2 H 1029

Recent Advances in First-Order Methods for Constrained Optimization and Related Problems (Part IV)

Organizers: Ion Necoara, Quoc Tran-Dinh
Chair: Ion Necoara

Stephen Becker, University of Colorado Boulder (joint work with Alireza Doostan, David Kozak, Luis Tenorio)

Stochastic Subspace Descent

Some optimization settings, such as certain types of PDE-optimization, do not give easy access to the gradient of the objective function. We analyze a simple 0th-order derivative-free stochastic method that computes the directional derivative in a stochastically chosen subspace, and also develop and analyze a variance-reduced version. Under an error bound condition we show convergence, and under strong convexity we show almost-sure convergence of the variables. Numerical experiments on problems from Gaussian Processes and PDE shape-optimization show good results even on non-convex problems.

Qihang Lin, University of Iowa (joint work with Mingrui Liu, Hassan Rafique, Tianbao Yang)

Solving Weakly-Convex-Weakly-Concave Saddle-Point Problems as Successive Strongly Monotone Variational Inequalities

In this paper, we consider first-order algorithms for solving a class of non-convex non-concave min-max problems, whose objective function is weakly convex (resp. weakly concave) in the minimization (resp. maximization). It has many important applications in machine learning such as training Generative Adversarial Networks. Our method is an inexact proximal point method which solves the weakly monotone variational inequality corresponding to the min-max problem. Our algorithm finds a nearly ϵ-stationary point of the min-max problem with a provable iteration complexity.

Phan Tu Vuong, University of Vienna

The Boosted DC Algorithm for nonsmooth functions

The Boosted Difference of Convex functions Algorithm (BDCA) was recently proposed for minimizing smooth DC functions. BDCA accelerates the convergence of the classical DCA thanks to an additional line search step. The purpose of this paper is twofold: to show that this scheme can be generalized and successfully applied to certain types of nonsmooth DC functions, and to show that there is complete freedom in the choice of the trial step size for the line search. We prove that any limit point of BDCA sequence is a critical point of the problem. The convergent rate is obtained under KL property.

DER

Tue.2 H 2038

Recent Advances in Derivative-Free Optimization (Part II)

Organizers: Ana Luisa Custodio, Sébastien Le Digabel, Margherita Porcelli, Francesco Rinaldi, Stefan Wild
Chair: Sébastien Le Digabel

Clément Royer, University of Wisconsin-Madison (joint work with Serge Gratton, Luis Nunes Vicente)

A decoupled first/second-order steps technique and its application to nonconvex derivative-free optimization

In this talk, we describe a technique that separately computes first-and second-order steps, in order to better relate each step to its corresponding stationarity criterion. Such an approach can lead to larger steps and decreases in the objective, which positively impacts both the complexity analysis and the practical behavior. Although its applicability is wider, we present our concept within a trust-region framework without derivatives. This allows us to highlight interesting connections between our decoupling paradigm and the criticality steps used to guarantee convergence of such methods.

Francesco Rinaldi, Università di Padova (joint work with Andrea Cristofari)

Derivative-free optimization for structured problems

In this talk, we describe a new approach for minimizing a black-box function over a structured convex set. We analyze the theoretical properties of the method. Furthermore, we report some numerical results showing that the algorithm scales up well when the dimensions of the problems get large.

Jan Feiling, Porsche AG (joint work with Christian Ebenbauer)

Multi-Variable Derivative-Free Optimization Based on Non-Commutative Maps

A novel class of derivative-free optimization algorithms based on non-commutative maps for multi-variable optimization problems is presented. The main idea is to utilize certain non-commutative maps in order to approximate the gradient of the objective function. We show how these maps can be constructed by so-called generating functions incorporated with either single- or two-point objective evaluation polices and how periodic exploration sequences can be designed to approximate gradients. Finally, we analyze the convergence of the proposed class of algorithms and present benchmarking results.

GLO

Tue.2 H 3002

Convergence Analysis and Kurdyka-Lojasiewicz Property

Organizer: Ting Kei Pong
Chair: Ting Kei Pong

Peiran Yu, The Hong Kong Polytechnic University (joint work with Guoyin Li, Ting Kei Pong)

Deducing Kurdyka-Lojasiewicz exponent via inf-projection

KL exponent plays an important role in inducing the local convergence rates of many first-order methods. These methods are applied to solve large-scale optimization problems encountered in fields like compressed sensing and machine learning. However, KL exponent is hard to estimate explicitly and few results are known. In this talk, we study when inf-projection preserves KL exponent. This enables us to deduce the KL exponent of some SDP-representable functions and some nonconvex models such as least squares with rank constraint.

Rujun Jiang, Fudan University (joint work with Duan Li)

Novel Reformulations and Efficient Algorithms for the Generalized Trust Region Subproblem

We present a new solution framework to solve the generalized trust region subproblem (GTRS) of minimizing a quadratic objective over a quadratic constraint. More specifically, we derive a convex quadratic reformulation of minimizing the maximum of the two convex quadratic functions for the case under our investigation. We develop algorithms corresponding to two different line search rules. We prove for both algorithms their global sublinear convergence rates. The first algorithm admits a local linear convergence rate by estimating the Kurdyka-Łojasiewicz exponent at any optimal solution.

Tran Nghia, Oakland University

Metric subregularity of the subdifferentials with applications to well-posedness and linear convergence

Metric subregularity of subdifferentials is an important property to study linear convergence of many first-order methods for solving convex and nonconvex optimization problems. This talk reviews recent achievements and provides some new developments in this direction. Moreover, we will show how metric subregularity of subdifferentials could play significant roles in investigating well-posedness of optimization problems via second-order variational analysis. Applications to some structured optimization problems such as ℓ_1, nuclear normed, Poisson regularized problems will be discussed.

MUL

Tue.2 H 3013

Recent Developments in Set Optimization (Part II)

Organizers: Akhtar A. Khan, Elisabeth Köbis, Christiane Tammer
Chair: Elisabeth Köbis

Christiane Tammer, Martin-Luther-University of Halle-Wittenberg (joint work with Truong Q. Bao)

Subdifferentials and SNC property of scalarization functionals with uniform level sets and applications

In this talk, we are dealing with necessary conditions for minimal solutions of constrained and unconstrained optimization problems with respect to general domination sets by using well-known nonlinear scalarization functionals with uniform level sets. The primary objective of this work is to establish revised formulas for basic and singular subdifferentials of the nonlinear scalarization functionals.The second objective is to propose a new way to scalarize a set-valued optimization problem.

Tamaki Tanaka, Niigata University

Sublinear-like scalarization scheme for sets and its applications

This paper is concerned with a certain historical background on set relations and scalarization methods for sets. Based on a basic idea of sublinear scalarization in vector optimization, we introduce a scalarization scheme for sets in a real vector space such that each scalarizing function has an order-monotone property for set relation and inherited properties on cone-convexity and cone-continuity. Accordingly, we show a certain application for this idea to establish some kinds of set-valued inequalities. Moreover, we shall mention another application to fuzzy theory.

Marius Durea, Alexandru Ioan Cuza University of Iasi (joint work with Radu Strugariu)

Barrier methods for optimization problems with convex constraint

In this talk, we consider some barrier methods for vector optimization problems with geometric and generalized inequality constraints. Firstly, we investigate some constraint qualification conditions and we compare them to the corresponding ones in literature, and then we introduce some barrier functions and we prove several of their basic properties in fairly general situations. Finally, we derive convergence results of the associated barrier method, and to this aim we restrict ourselves to convex case and finite dimensional setting.

NON

Tue.2 H 0104

Recent Advances in First-Order Methods (Part I)

Organizers: Guanghui Lan, Yuyuan Ouyang, Yi Zhou
Chair: Yuyuan Ouyang

Renato Monteiro, Georgia Institute of Technology

An Average Curvature Accelerated Composite Gradient Method for Nonconvex Smooth Composite Optimization Problems

This talk discusses an accelerated composite gradient (ACG) variant for solving nonconvex smooth composite minimization problems. As opposed to well-known ACG variants which are based on either a known Lipschitz gradient constant or the sequence of maximum observed curvatures, the current one is based on the sequence of average observed curvatures.

William Hager, University of Florida (joint work with Hongchao Zhang)

Inexact alternating direction multiplier methods for separable convex optimization

Inexact alternating direction multiplier methods (ADMMs) are developed for solving general separable convex optimization problems with a linear constraint and with an objective that is the sum of smooth and nonsmooth terms. The approach involves linearized subproblems, a back substitution step, and either gradient or accelerated gradient techniques. Global convergence is established and convergence rate bounds are obtained for both ergodic and non-ergodic iterates.

Dmitry Grishchenko, Université Grenoble Alpes (joint work with Franck Iutzeler, Jerome Malick)

Identification-based first-order algorithms for distributed learning

In this talk, we present a first-order optimization algorithm for distributed learning problems. We propose an efficient sparsification of proximal-gradient updates to lift the communication bottleneck of exchanging huge size updates between master machine and workers machines. Using a sketch-and-project technique with projections onto near-optimal low-dimensional subspaces, we get a significant performance improvement in terms of convergence with respect to the total size of communication.

NON

Tue.2 H 0105

Nonlinear and Stochastic Optimization (Part IV)

Organizers: Albert Berahas, Geovani Grapiglia
Chair: Albert Berahas

Michael Overton, New York University (joint work with Azam Asl)

Behavior of L-BFGS on Nonsmooth Problems in Theory and in Practice

When applied to minimize nonsmooth functions, the "full" BFGS method works remarkably well, typically converging linearly to Clarke stationary values, with no counterexamples to this behavior known in the convex case, though its theoretical behavior is not yet well understood. In contrast, limited-memory BFGS may converge to non-stationary values, even on a simple convex function, but this seems to be rare. We summarize our experience with L-BFGS in both theory and practice.

Anton Rodomanov, UCLouvain

Greedy Quasi-Newton Method with Explicit Superlinear Convergence

We propose a new quasi-Newton method for unconstrained minimization of smooth functions. Our method is based on the famous BFGS scheme but it uses a greedily selected coordinate vector for updating the Hessian approximation at each iteration instead of the previous search direction. We prove that the proposed method has local superlinear convergence and establish a precise bound for its rate. To our knowledge, this result is the first explicit non-asymptotic rate of superlinear convergence for quasi-Newton methods. All our conclusions are confirmed by numerical experiments.

Albert Berahas, Lehigh University (joint work with Frank E. Curtis, Baoyu Zhou)

Limited-Memory BFGS with Displacement Aggregation

We present a displacement aggregation strategy for the curvature pairs stored in a limited-memory BFGS method such that the resulting (inverse) Hessian approximations are equal to those derived from a full-memory BFGS method. Using said strategy, an algorithm employing the limited-memory method can achieve the same convergence properties as when full-memory Hessian approximations are employed. We illustrate the performance of an LBFGS algorithm that employs the aggregation strategy.

NON

Tue.2 H 2053

Interplay of Linear Algebra and Optimization (Part I)

Organizers: Robert Luce, Yuji Nakatsukasa
Chair: Yuji Nakatsukasa

Henry Wolkowicz, University of Waterloo

Completions for Special Classes of Matrices: Euclidean Distance, Low Rank, sparse, and Toeplitz

We consider the matrix completion problem for special classes of matrices. This includes EDM, low rank, robust PCA, and Toeplitz. We consider both the exact and noisy cases. We include theoretical results as well as efficient numerical techniques. Our tools are semidefinite programming, facial reduction, and trust region subproblems.

Dominik Garmatter, TU Chemnitz (joint work with Margherita Porcelli, Francesco Rinaldi, Martin Stoll)

An Improved Penalty Algorithm for mixed integer and PDE constrained optimization problems

We present a novel Improved Penalty Algorithm (IPA) designed for large-scale problems. The Algorithm utilizes the framework of an existing Exact Penalty Algorithm to correctly increase the penalization throughout its iteration, while, in each iteration, it tries to find an iterate that decreases the current objective function value. Such a decrease can be achieved via a problem-specific perturbation strategy. Based on a numerical toy problem, we will compare the IPA to existing penalization strategies, simple rounding schemes, and a Branch and Bound routine of Cplex.

Robert Luce, Gurobi

Regularization of binary quadratic programming problems

We consider the solution of binary quadratic programming (BQP) problems in the standard branch-and-bound framework. The idempotency of binary variables allows for regularization of the objective function without altering the set of optimal solutions. Such regularization can serve two purposes. First, it can be applied to ensure the convexity of the continuous relaxation, and secondly to strengthen the root relaxation of (convex) BQP problems. Computing such a regularization can be achieved by the solution of an auxiliary SDP, for which we compare different computational techniques.

NON

Tue.2 H 3025

Advances in Interior Point Methods

Organizer: Coralia Cartis
Chair: Margherita Porcelli

Renke Kuhlmann, University of Wisconsin-Madison

Learning to Steer Nonlinear Interior-Point Methods

Interior-point methods handle nonlinear programs by sequentially solving barrier subprograms with a decreasing sequence of barrier parameters. In practice, adaptive barrier updates have been shown to lead to superior performance. In this talk we interpret the adaptive barrier update as a reinforcement learning task and train a deep Q-learning to solve it. Numerical results based on an implementation within the nonlinear programming solver WORHP show that the agent successfully learns to steer the barrier parameter and additionally improves WORHP's performance on the CUTEst test set.

Andre Tits, University of Maryland College Park (joint work with M. Paul Laiu)

Constraint Reduction in Infeasible-Start Interior-Point for Imbalanced Large Sparse Convex Quadratic Optimization

A framework for accommodating infeasible starts, given a user-supplied feasible-start "base" iteration for CQP, is proposed and analyzed. Requirements to be satisfied by the base iteration allow for inexact computation of search directions. The framework is applied to a recent feasible-start "constraint-reduced" MPC algorithm, involving a small "working set" of constraints, updated at each iteration. In early numerical tests with Matlab/CVX, a speedup of up to 10x over SDPT3/SeDuMi was observed, on both randomly generated and data fitting problems with many more constraints than variables.

Margherita Porcelli, University of Bologna (joint work with Stefania Bellavia, Jacek Gondzio)

A new interior point approach for low-rank semidefinite programs

We address the solution of semidefinite programming (SDP) problems in which the primal variable X is expected to be low-rank at optimality, a common situation in relaxations of combinatorial optimization (maximum cut) or in matrix completion. SDPs are solved efficiently using interior-point methods (IPMs), but such algorithms typically converge to a maximum-rank solution. We propose a new IPM approach which works with a low-rank X and gradually reveals the optimal (minimum) rank. Preliminary results show that using alternating directions improves the efficiency of the linear algebra.

IMP

Tue.2 H 0111

Computational Optimization in Julia

Organizer: Abel Soares Siqueira
Chair: Michael Garstka

Maxim Demenkov, Institute of Control Sciences

From concave programming to polytope projection with Julia

Concave programming (CP) is a problem of maximizing convex function over a convex set of constraints. If the set is polyhedral, the solutions of this global optimization problem lie on its vertices. We consider a largely forgotten branch of research in CP, originated from the work of Hoang Tuy and based on the cone splitting techniques. The same type of methods could be applied to characterize vertices of the whole polyhedron and to compute its projection in the lower-dimensional subspace. We describe our Julia implementation of the projection method for polytopes.

Mattias Fält, Lund University (joint work with Pontus Giselsson)

QPDAS: Dual Active Set Solver for Mixed Constraint Quadratic Programming

We present a method for solving the general mixed constrained quadratic programming problem using an active set method on the dual problem. There are two main contributions; we present a new way of handling the factorization in the the dual problem, and show how iterative refinement can be used to handle the problems arising when the dual is not positive definite. An open source implementation in Julia is available, which can be used to solve problems using arbitrary-precision floating-point numbers.

Michael Garstka, Oxford University

COSMO – A conic operator splitting method for large convex conic problems

COSMO is an operator splitting algorithm for convex optimisation problems with quadratic objective function and conic constraints. At each step the algorithm alternates between solving a quasi-definite linear system with a constant coefficient matrix and a projection onto convex sets. The solver is able to exploit chordal sparsity in the problem data and to detect infeasible problems. The low per-iteration computational cost makes the method particularly efficient for large problems. Our Julia implementation COSMO.jl is open-source, extensible and performs well on a variety of problem classes.

PDE

Tue.2 H 0106

Computational Design Optimization (Part II)

Organizers: Martin Siebenborn, Kathrin Welker
Chair: Martin Siebenborn

Volker Schulz, Trier University
On the volume formulation for the shape Hessian

The shape Hessian is usually formulated as a boundary operator, which is even symmetric in the Riemannian variant. However, it might be advantageous to use its volume formulation for analytical and also numerical reasons. This has the drawback of a severe lack of definiteness. This talk discusses an approach to deal with the quite large null space of the volumic shape Hessian within an overall shape optimization algorithm utilizing second order information.

Kathrin Welker, Helmut-Schmidt-Universität Hamburg
Computational investigations of shape optimization problems constrained by variational inequalities of the first kind

In this talk, we consider shape optimization problems constrained by variational inequalities (VI) in shape spaces. These problems are in particular highly challenging because of two main reasons: First, one needs to operate in inherently nonlinear, non-convex and infinite-dimensional spaces. Second, one cannot expect the existence of the shape derivative, which imply that the adjoint state cannot be introduced and, thus, the problem cannot be solved directly without any regularization techniques. We investigate computationally a VI constrained shape optimization problem of the first kind.

Peter Gangl, Graz University of Technology (joint work with Kevin Sturm)
Shape and Topology Optimization subject to 3D Nonlinear Magnetostatics – Part II: Numerics

We present the application of design optimization algorithms based on the shape and topological derivative for 3D nonlinear magnetostatics to the optimization of an electric motor. The topological derivative for this quasilinear problem involves the solution of two transmission problems on the unbounded domain for each point of evaluation. We present a way to efficiently evaluate this quantity on the whole design domain. Moreover, we present optimization results obtained by a level set algorithm which is based on the topological derivative, as well as shape optimization results.

PDE

Tue.2 H 0107

Recent Advances in PDE Constrained Optimization (Part I)

Organizer: Axel Kröner
Chair: Axel Kröner

Simon Funke, Simula Research Laboratory (joint work with Jørgen Dokken, Sebastian Mitusch)
Algorithmic differentation for shape derivatives with PDE constraints

Shape-derivatives combined with the adjoint approach offer an efficient approach for solving shape optimisation problems, but their derivation is error-prone especially for complex PDEs. In this talk, we present an algorithmic differentiation tool that automatically computes shape derivatives by exploiting the symbolic representation of variational problems in the finite element framework FEniCS. We demonstrate that our approach computes first and second order shape derivatives for a wide range of PDEs and functionals, approaches optimal performance and works naturally in parallel.

Constantin Christof, Technical University of Munich (joint work with Boris Vexler)
New Regularity Results for a Class of Parabolic Optimal Control Problems with Pointwise State Constraints

This talk is concerned with parabolic optimal control problems that involve pointwise state constraints. We show that, if the bound in the state constraint satisfies a suitable compatibility condition, then optimal controls enjoy $L^\infty(L^2)$, $L^2(H^1)$ and (with a suitable Banach space Y) BV(Y^*)-regularity. In contrast to classical approaches, our analysis requires neither a Slater point nor additional control constraints nor assumptions on the spatial dimension nor smoothness of the objective function.

Axel Kröner, Humboldt-Universität zu Berlin (joint work with Maria Soledad Aronna, Frederic Bonnans)
Optimal control of a semilinear heat equation with bilinear control-state terms subject to state and control constraints

In this talk we consider an optimal control problem governed by a semilinear heat equation with bilinear control-state terms and subject to control and state constraints. The state constraints are of integral-type, the integral being with respect to the space variable. The control is multidimensional. The cost functional is of a tracking-type and contains a linear term in the control variables. We derive second order necessary and sufficient conditions relying on the Goh transformation, the concept of alternative costates, and quasi-radial critical directions.

PDE

Tue.2 H 0112

Optimal Control and Dynamical Systems (Part II)

Organizers: Cristopher Hermosilla, Michele Palladino
Chair: Cristopher Hermosilla

Nathalie T. Khalil, Universidade do Porto Faculdade de Engenharia

Numerical solutions for regular state-constrained optimal control problems via an indirect approach

We present an indirect method to solve state-constrained optimal control problems. The presented method is based on the maximum principle in Gamkrelidze's form. We focus on a class of problems having a certain regularity condition, which will ensure the continuity of the measure Lagrange multiplier associated with the state constraint. This property of the multiplier will play a key role in solving the two-point boundary value problem resulting from the maximum principle. Several illustrative applications to time optimal control problems are considered.

Luis Briceño-Arias, Universidad Tecnica Federico Santa Maria (joint work with Dante Kalise, Francisco Silva-Alvarez)

Mean Field Games with local couplings: numerical approaches

We address the numerical approximation of Mean Field Games with local couplings. For power-like Hamiltonians, we consider both unconstrained and constrained stationary systems with density constraints in order to model hard congestion effects. For finite difference discretizations of the Mean Field Game system, we follow a variational approach. We prove that the aforementioned schemes can be obtained as the optimality system of suitably defined optimization problems. Next, we study and compare several efficiently convergent first-order methods.

Daria Ghilli, University of Padua

Inverse problem of crack identification by shape optimal control

We study an inverse problem of crack identification formulated as an optimal control problem with a PDE constraint describing the anti-plane equilibrium of an elastic body with a stress-free crack under the action of a traction force. The optimal control problem is formulated by minimizing the L^2-distance between the displacement and the observation and then is solved by shape optimization techniques via a Lagrangian approach. An algorithm is proposed based on a gradient step procedure and several numerical experiments are carried out to show its performance in diverse situations.

ROB

Tue.2 H 1058

Advances in Data-Driven and Robust Optimization

Organizer: Velibor Misic
Chair: Velibor Misic

Vishal Gupta, USC Marshall School of Business (joint work with Nathan Kallus)

Data-Pooling in Stochastic Optimization

Applications often involve solving thousands of potentially unrelated stochastic optimization problems, each with limited data. Intuition suggests decoupling and solving these problems separately. We propose a novel data-pooling algorithm that combines problems and outperforms decoupling, even if data are independent. Our method does not require strong distributional assumptions and applies to constrained, possibly non-convex problems. As the number of problems grows large, our method learns the optimal amount to pool, even if the expected amount of data per problem is bounded and small.

Andrew Li, Carnegie Mellon University (joint work with Jackie Baek, Vivek Farias, Deeksha Sinha)

Toward a Genomic Liquid Biopsy

The cost of DNA sequencing has recently fallen to the point that an affordable blood test for early-stage cancer is nearly feasible. What remains is a massive variable selection problem. We propose an efficient algorithm, based on a decomposition at the gene level, that scales to full genomic sequences across thousands of patients. We contrast our selected variables against DNA panels from two recent, high-profile studies and demonstrate that our own panels achieve significantly higher sensitivities at the same cost, along with accurate discrimination between cancer types for the first time.

Velibor Misic, UCLA (joint work with Yi-Chun Chen)

Decision Forests: A Nonparametric Model for Irrational Choice

Most choice models assume that customers obey the weak rationality property, but increasing empirical evidence suggests that customers. We propose a new model, the decision forest model, which models customers via a distribution over trees. We characterize its representational power, study the model complexity needed to fit a data set and present a practical estimation algorithm based on randomization and linear optimization. We show using real transaction data that this approach yields improvements in predictive accuracy over mainstream models when customers behave irrationally.

ROB

Tue.2 H 3012

Applications of Data-Driven Robust Design

Organizer: Man-Chung Yue
Chair: Man-Chung Yue

Ihsan Yanikoglu, Ozyegin University

Robust Parameter Design and Optimization for Injection Molding

The aim of this study is to propose an optimization methodology to determine the values of the key decision parameters of an injection molding machine such that the desired quality criteria are met in a shorter production cycle time. The proposed robust parameter design and optimization approach utilizes the Taguchi methodology to find critical parameters for use in the optimization, and it utilizes robust optimization to immunize the obtained solution against estimation errors. The 'optimal' designs found by the robust parameter design and optimization approach are implemented in real-life.

Shubhechyya Ghosal, Imperial College Business School (joint work with Wolfram Wiesemann)

The Distributionally Robust Chance Constrained Vehicle Routing Problem

We study a variant of the capacitated vehicle routing problem (CVRP), where demands are modelled as a random vector with ambiguous distribution. We require the delivery schedule to be feasible with a probability of at least $1-\epsilon$, where ϵ is the risk tolerance of the decision maker. We argue that the emerging distributionally robust CVRP can be solved efficiently with standard branch-and-cut algorithms whenever the ambiguity set satisfies a subadditivity condition. We derive efficient cut generation schemes for some widely used moment ambiguity sets, and obtain favourable numerical results.

Marek Petrik, University of New Hampshire (joint work with Chin Pang Ho, Wolfram Wiesemann)

Robust Bellman Updates in Log-Linear Time

Robust Markov decision processes (RMDPs) are a promising framework for reliable data-driven dynamic decision-making. Solving even medium-sized problems, however, can be quite challenging. Rectangular RMDPs can be solved in polynomial time using linear programming but the computational complexity is cubic in the number of states. This makes it computationally prohibitive to solve problems of even moderate size. We describe new methods that can compute Bellman updates in quasi-linear time for common types of rectangular ambiguity sets using novel bisection and homotopy techniques.

SPA

Tue.2 H 3007

Nonlinear Optimization Algorithms and Applications in Data Analysis (Part II)

Organizers: Xin Liu, Cong Sun
Chair: Cong Sun

Xin Liu, Academy of Mathematics and Systems Science, Chinese Academy of Sciences

Multipliers Correction Methods for Optimization Problems with Orthogonality Constraints

We establish an algorithm framework for solving optimization problems with orthogonality constraints. The new framework combines a function value reduction step with a multiplier correction step. The multiplier correction step minimizes the objective function in the range space of the current iterate. We also propose three algorithms which are called gradient reflection (GR), gradient projection (GP) and columnwise block coordinate descent (CBCD), respectively. Preliminary numerical experiments demonstrate that our new framework is of great potential.

Xiaoyu Wang, Academy of Mathematics and Systems Science, Chinese Academy of Sciences (joint work with Yaxiang Yuan)

Stochastic Trust Region Methods with Trust Region Radius Depending on Probabilistic Models

We present a stochastic trust region scheme in which the trust region radius is directly related to the probabilistic models. Especially, we show a specific algorithm STRME in which the trust region radius is selected as depending linearly on model gradient. Moreover, the complexity of STRME in nonconvex, convex and strongly convex settings has all been analyzed. Finally, some numerical experiments are carried out to reveal the benefits of the proposed methods compared to the existing stochastic trust region methods and other relevant stochastic gradient methods.

Yanfei Wang, Chinese Academy of Sciences

Regularization and optimization methods for micro pore structure analysis of shale based on neural networks with deep learning

With the CT image segmentation, the images of shale micropores can be obtained, especially the pore type, shape, size, spatial distribution and connectivity. In this work, based on the reconstructed synchrotron radiation X-ray shale CT data, we develop a neural network image segmentation technique with deep learning based on multi-energy CT image data in order to obtain the 3D structural characteristics and spatial distribution of shale. Since it is an ill-posed inverse problem, regularization and optimization issues are discussed.

STO

Tue.2 H 2033

Large-Scale Stochastic First-Order Optimization (Part I)

Organizers: Filip Hanzely, Samuel Horvath
Chair: Samuel Horvath

Zheng Qu, The University of Hong Kong (joint work with Fei Li)

Adaptive primal-dual coordinate descent methods for non-smooth composite minimization with linear operator

We propose and analyse an inexact augmented Lagrangian (I-AL) algorithm for solving large-scale composite, nonsmooth and constrained convex optimization problems. Each subproblem is solved inexactly with self-adaptive stopping criteria, without requiring the target accuracy a priori as in many existing variants of I-AL methods. In addition, each inner problem is solved by applying accelerated coordinate descent method, making the algorithm more scalable when the problem dimension is high.

Pavel Dvurechensky, Weierstrass Institute for Applied Analysis and Stochastics (WIAS) (joint work with Alexander Gasnikov, Alexander Tiurin)

A Unifying Framework for Accelerated Randomized Optimization Methods

We consider smooth convex optimization problems with simple constraints and inexactness in the oracle information such as value, partial or directional derivatives of the objective function. We introduce a unifying framework, which allows to construct different types of accelerated randomized methods for such problems and to prove convergence rate theorems for them. We focus on accelerated random block-coordinate descent, accelerated random directional search, accelerated random derivative-free method.

Xun Qian, KAUST (joint work with Robert Gower, Nicolas Loizou, Peter Richtárik, Alibek Sailanbayev, Egor Shulgin)

SGD: General Analysis and Improved Rates

We propose a general yet simple theorem describing the convergence of SGD under the arbitrary sampling paradigm. Our analysis relies on the recently introduced notion of expected smoothness and does not rely on a uniform bound on the variance of the stochastic gradients. By specializing our theorem to different mini-batching strategies, such as sampling with replacement and independent sampling, we derive exact expressions for the stepsize as a function of the mini-batch size.

Tue.3 14:45–16:00

APP

Tue.3 H 1012

Applications in Energy (Part III)
Chair: Alberto J. Lamadrid L.

Güray Kara, Norwegian University of Science and Technology (joint work with Hossein Farahmand, Asgeir Tomasgard)
Optimal Scheduling and Bidding of Flexibility for a Portfolio of Power System Assets in a Multi-Market Setting

Flexibility is an important concept to cope with uncertainty in energy systems. In this paper, we consider the problem of an actor that manages a portfolio of flexible assets. We present a Stochastic Programming model for the dynamic scheduling of a portfolio for which energy and flexibility products can be delivered into multiple markets like day-ahead, intraday, and flexibility markets. Some of these products are locations specific, while others are system-wide or even cross-border. The purpose in the short-term is to remove bottlenecks and ensure security of supply at the minimum cost.

Clovis Gonzaga, LACTEC (joint work with Elizabeth Karas, Gislaine Periçaro)
Optimal non-anticipative scenarios for non-linear hydro-thermal power systems

The long-term operation of hydro-thermal power systems is modeled by a large-scale stochastic optimization problem with non-linear constraints due to the head computation in hydroelectric plants. We state the problem as a non-anticipative scenario analysis, leading to a large-scale non-linear programming problem. This is solved by a Filter-SQP algorithm whose iterations minimize quadratic Lagrangian approximations using exact Hessians in L^∞ trust regions. The method is applied to the long-term planning of the Brazilian system, with over 100 hydroelectric and 50 thermoelectric plants.

Alberto J. Lamadrid L., Lehigh University (joint work with Luis Zuluaga)
Equilibrium prices for competitive electricity markets

We consider an electricity market in which uncertainty arises from the presence of renewable energy sources. We consider a robust model for the market using chance constraints together with a proportional control law for power generation. We prove that in this framework, market clearing prices yielding a robust competitive market equilibrium, as well as revenue adequate prices, can be computed and used for uncertain market settlements by risk-aware system operators. We contrast our results to methods using a sample average stochastic program from desired prices can be obtained in each scenario.

BIG

Tue.3 H 0105

Recent Advancements in Optimization Methods for Machine Learning (Part I)
Organizers: Albert Berahas, Paul Grigas, Martin Takáč
Chair: Albert Berahas

Alexandre d'Aspremont, CNRS / École Normale Supérieure (joint work with Thomas Kerdreux, Sebastian Pokutta)
Restarting Frank-Wolfe

The vanilla Frank-Wolfe algorithm only ensures a worst-case complexity of $O(1/\operatorname{epsilon})$. Various recent results have shown that for strongly convex functions, the method can be slightly modified to achieve linear convergence. However, this still leaves a huge gap between sublinear $O(1/\operatorname{epsilon})$ convergence and linear $O(\log 1/\operatorname{epsilon})$ convergence. Here, we present a new variant of Conditional Gradients, that can dynamically adapt to the function's geometric properties using restarts and smoothly interpolates between the sublinear and linear regimes.

Heyuan Liu, University of California, Berkeley (joint work with Paul Grigas)
[moved] New Methods for Regularization Path Optimization via Differential Equations

We develop and analyze several different second order algorithms for computing an approximately optimal solution/regularization path of a parameterized convex optimization problem with smooth Hessian. Our algorithms are inspired by a differential equations perspective on the parametric solution path and do not rely on the specific structure of the regularizer. We present computational guarantees that bound the oracle complexity to achieve an approximately optimal solution path under different sets of smoothness assumptions and that also hold in the presence of approximate subproblem solutions.

Lin Xiao, Microsoft Research (joint work with Junyu Zhang)
A Composite Randomized Incremental Gradient Method

We consider the problem of minimizing the composition of a smooth function (which can be nonconvex) and a smooth vector mapping, where both of them can be expressed as the average of a large number of components. We propose a composite randomized incremental gradient method based on a SAGA-type of gradient estimator. The gradient sample complexity of our method matches that of several recently developed methods based on SVRG in the general case. However, for structured problems where linear convergence rates can be obtained, our method has much better complexity for ill-conditioned problems.

VIS

Tue.3 H 0110

Quasi-Variational Inequalities and Generalized Nash Equilibrium Problems (Part I)

Organizers: Amal Alphonse, Carlos Rautenberg
Chair: Amal Alphonse

Christian Kanzow, University of Würzburg (joint work with Daniel Steck)

Quasi-Variational Inequalities in Banach Spaces: Theory and Augmented Lagrangian Methods

This talk deals with quasi-variational inequality problems (QVIs) in a generic Banach space setting. We provide a theoretical framework for the analysis of such problems based on the pseudomonotonicity (in the sense of Brezis) of the variational operator and a Mosco-type continuity of the feasible set mapping. These assumptions can be used to establish the existence of solutions and their computability via suitable approximation techniques. An augmented Lagrangian technique is then derived and shown to be convergent both theoretically and numerically.

Steven-Marian Stengl, WIAS/HU Berlin

On the Convexity of Optimal Control Problems involving Nonlinear PDEs or VIs

In recent years, generalized Nash equilibrium problems in function spaces involving control of PDEs have gained increasing interest. One of the central issues arising is the question of existence, which requires the topological characterization of the set of minimizers for each player. In this talk, we propose conditions on the operator and the functional, that guarantee the reduced formulation to be a convex minimization problem. Subsequently, we generalize the results of convex analysis to derive optimality systems also for nonsmooth operators. Our findings are illustrated with examples.

Rafael Arndt, Humboldt-Universität zu Berlin (joint work with Michael Hintermüller, Carlos Rautenberg)

On quasi-variational inequality models arising in the description of sandpiles and river networks

We consider quasi-variational inequalities with pointwise constraints on the gradient of the state, that arise in the modeling of sandpile growth, where the constraint depends on local properties of the supporting surface and the solution. We will demonstrate an example where multiple solutions exist in the unregularized problem but not after regularization. Solution algorithms in function space are derived, considering two approaches: a variable splitting method and a semismooth Newton method. The application can further be extended to regarding water-drainage as the limiting case.

CON

Tue.3 H 2032

Semidefinite Programming: Solution Methods and Applications

Organizer: Angelika Wiegele
Chair: Angelika Wiegele

Marianna De Santis, Sapienza University of Rome (joint work with Martina Cerulli, Elisabeth Gaar, Angelika Wiegele)

Augmented Lagrangian Approaches for Solving Doubly Nonnegative Programming Problems

Augmented Lagrangian methods are among the most popular first-order approaches to handle large scale semidefinite programming problems. We focus on doubly nonnegative problems, namely semidefinite programming problems where elements of the matrix variable are constrained to be nonnegative. Starting from two methods already proposed in the literature on conic programming, we introduce Augmented Lagrangian methods with the possibility of employing a factorization of the dual variable. We present numerical results for instances of the DNN relaxation of the stable set problem.

Christoph Helmberg, TU Chemnitz

T.he B.undle A.pproach – Scaling in ConicBundle 1.0 for Convex and Conic Optimization

Bundle methods form a cutting model from collected subgradient information and determine the next candidate as the minimizer of the model augmented with a proximal term. The choice of cutting model and proximal term offers a lot of flexibility and may even allow to move towards second order behavior. After a short introduction to bundle methods in general, we discuss the current approach for integrating such choices in the forthcoming ConicBundle 1.0 for the general and the semidefinite case and report on experience gathered on several test instances.

Georgina Hall, INSEAD

Semidefinite Programming-Based Consistent Estimators for Shape-Constrained Regression

In this talk, I consider the problem of shape-constrained regression, where response variables are assumed to be a function f of some features (corrupted by noise) and f is constrained to be monotonous or convex with respect to these features. Problems of these type occur in many areas, such as, e.g., pricing. Using semidefinite programming, I construct a regressor for the data which has the same monotonicity and convexity properties as f. I further show that this regressor is a consistent estimator of f.

CON

Tue.3 H 3006

Advances in Interior Point Methods for Convex Optimization

Organizer: Etienne de Klerk
Chair: Etienne de Klerk

Mehdi Karimi, University of Waterloo (joint work with Levent Tuncel)

Convex Optimization Problems in Domain-Driven Form: Theory, Algorithms, and Software

In this talk, we introduce the Domain-Driven form for convex optimization problems and show how general it is by several examples. We have designed infeasible-start primal-dual interior-point algorithms for the Domain-Driven form, which accepts both conic and non-conic constraints. Our algorithms enjoy many advantages of primal-dual interior-point techniques available for conic formulations, such as the current best complexity bounds. At the end, we introduce our software package DDS created based on our results for many classes of convex optimization problems.

Riley Badenbroek, Tilburg University (joint work with Etienne de Klerk)

Simulated Annealing with Hit-and-Run for Convex Optimization

We analyze the simulated annealing algorithm by Kalai and Vempala [Math of OR 31.2 (2006): 253-266] using the temperature schedule put forward by Abernethy and Hazan [arXiv 1507.02528v2, 2015]. This algorithm only assumes a membership oracle of the feasible set, and returns a solution in polynomial time which is near-optimal with high probability. Moreover, we propose a number of modifications to improve the practical performance of this method. Numerical examples show the method has an application to convex problems where no other method is readily available, such as copositive programming.

David Papp, North Carolina State University (joint work with Sercan Yildiz)

alfonso: A new conic solver for convex optimization over non-symmetric cones

Many optimization problems can be conveniently written as conic programs over non-symmetric cones; however, these problems are lacking the solver support that symmetric conic optimization problems have. We propose alfonso, a highly general Matlab-based interior point solver for non-symmetric conic optimization. Alfonso can solve optimization problems over a cone as long as the user can supply the gradient and Hessian of a logarithmically homogeneous self-concordant barrier for either the cone or its dual. We demonstrate its efficiency using non-symmetric cones arising in polynomial programming

CNV

Tue.3 H 1028

Operator Splitting and Proximal Decomposition Methods

Organizers: Patrick L. Combettes, Jonathan Eckstein
Chair: Patrick L. Combettes

Yu Du, University of Colorado Denver

An outer-inner linearization method for non-convex and non-differentiable composite regularization problems

We propose a new outer-inner linearization method for nonconvex statistical learning problems involving nonconvex structural penalties and nonconvex loss. It linearizes the outer concave functions and solves the resulting convex, but still nonsmooth, subproblems by a special alternating linearization method. We provide proof of convergence of the method under mild conditions. Finally, numerical examples involving nonconvex structural penalties and nonconvex loss functions demonstrate the efficacy and accuracy of the method.

Maicon Marques Alves, Federal University of Santa Catarina - UFSC (joint work with Jonathan Eckstein, Marina Geremia)

Relative-Error Inertial-Relaxed Inexact Versions of Douglas-Rachford and ADMM Splitting Algorithms

This paper derives new inexact variants of the Douglas-Rachford splitting method for maximal monotone operators and the alternating direction method of multipliers (ADMM) for convex optimization. The analysis is based on a new inexact version of the proximal point algorithm that includes both an inertial step and and overrelaxation. We apply our new inexact ADMM method to LASSO and logistic regression problems and obtain better computational performance than earlier inexact ADMM methods.

Jonathan Eckstein, Rutgers University (joint work with Patrick Johnstone)

Projective Splitting with Co-coercive Operators

This talk describes a new variant of monotone operator projective splitting in which co-coercive operators can be processed with a single forward step per iteration. This result establishes a symmetry between projective splitting algorithms, the classical forward-backward method, and Tseng's forward-backward-forward method: In a situation in which Lipschitz monotone operators require two forward steps, co-coercive operators may be processed with a single forward step. The single forward step may be interpreted as a single step of the classical forward-backward method for the standard "prox" problem associated with the cocoercive operator, starting at the previous known point in the operator graph. Proving convergence of the algorithm requires some departures from the usual proof framework for projective splitting. We have also developed a backtracking variant of the method for cases in which the co-coercivity constant is unknown, and present some computational tests of this method on large-scale optimization problems from data fitting and portfolio applications.

CNV

Tue.3 H 1029

Matrix Optimization Problems: Theory, Algorithms and Applications

Organizer: Chao Ding
Chair: Chao Ding

Xinyuan Zhao, Beijing University of Technology (joint work with Chao Ding, Zhuoxuan Jiang)

A DC algorithm for quadratic assignment problem

We show that the quadratic assignment problem (QAP) is equivalent to the doubly nonnegative (DNN) problem with a rank constraint. A DC approach is developed to solve that DNN problem. And its subproblems are solved by the semi-proximal augmented Lagrangian method. The sequence generated by the proposed algorithm converges to a stationary point of the DC problem with a suitable parameter. Numerical results demonstrate: for some examples of QAPs, the optimal solutions can be found directly; for the others, good upper bounds with the feasible solutions are provided.

Xudong Li, Fudan University (joint work with Liang Chen, Defeng Sun, Kim-Chuan Toh)

On the Equivalence of Inexact Proximal ALM and ADMM for a Class of Convex Composite Programming

In this talk, we show that for a class of linearly constrained convex composite optimization problems, an (inexact) symmetric Gauss-Seidel based majorized multi-block proximal alternating direction method of multipliers (ADMM) is equivalent to an inexact proximal augmented Lagrangian method (ALM). This equivalence not only provides new perspectives for understanding some ADMM-type algorithms but also supplies meaningful guidelines on implementing them to achieve better computational efficiency.

Chao Ding, AMSS, Chinese Academy of Sciences

Perturbation analysis of matrix optimization

The nonsmooth composite matrix optimization problem, in particular, the matrix norm optimization problem, is a generalization of the matrix conic program with wide applications in numerical linear algebra, computational statistics and engineering. This talk is devoted to study some perturbation properties of matrix optimization problems

DER

Tue.3 H 2038

Emerging Trends in Derivative-Free Optimization (Part I)

Organizers: Ana Luisa Custodio, Sébastien Le Digabel, Margherita Porcelli, Francesco Rinaldi, Stefan Wild
Chair: Anne Auger

Christine Shoemaker, National University of Singapore (joint work with Yichi Shen)

Global optimization of noisy multimodal functions with RBF surrogates

We consider the optimization of multimodal, computationally expensive noisy functions $f(x)$ with the assistance of a Radial Basis Function (RBF) surrogate approximation of $f(x)$. This RBF surrogate is then used to help guide the optimization search to reduce the number of evaluations required. Because the function is noisy, it is necessary to resample some points to estimate the mean variance of $f(x)$ at each location. The results compare favorably to Bayesian Optimization methods for noisy functions and can be more flexible in the choice of objective function.

Nikolaus Hansen, Inria / Ecole Polytechnique (joint work with Youhei Akimoto)

Diagonal acceleration for covariance matrix adaptation evolution strategies

We introduce an acceleration for covariance matrix adaptation evolution strategies (CMA-ES) by means of adaptive diagonal decoding. This diagonal acceleration endows the default CMA-ES with the advantages of separable CMA-ES without inheriting its drawbacks. Diagonal decoding can learn a rescaling of the problem in the coordinates within linear number of function evaluations. It improves the performance, and even the scaling, of CMA-ES on classes of non-separable test functions that reflect, arguably, a landscape feature commonly observed in practice.

Giacomo Nannicini, IBM T.J. Watson

The evolution of RBFOpt: improving the RBF method, with one eye on performance

This talk will discuss several improvements to the open-source library RBFOpt for surrogate model based optimization. RBFOpt is used in commercial applications and practical needs drove its development. We will discuss efficient model selection, local search, parallel optimization and – time permitting – multi objective optimization. Part of this talk is devoted to engineering issues, but we will try to be precise regarding the mathematics for efficient model selection and local search. This is based on results scattered in various recent papers; some details are currently unpublished.

GLO

Tue.3 H 3002

Recent Developments in Structured Difference-Of-Convex Optimization

Organizer: Zirui Zhou
Chair: Zirui Zhou

Akiko Takeda, The University of Tokyo/RIKEN (joint work with Jun-ya Gotoh, Katsuya Tono)

DC Formulations and Algorithms for Sparse Optimization Problems

We address the minimization of a smooth objective function under an L^0-norm constraint and simple constraints. Some efficient algorithms are available when the problem has no constraints except the L^0-norm constraint, but they often become inefficient when the problem has additional constraints. We reformulate the problem by employing a new DC (difference of two convex functions) representation of the L^0-norm constraint, so that DC algorithm can retain the efficiency by boiling down its subproblems to the projection operation onto a simple set.

Hongbo Dong, Washington State University (joint work with Min Tao)

On the Linear Convergence of DC Algorithms to Strong Stationary Points [canceled]

We consider the linear convergence of algorithms for structured DC optimization. We allow nonsmoothness in both of the convex and concave components, with a finite max structure in the concave component, and focus on algorithms computing d(irectional)-stationary points. Our results are based on standard error bounds assumptions and a new locally linear regularity regarding the intersection of certain stationary sets and dominance regions. A by-product of our work is a unified description of strong stationary points and global optimum by using the notion of approximate subdifferential.

MUL

Tue.3 H 3013

Recent Developments in Set Optimization (Part III)

Organizers: Akhtar A. Khan, Elisabeth Köbis, Christiane Tammer
Chair: Christiane Tammer

Markus Arthur Köbis, Free University Berlin

Set optimization in systems biology: application to dynamic resource allocation problems

We will address how set-valued optimization can be used to approach problems from systems biology and that way opens doorways to simplifying and systematizing many, often pragmatic frameworks in this field. We will concentrate on problems concerning the dynamic simulation of metabolic networks with potential applications ranging from personalized medicine over bio-fuel production to ecosystem biology. From the mathematical modeling viewpoint, we will underline how evolutionary principles may in this regard be interpreted as a regularization and illustrate this by some small-scale examples.

Elisabeth Köbis, Martin Luther University Halle-Wittenberg (joint work with César Gutiérrez, Lidia Huerga, Christiane Tammer)

A scalarization scheme in ordered sets with applications to set-valued and robust optimization

In this talk, a method for scalarizing optimization problems whose final space is an ordered set is stated without assuming any additional assumption on the data of the problem. By this approach, nondominated and minimal solutions are characterized in terms of solutions of scalar optimization problems whose objective functions are the post-composition of the original objective with scalar functions satisfying suitable properties. The obtained results generalize some recent ones stated in quasi ordered sets and real topological linear spaces.

Akhtar A. Khan, Rochester Institute of Technology

Analysing the Role of the Inf-Sup Condition in Inverse Problems for Saddle Point Problems

We will discuss the inverse problem of parameter identification in general saddle point problems that frequently appear in applied models. We focus on examining the role of the inf-sup condition. Assuming the saddle point problem is solvable, we study the differentiability of the set-valued parameter-to-solution map by using the first-order and the second-order contingent derivatives. We investigate the inverse problem by using the nonconvex output least-squares and the convex modified output least-squares objectives. Numerical results and applications will be presented.

NON

Tue.3 H 0104

Recent Advances in First-Order Methods (Part II)

Organizers: Guanghui Lan, Yuyuan Ouyang, Yi Zhou
Chair: Yuyuan Ouyang

Mert Gurbuzbalaban, Rutgers University

A Universally Optimal Multistage Accelerated Stochastic Gradient Method

We study the problem of minimizing a strongly convex and smooth function when we have noisy estimates of its gradient. We first provide a framework that can systematically trade-off acceleration and robustness to gradient errors. Building on our framework, we propose a novel multistage accelerated algorithm that is universally optimal in the sense that it achieves the optimal rate both in the deterministic and stochastic case and operates without knowledge of noise characteristics.

Hilal Asi, Stanford University (joint work with John Duchi)

The importance of better models in stochastic optimization

Standard stochastic optimization methods are brittle, sensitive to algorithmic parameters, and exhibit instability outside of well-behaved families of objectives. To address these challenges, we investigate models that exhibit better robustness to problem families and algorithmic parameters. With appropriately accurate models, which we call the aProx family, stochastic methods can be made stable, provably convergent and asymptotically optimal. We highlight the importance of robustness and accurate modeling with a careful experimental evaluation of convergence time and algorithm sensitivity.

Damien Scieur, SAIT Montreal (joint work with Raghu Bollapragada, Alexandre d'Aspremont)

Nonlinear Acceleration of Momentum and Primal-Dual Algorithms

We describe a convergence acceleration scheme for multistep optimization algorithms. The extrapolated solution is written as a nonlinear average of the iterates produced by the original optimization algorithm. Our scheme handles algorithms with momentum terms such as Nesterov's accelerated method, or primal-dual methods. The weights are computed via a simple linear system and we analyze performance in both online and offline modes. We use Crouzeix's conjecture to show that acceleration performance is controlled by the solution of a Chebyshev problem.

NON

Tue.3 H 2013

Stochastic Methods for Nonsmooth Optimization

Organizer: Konstantin Mishchenko
Chair: Konstantin Mishchenko

Tianyi Lin, University of California, Berkeley

Improved oracle complexity for stochastic compositional variance reduced gradient

We propose an accelerated stochastic compositional variance reduced gradient method for optimizing the sum of a composition function and a convex nonsmooth function. We provide an incremental first-order oracle (IFO) complexity analysis for the proposed algorithm and show that it is provably faster than all the existing methods. In particular, we show that our method achieves an asymptotic IFO complexity of $O((m+n)\log(1/\mathrm{eps})+1/\mathrm{eps}^3)$ where m and n are the number of inner/outer component functions, improving the best-known results of $O(m+n+(m+n)^{2/3}/\mathrm{eps}^2)$ for convex composition problem.

Adil Salim, King Abdullah University of Science and Technology (KAUST)

On the Convergence of some Stochastic Primal-Dual Algorithms

Primal-dual algorithms, like Chambolle-Pock or Vu-Condat algorithms, are suitable methods to solve nonsmooth optimization problems involving linear constraints. In this talk, we will consider stochastic versions of these algorithms where every function used to define the problem is written as an expectation, including the constraints. Asymptotic and non-asymptotic convergence results involving the expected primal-dual gap will be provided. These results cover some recent findings regarding stochastic proximal (gradient) algorithms.

Konstantin Mishchenko, KAUST (joint work with Peter Richtárik)

Variance Reduction for Sums with Smooth and Nonsmooth Components with Linear Convergence

We present a stochastic variance reduction method for convex sums with smooth and nonsmooth entries. In the case where the smooth part is strongly convex and the nonsmooth entries are of the form $g_j(A_j x)$ the method achieves linear convergence with rate $O(\max(n,\kappa,\lambda_{\min}(A))*\log(1/\epsilon))$, where n is the number of smooth terms, κ is the conditioning and $\lambda_{\min}(A)$ is the smallest eigenvalue of the matrix constructed from the rows of A_1, A_2, etc. Without these assumption, the method has rate $O(1/t)$ which improves to $O(1/t^2)$ under strong convexity.

NON

Tue.3 H 2053

Interplay of Linear Algebra and Optimization (Part II)
Organizers: Robert Luce, Yuji Nakatsukasa
Chair: Robert Luce

Yuji Nakatsukasa, University of Oxford (joint work with Paul Goulart, Nikitas Rontsis)
Eigenvalue perturbation theory in optimization: accuracy of computed eigenvectors and approximate semidefinite projection

Eigenvalue perturbation theory is a classical subject in matrix analysis and numerical linear algebra, but seemingly has had little impact in optimization. This talk presents recent progress in eigenvalue perturbation theory, highlighting its roles in optimization. We first derive sharp perturbation and error bounds for Ritz vectors (approximate eigenvectors) and approximate singular vectors, which are used e.g. in SDP, PCA and trust-region subproblems. We also present bounds on the accuracy of approximate semidefinite projection, motivated by operator splitting methods in optimization.

Zsolt Csizmadia, FICO
Eliminations and cascading in nonlinear optimization

The talk explores the numerical implications of using variable eliminations in nonlinear problems versus applying intermediate variables; looking at implications on feasibility, formula sizes or the size of the auto differentiation stacks. For bounded cases when eliminations are not applicable, the talk will present cascading, a technology originating from classical refinery optimization models but recently successfully applied to financial problems. Detection methods of elimination candidates and cascading structures will be presented.

John Pearson, University of Edinburgh
Interior point methods and preconditioners for PDE-constrained optimization

In this talk we consider the effective numerical solution of PDE-constrained optimization problems with additional box constraints on the state and control variables. Upon discretization, a sensible solution strategy is to apply an interior point method, provided one can solve the large and structured matrix systems that arise at each Newton step. We therefore consider fast and robust preconditioned iterative methods for these systems, examining two cases: (i) with L^2 norms arising within the cost functional; (ii) with an additional L^1 norm term promoting sparsity in the control variable.

IMP

Tue.3 H 0111

Advances in Linear Programming
Chair: Daniel Rehfeldt

Julian Hall, University of Edinburgh
HiGHS: a high-performance linear optimizer

This talk will present HiGHS, a growing open-source repository of high-performance software for linear optimization based on award-winning computational techniques for the dual simplex method. The talk will give an insight into the work which has led to the creation of HiGHS and then set out the features which allows it to be used in a wide range of applications. Plans to extend the class of problems which can be solved using HiGHS will be set out.

Ivet Galabova, University of Edinburgh
Solution of quadratic programming problems for fast approximate solution of linear programming problems

Linear programming problems (LP) are widely solved in practice and reducing the solution time is essential for many applications. This talk will explore solving a sequence of unconstrained quadratic programming (QP) problems to derive an approximate solution and bound on the optimal objective value of an LP. Techniques for solving these QP problems fast will be discussed.

Daniel Rehfeldt, Technische Universität Berlin (joint work with Ambros Gleixner, Thorsten Koch)
Solving large-scale doubly bordered block diagonal LPs in parallel

We consider LPs of block diagonal structure with linking variables and constraints, motivated by energy system applications. To solve these problems, we have extended the interior-point solver PIPS-IPM (for stochastic QPs). This talk focuses on methods to handle large numbers of linking variables and constraints. A preconditioned iterative approach and a hierarchical algorithm will be presented, both of which exploit structure within the linking part. The extensions allow us to solve real-world problems with over 500 million variables and constraints in a few minutes on a supercomputer.

PDE

Tue.3 H 0106

Computational Design Optimization (Part III)

Organizers: Martin Siebenborn, Kathrin Welker
Chair: Martin Siebenborn

Estefania Loayza-Romero, Chemnitz University of Technology (joint work with Ronny Bergmann, Roland Herzog)

A discrete shape manifold and its use in PDE-constrained shape optimization

This work aims to present the novel notion of discrete shape manifold, which will allow solving PDE-constrained shape optimization problems using a discretize-then-optimize approach. This manifold will be endowed with a complete Riemannian metric that prevents mesh destruction. The computation of discrete shape derivatives and its relation with the optimize-then-discretize approach will be discussed. Finally, we will present the application of this approach to the solution of simple 2D optimization problems.

Veronika Schulze, Paderborn University (joint work with Benjamin Jurgelucks, Andrea Walther)

Increasing Sensitivity of Piezoelectric Ceramics by Electrode Shape Optimization

Piezoelectricity defines the relation between electrical and mechanical changes in a specimen and can be described by a damped PDE system. Often material parameters of given piezoelectrics are not known precisely, but are required to be accurate. The solution of an inverse problem provides these values. For this purpose, sensitivities with respect to the material parameters can be calculated. In order to compute all parameters the sensitivities of some specific parameters must be increased. This is achieved by adjusting the electrode shapes with shape and topology optimization techniques.

Christian Kahle, Technische Universität München (joint work with Harald Garcke, Michael Hinze, Kei-Fong Lam)

The phase field approach for topology optimization

In a given domain Ω we search for a fluid domain E, such that an objective depending on E and the velocity and the pressure field in E is minimized. We describe the distribution of the fluid and void domain by a phase field variable $\varphi \in H^1(\Omega) \cap L^\infty(\Omega)$ that encodes the subdomains by $\varphi(x) = \pm 1$. Additionaly we use a porosity approach to extend the Navier–Stokes equation from E to Ω. As solution algorithm we apply the variable metric projection type method from [L. Blank and C. Rupprecht, SICON 2017, 55(3)].

PDE

Tue.3 H 0107

Optimal Control and Dynamical Systems (Part III)

Organizers: Cristopher Hermosilla, Michele Palladino
Chair: Cristopher Hermosilla

Matthias Knauer, Universität Bremen (joint work with Christof Büskens)

Real-Time Approximations for Discretized Optimal Control Problems using Parametric Sensitivity Analysis

In many industrial applications solutions of optimal control problems are used, where the need for low computational times outweighs the need for absolute optimality. For solutions of fully discretized optimal control problems we propose two methods to approximate the solutions of problems with modified parameter values in real-time by using sensitivity derivatives. Using the NLP solver WORHP, the quality and applicability of both methods are illustrated by the application of an oscillation free movement of a container crane in a high rack warehouse.

Tan Cao, State University of New York–Korea (joint work with Boris Mordukhovich)

Optimal Control for a Nonconvex Sweeping Process with Applications to the Crowd Motion Model [canceled]

The talk concerns the study a new class of optimal control problems of (Moreau) sweeping process. A major motivation for our study of such challenging optimal control problems comes from the application to the crowd motion model in a practically adequate planar setting with nonconvex but prox-regular sweeping sets. Based on a constructive discrete approximation approach and advanced tools of variational analysis and generalized differentiation, we derive necessary optimality conditions for discrete-time and continuous-time sweeping control systems expressed entirely via the problem data.

Gerardo Sanchez Licea, Facultad de Ciencias UNAM

Sufficiency for purely essentially bounded singular optimal controls

In this talk we study certain classes of fixed end-point optimal control problems of Lagrange with nonlinear dynamics, inequality and equality isoperimetric restraints and pointwise mixed time-state-control inequality and equality constraints. The diminishing of the gap between the classical necessary and sufficient conditions for optimality becomes the main novelty of the talk. In fact, we illustrate the properties of the new theory by exhibiting some singular and purely essentially bounded optimal controls satisfying all conditions of the corresponding sufficiency theorems.

PDE

Tue.3 H 0112

Recent Advances in PDE Constrained Optimization (Part II)

Organizer: Axel Kröner
Chair: Axel Kröner

Meenarli Sharma, Indian Institute of Technology Bombay (joint work with Sven Leyffer, Lars Ruthotto, Bart van Bloemen Waanders)

Inversion of Convection-Diffusion PDE with Discrete Sources

We aim to find the number and location of sources from discrete measurements of concentration on computational domain. We formulate a forward PDE model and then invert it for the unknown sources by reformulating the latter as a MINLP, resulting in mixed-integer PDE constrained optimization (MIPDECO). For MINLP solvers, solving such MINLPs is computationally prohibitive for fine meshes and 3D cases. We propose a trust-region improvement heuristic that uses continuous relaxation of MIPDECO problem with different rounding schemes.

Johanna Katharina Biehl, TU Darmstadt (joint work with Stefan Ulbrich)

Adaptive Multilevel Optimization with Application to Fluid-Structure Interaction

We present a multilevel optimization algorithm for PDE-constrained problems. The basis of the algorithm is an adaptive SQP method, using adaptive grid refinement to reduce the computational cost. This method is extended by introducing a level build with reduced order models (ROM) for state and adjoint equation. For this algorithm we can show convergence, when suitable a posteriori error estimators on the discretization and the ROM are available. The algorithm is applied to a benchmark problem of fluid-structure interaction, which is a problem of interest in many engineering applications.

Johann Michael Schmitt, TU Darmstadt (joint work with Stefan Ulbrich)

Optimal boundary control of hyperbolic balance laws with state constraints

We study optimal control problems governed by balance laws with initial and boundary conditions and pointwise state constraints. The boundary data switch between smooth functions at certain points, where we consider the smooth parts and the switching points as control. State constraints are challenging in this context since solutions of nonlinear hyperbolic balance laws may develop shocks after finite time which prohibits the use of standard methods. We derive optimality conditions and prove convergence of the Moreau-Yosida regularization that is used to treat the state constraints.

ROB

Tue.3 H 1058

Distributionally Robust Optimization: Computation and Insights

Organizer: Karthik Natarajan
Chair: Karthik Natarajan

Jianqiang Cheng, University of Arizona

Computationally Efficient Approximations for Distributionally Robust Optimization [canceled]

Many distributionally robust optimization (DRO) instances can be formulated as semidefinite programming (SDP) problems. However, SDP problems in practice are computationally challenging. In this talk, we present computationally efficient (inner and outer) approximations for DRO problems based on the idea of the principal component analysis (PCA). We also derive theoretical bounds on the gaps between the original problem and its PCA approximations. Furthermore, an extensive numerical study shows the strength of the proposed approximations in terms of solution quality and runtime.

Divya Padmanabhan, Singapore University of Technology and Design (joint work with Karthik Natarajan, Arjun Ramachandra)

Bounds on Sums of Dependent Random Variables: An Optimization Approach

Computing tight bounds for the probability of sums of dependent variables is a fundamental problem with several applications. In this work we study the problem of computing the probability of a sum of dependent Bernoulli random variables exceeding k, from a DRO perspective. We study the problem under known univariate and bivariate marginals with tree structure, where a consistent joint distribution is guaranteed to exist. We propose exact and compact linear programming formulations for these sparse forms. This is based on joint work with Arjun Ramachandra and Karthik Natarajan at SUTD.

Karthik Natarajan, Singapore University of Technology and Design (joint work with Bikramjit Das, Anulekha Dhara)

On the Heavy-Tail Behavior of the Distributionally Robust Newsvendor

Since the seminal work of Scarf (1958) on the newsvendor problem with ambiguity in the demand distribution, there has been a growing interest in the study of the distributionally robust newsvendor problem. A simple observation shows that the optimal order quantity in Scarf's model with known first and second moment is also optimal for a heavy-tailed censored student-t distribution with degrees of freedom 2. In this paper, we generalize this "heavy-tail optimality" property of the distributionally robust newsvendor to a more general ambiguity set.

ROB

Tue.3 H 3012

Distributionally Robust Optimization

Organizer: Soroosh Shafieezadeh Abadeh
Chair: Soroosh Shafieezadeh Abadeh

Tobias Sutter, École Polytechnique Fédérale de Lausanne (EPFL) (joint work with Daniel Kuhn, John Lygeros, Peyman Mohajerin Esfahani)

Data-driven Approximate Dynamic Programming

We consider linear programming (LP) problems in infinite dimensional spaces and develop an approximation bridge from the infinite-dimensional LP to tractable finite convex programs in which the performance of the approximation is quantified explicitly. We illustrate our theoretical results in the optimal control problem for Markov decision processes on Borel spaces when the dynamics are unknown and learned from data and derive a probabilistic explicit error bound between the data-driven finite convex program and the original infinite linear program.

Nian Si, Stanford University (joint work with Jose Blanchet, Karthyek Murthy)

Asymptotic Normality and Optimal Confidence Regions in Wasserstein Distributionally Robust Optimization

We provide a theory of confidence regions for Wasserstein distributionally robust optimization (DRO) formulations. In addition to showing the asymptotic normality of these types of estimators (under natural convex constraints), we also characterize optimal confidence regions (in a certain sense informed by the underlying DRO formulation and study the asymptotic shape of these regions in a suitable topology defined for convergence of sets.

Soroosh Shafieezadeh Abadeh, EPFL (joint work with Daniel Kuhn, Peyman Mohajerin Esfahani, Viet Anh Nguyen)

Bridging Bayesian and Minimax Mean Square Error Estimation via Wasserstein Distributionally Robust Optimization

We bridge the Bayesian and the minimax mean square error estimators by leveraging tools from modern distributionally robust optimization. We show that the optimal estimator and the least favorable distribution form a Nash equilibrium for the Wasserstein ambiguity set and can be computed by solving a single tractable convex program. We further devise a Frank-Wolfe algorithm with a linear convergence rate to solve the convex program whose direction-searching subproblem can be solved in a quasi-closed form. Using these ingredients, we introduce an image denoiser and a robust Kalman filter.

SPA

Tue.3 H 3007

Continuous Systems in Information Processing (Part I)

Organizer: Martin Benning
Chair: Martin Benning

Elena Celledoni, Norwegian University of Science and Technology

Deep learning as optimal control problems: models and numerical methods

We consider recent work by Haber and Ruthotto, where deep learning neural networks are viewed as discretisations of an optimal control problem. We review the first order conditions for optimality, and the conditions ensuring optimality after discretization. This leads to a class of algorithms for solving the discrete optimal control problem which guarantee that the corresponding discrete necessary conditions for optimality are fulfilled. We discuss two different deep learning algorithms and make a preliminary analysis of the ability of the algorithms to generalize.

Robert Tovey, University of Cambridge (joint work with Martin Benning, Carola-Bibiane Schönlieb, Evren Yarman, Ozan Öktem)

Continuous optimisation of Gaussian mixture models in inverse problems

In inverse problems it is common to include a convex optimisation problem which enforces some sparsity on the reconstruction, e.g. atomic scale Electron tomography. One draw-back to this, in the era of big data, is that we are still required to store and compute using each of those coefficients we expect to be zero. In this talk, we address this by parametrising the reconstruction as a sparse Gaussian Mixture Model and fitting, on a continuous grid, to the raw data. We will discuss the pros (computational complexity) and overcoming the cons (introduction of non-convexity) of such an approach.

Martin Benning, Queen Mary University of London (joint work with Martin Burger, Elena Resmerita)

Iterative regularisation of continuous inverse problems via an entropic projection method

In this talk, we discuss iterative regularisation of continuous, linear ill-posed problems via an entropic projection method. We present a detailed convergence analysis of the scheme that respects the continuous nature of the underlying problem and we present numerical results for continuous and ill-posed inverse problems to support the theory.

STO

Tue.3 H 2033

Large-Scale Stochastic First-Order Optimization (Part II)

Organizers: Filip Hanzely, Samuel Horvath
Chair: Samuel Horvath

Nidham Gazagnadou, Télécom ParisTech (joint work with Robert Gower, Joseph Salmon)

Optimal mini-batch and step sizes for SAGA

Recently, it has been shown that the step sizes of a family of stochastic variance reduced gradient methods, called the JacSketch methods, depend on the expected smoothness constant. We provide closed form expressions for this constant, leading to larger step sizes and thus to faster convergence, and numerical experiments verifying these bounds. We suggest a new practice for setting the mini-batch and step sizes for SAGA, part of the JacSketch family. Furthermore, we can now show that the total complexity of the SAGA algorithm decreases linearly in the mini-batch size up to an optimal value.

Hamed Sadeghi, Lund University (joint work with Pontus Giselsson)

Acceleration of reduced variance stochastic gradient method [canceled]

We propose a convergence acceleration scheme for optimization problems in stochastic settings. We use Anderson acceleration in combination with a reduced variance stochastic gradient method and show that the iterates are stochastically quasi-Fejér monotone. This allows us to prove almost sure convergence of the method. We apply the acceleration technique to reduced variance stochastic gradient algorithms SVRG and SAGA to show its performance gains.

Samuel Horvath, King Abdullah University of Science and Technology

Stochastic Distributed Learning with Gradient Quantization and Variance Reduction

We consider distributed optimization where the objective function is spread among different devices, each sending incremental model updates to a central server. To alleviate the communication bottleneck, recent work proposed various schemes to compress (e.g. quantize or sparsify) the gradients, thereby introducing additional variance, that might slow down convergence. We provided a unified analysis of these approaches in strongly/weakly convex and non-convex frameworks and provide the first methods that achieve linear convergence for arbitrary quantized updates.

Tue.4 16:30–17:45

Memorial Session

Tue.4 H 0105

Reflections on the Life and Work of Andrew R. Conn

Chair: Michael Overton

Andrew R. Conn passed away on March 14, 2019. He played a pioneering role in nonlinear optimization and remained very active in the field until shortly before his death. At this session, five of his friends and colleagues will give 10 minutes tributes to his work and his life. These will be followed by 30 minutes where everyone will have the opportunity to contribute a few words in memory of Andy, as he was always known. The five speakers are:

- Philippe L. Toint, University of Namur
- Katya Scheinberg, Lehigh University
- Annick Sartenaer, University of Namur
- Henry Wolkowicz, University of Waterloo
- James Burke, University of Washington

More information about this memorial session on page 15.

APP

Tue.4 H 1028

Applications in Energy (Part IV)

Chair: Orcun Karaca

Julien Vaes, University of Oxford (joint work with Raphael Hauser)

Optimal Execution Strategy Under Price and Volume Uncertainty

In the seminal paper on optimal execution of portfolio transactions, Almgren and Chriss define how to liquidate a fixed volume of a single security under price uncertainty. Yet sometimes, as in the power market, the volume to be traded can only be estimated and becomes more accurate when approaching the delivery time. We propose a model that accounts for volume uncertainty and show that a risk-averse trader has benefit in delaying trades. With the incorporation of a risk, we avoid the high complexity associated to dynamic programming solutions while yielding to competitive performance.

Harald Held, Siemens, Corporate Technology (joint work with Christoph Bergs)

MINLP to Support Plant Operators in Energy Flexibilization

Many production industries require energy, e.g. in form of electricity, heat, or compressed air. With the rise of renewable energies and storage technologies, the question arises how such industries can take advantage of it, and to get an idea of energy flexibilization potentials at all. In this talk, we will introduce a software tool that is currently being developed at Siemens that allows industry users to assess their flexibilization potentials, and also to ensure cost-optimal operation of production systems. The underlying optimization problem is a Mixed-Integer NonLinear Program (MINLP).

Orcun Karaca, ETH Zürich (joint work with Maryam Kamgarpour)

Core-Selecting Stochastic Auctions

Core-selecting auctions are well-studied in the deterministic case for their coalition-proofness and competitiveness. Recently, stochastic auctions have been proposed as a method to integrate intermittent participants in electricity markets. In this talk, we define core-selecting stochastic auctions and show their properties depending on the way uncertainty is accounted for in the payment mechanism. We illustrate a trade-off between achieving desirable properties, such as cost-recovery and budget-balance, in expectation or in every scenario. Our results are verified with case studies.

BIG

Tue.4 H 2013

Recent Advancements in Optimization Methods for Machine Learning (Part II)

Organizers: Albert Berahas, Martin Takáč
Chair: Albert Berahas

Sebastian U. Stich, EPFL

Communication Efficient Variants of SGD for Distributed Training

The communication overhead is a key bottleneck that hinders perfect scalability of distributed optimization algorithms. Various recent works proposed to use quantization or sparsification techniques to reduce the amount of data that needs to be communicated. We analyze Stochastic Gradient Descent (SGD) with compression of all exchanges messages (like e.g. sparsification or quantization) and show that these schemes converge at the same rate as vanilla SGD when equipped with error compensation technique (i.e. keeping track of accumulated errors in memory).

Martin Takáč, Lehigh University (joint work with Albert Berahas, Majid Jahani)

Quasi-Newton Methods for Deep Learning: Forget the Past, Just Sample

We present two sampled quasi-Newton methods for deep learning: sampled LBFGS (S-LBFGS) and sampled LSR1 (S-LSR1). Contrary to the classical variants of these methods that sequentially build Hessian or inverse Hessian approximations as the optimization progresses, our proposed methods sample points randomly around the current iterate at every iteration to produce these approximations. As a result, the approximations constructed make use of more reliable (recent and local) information, and do not depend on past iterate information that could be significantly stale.

Nicolas Loizou, The University of Edinburgh (joint work with Mahmoud Assran, Nicolas Ballas, Mike Rabbat)

Stochastic Gradient Push for Distributed Deep Learning

Distributed data-parallel algorithms aim to accelerate the training of deep neural networks by parallelizing the computation of large mini-batch gradient updates across multiple nodes. In this work, we study Stochastic Gradient Push (SGP) which combines PushSum gossip protocol with stochastic gradient updates. We prove that SGP converges to a stationary point of smooth, non- convex objectives at the same sub-linear rate as SGD, that all nodes achieve consensus, and that SGP achieves a linear speedup with respect to the number of nodes. Finally, we empirically validate the performance of SGP.

BIG

Tue.4 H 3004

Recent Advances in Algorithms for Large-Scale Structured Nonsmooth Optimization (Part II)

Organizer: Xudong Li
Chair: Xudong Li

Ling Liang, National University of Singapore (joint work with Kim-Chuan Toh, Quoc Tran-Dinh)

A New Homotopy Proximal Variable-Metric Framework for Composite Convex Minimization

This paper suggests a novel idea to develop new proximal variable-metric methods for solving a class of composite convex problems. The idea is to utilise a new optimality condition parameterization to design a class of homotopy proximal variable-metric methods that can achieve linear convergence and finite global iteration-complexity bounds. Moreover, rigorous proofs of convergence results are also provided. Numerical experiments on several applications are given to illustrate our theoretical and computational advancements when compare to other state-of-the-art algorithms.

Meixia Lin, National University of Singapore (joint work with Defeng Sun, Kim-Chuan Toh, Yancheng Yuan)

On the Closed-form Proximal Mapping and Efficient Algorithms for Exclusive Lasso Models

The exclusive lasso regularization based on the $\ell_{1,2}$ norm has become popular due to its superior performance, which results in both inter-group and intra-group sparsity. In this paper, we derive a closed-form solution for the proximal mapping of the $\ell_{1,2}$ norm and its generalized Jacobian. Then we design efficient first and second order algorithms for machine learning models involving the exclusive lasso regularization.

Krishna Pillutla, University of Washington (joint work with Zaid Harchaoui, Sham Kakade, Vincent Roulet)

Large-scale optimization of structured prediction models by inf-convolution smoothing of max-margin inference

We consider the problem of optimizing the parameters of a maximum-margin structured prediction model at a large-scale. We show how an appropriate smoothing by infimal convolution of such non-smooth objectives paves the way to the development of large-scale smooth optimization algorithms making calls to smooth inference oracles, comparable in complexity to the regular inference oracles. We present such an algorithm called Casimir, establish its worst-case information-based complexity, and demonstrate its effectiveness on several machine learning applications.

VIS

Tue.4 H 0110

Semismoothness for Set-Valued Mappings and Newton Method (Part I)

Organizer: Helmut Gfrerer
Chair: Helmut Gfrerer

Ebrahim Sarabi, Miami University, Ohio (joint work with Boris Mordukhovich)

A Semismooth Inverse Mapping Theorem via Tilt Stability and Its Applications in the Newton Method

We present a semismooth inverse mapping theorem for tilt-stable local minimizers of a function. Then we discuss a Newton method for a tilt-stable local minimum of an unconstrained optimization problem.

Jiri Outrata, The Institute of Information Theory and Automation (joint work with Helmut Gfrerer)

On semismooth sets and mappings

The talk is devoted to a new notion of semismoothness which pertains both sets as well as multifunctions. In the case of single-valued maps it is closely related with the standard notion of semismoothness introduced by Qi and Sun in 1993. Semismoothness can be equivalently characterized in terms of regular, limiting and directional limiting coderivatives and seems to be the crucial tool in construction of Newton steps in case of generalized equations. Some basic classes of semismooth sets and mappings enabling us to create an elementary semismooth calculus will be provided.

Helmut Gfrerer, Johannes Kepler University Linz (joint work with Jiri Outrata)

On a semismooth Newton method for generalized equations

The talk deals with a semismooth Newton method for solving generalized equations (GEs), where the linearization concerns both the single-valued and the multi-valued part and it is performed on the basis of the respective coderivatives. Two conceptual algorithms will be presented and shown to converge locally superlinearly under relatively weak assumptions. Then the second one will be used in order to derive an implementable Newton-type method for a frequently arising class of GEs.

CON

Tue.4 H 2032

Advances in Polynomial Optimization

Organizer: Luis Zuluaga
Chair: Luis Zuluaga

Olga Kuryatnikova, Tilburg University (joint work with Renata Sotirov, Juan Vera)

New SDP upper bounds for the maximum k-colorable subgraph problem

For a given graph with n vertices, we look for the largest induced subgraph that can be colored in k colors such that no two adjacent vertices have the same color. We propose several new SDP upper bounds for this problem. The matrix size in the basic SDP relaxations grows with k. To avoid this growth, we use the invariance of the problem under the color permutations. As a result, the matrix size reduces to order $(n+1)$, independently of k or the graph considered. Numerical experiments show that our bounds are tighter than the existing SDP and IP-based bounds for about a half of tested graphs.

Benjamin Peters, Otto von Guericke University Magdeburg

Convexification by means of monomial patterns

A novel convexification strategy based on relaxing monomial relationships is presented. We embed both currently popular strategies, general approaches rooted in nonlinear programming and approaches based on sum-of-squares or moment relaxations, into a unified framework. Within this framework we are able to trade off the quality of relaxation against computational expenses. Our computational experiments show that a combination with a prototype cutting-plane algorithm gives very encouraging results.

Timo de Wolff, TU Braunschweig (joint work with Adam Kurpisz)

New Dependencies of Hierarchies in Polynomial Optimization

We compare four key hierarchies for solving Constrained Polynomial Optimization Problems (CPOP): Sum of Squares (SOS), Sum of Diagonally Dominant (SDSOS), Sum of Nonnegative Circuits (SONC), and the Sherali Adams (SA) hierarchies. We prove a collection of dependencies among these hierarchies. In particular, we show on the Boolean hypercube that Schmüdgen-like versions SDSOS*, SONC*, and SA* of the hierarchies are polynomially equivalent. Moreover, we show that SA* is contained in any Schmüdgen-like hierarchy that provides a $O(n)$ degree bound.

CON

Tue.4 H 3006

Geometry and Algorithms for Conic Optimization

Organizer: Fatma Kilinc-Karzan
Chair: Fatma Kilinc-Karzan

Levent Tuncel, University of Waterloo (joint work with Lieven Vandenberghe)

Recent progress in primal-dual algorithms for convex optimization

We will present new primal-dual algorithms for hyperbolic programming problems. Our algorithms have many desired properties including polynomial-time iteration-complexity for computing an approximate solution (for well-posed instances). In the special case of dense SDPs (as well as for symmetric cone programming problems with self-scaled barriers), our algorithms specialize to Nesterov-Todd algorithm. However, for certain sparse SDPs, our algorithms are new and have additional desired properties.

Leonid Faybusovich, University of Notre Dame (joint work with Cunlu Zhou)

Self-concordance and matrix monotonicity with applications to quantum entanglement problem

We construct a new class of objective functions on a symmetric cone compatible in the sense of Nesterov and Nemirovsky with the standard self-concordant barrier attached to the symmetric cone. The construction involves a matrix monotone scalar function on a positive semi-line. This allows us to develop a long-step path-following algorithm for symmetric programming problems with both equality and inequality constraints and objective functions from the class. In particular, the objective function arising in quantum entanglement problem belongs to this class. Numerical results are presented.

Fatma Kilinc-Karzan, Carnegie Mellon University (joint work with C.J. Argue)

On Sufficient and Necessary Conditions for Rank-1 Generatedness Property of Cones

A convex cone K that is a subset of the positive semidefinite (PSD) cone is rank-one generated (ROG) if all of its extreme rays are generated by rank 1 matrices. ROG property is closely related to the characterizations of exactness of SDP relaxations, e.g., of nonconvex quadratic programs. We consider the case when K is obtained as the intersection of the PSD cone with finitely many linear (or conic) matrix inequalities, and identify sufficient conditions that guarantee that K is ROG. In the case of two linear matrix inequalities, we also establish the necessity of our sufficient condition.

CNV

Tue.4 H 1029

Quasi-Newton-Type Methods for Large-Scale Nonsmooth Optimization

Organizers: Andre Milzarek, Zaiwen Wen
Chair: Andre Milzarek

Ewout van den Berg, IBM T.J. Watson

Speeding up basis-pursuit denoise: hybrid quasi-Newton and beyond

The well-known basis-pursuit denoise problem can be solved using the root-finding approach that was introduced in the SPGL1 solver. In this talk we present several techniques that can improve the performance of the solver. For the Lasso subproblems we develop a hybrid quasi-Newton method that enables light-weight switching between the regular spectral projected-gradient steps and quasi-Newton steps restricted to the current face of the one-norm ball. We also introduce additional improvements to the root-finding procedure and the generation of dual-feasible points.

Minghan Yang, Peking University (joint work with Andre Milzarek, Zaiwen Wen, Tong Zhang)

A stochastic quasi-Newton extragradient method for nonsmooth nonconvex optimization

We present a stochastic quasi-Newton extragradient method for solving composite-type optimization problems. We assume that gradient information of the smooth part of the objective function can only be accessed via stochastic oracles. The proposed algorithm combines semismooth quasi-Newton steps for a fixed-point equation with stochastic proximal extragradient steps and converges to stationary points in expectation. Local convergence results are discussed for a variant of the approach using variance reduction and numerical comparisons are provided illustrating the efficiency of the method.

Florian Mannel, University of Graz (joint work with Armin Rund)

A hybrid semismooth quasi-Newton method for large-scale structured nonsmooth optimization

We present an algorithm for the efficient solution of structured nonsmooth operator equations in Banach spaces. The term structured indicates that we consider equations which are composed of a smooth and a semismooth mapping. The novel algorithm combines a semismooth Newton method with a quasi-Newton method. This hybrid approach retains the local superlinear convergence of both these methods under standard assumptions and can be embedded in a matrix-free limited-memory truncated trust-region framework. Numerical results on nonconvex and nonsmooth large-scale real-world problems are provided.

CNV

Tue.4 H 3002

Performance Estimation of First-Order Methods

Organizers: François Glineur, Adrien Taylor
Chair: Adrien Taylor

Yoel Drori, Google (joint work with Ohad Shamir)
Performance estimation of stochastic first-order methods

We present an extension to the performance estimation methodology, allowing for a computer-assisted analysis of stochastic first-order methods. The approach is applicable in the convex and non-convex settings, and for various suboptimality criteria including the standard minimal gradient norm of the iterates. We describe the approach, new numerical and analytical bounds on the stochastic gradient method, and a construction of a worst-case example establishing tightness of the analyses.

Donghwan Kim, KAIST
Accelerated Proximal Point Method for Maximally Monotone Operators

This work proposes an accelerated proximal point method for maximally monotone operators. The proof is computer-assisted via the performance estimation problem approach. The proximal point method includes many well-known convex optimization methods, such as the alternating direction method of multipliers and the proximal method of multipliers, and thus the proposed acceleration has wide applications. Numerical experiments will be presented to demonstrate the accelerating behaviors.

François Glineur, Université catholique de Louvain (joint work with Antoine Daccache, Julien Hendrickx)
On the Worst-Case of the Fixed-Step Gradient Method for Arbitrary Stepsizes

The problem of computing of the worst-case performance of a given optimization algorithm over a given class of objective functions can in some cases be formulated exactly as a semidefinite optimization problem, whose solution provides both the sought worst-case performance and a description the corresponding objective function. We use this methodology to study the gradient method performing N steps with fixed but arbitrary stepsizes, applied to a smooth convex function. Results suggest the existence of an exponential (in N) number of distinct worst-case behaviours depending on the stepsizes.

DER

Tue.4 H 2038

Challenging Applications in Derivative-Free Optimization (Part II)

Organizers: Ana Luisa Custodio, Sébastien Le Digabel, Margherita Porcelli, Francesco Rinaldi, Stefan Wild
Chair: Sébastien Le Digabel

Mark Abramson, Utah Valley University (joint work with Gavin Smith)
Direct search applied to computation of penetration depth between two polytopes arising from discretized geometry models

An important consistency check in aerospace design is to ensure that no two distinct parts occupy the same space. Discretization of geometry models often introduces small interferences not present in the fully detailed model. We focus on the efficient computation of penetration depth between two 3-D convex polytopes, a well-studied computer graphics problem, to distinguish between real interference and discretization error. We reformulate a 5-variable constrained global optimization problem into a 2-variable nonsmooth problem to more easily find global solutions with a direct search method.

Miguel Munoz Zuniga, IFPEN (joint work with Delphine Sinoquet)
Kriging based optimization of a complex simulator with mixed variables: A randomized exploration of the categorical variables in the Expected Improvement sub-optimization

Real industrial studies often boils down to complex optimization problems involving mixed variables and time consuming simulators. To deal with these difficulties we propose the use of a Gaussian process regression surrogate with a suitable kernel able to capture simultaneously the output correlations with respect to continuous and categorical/discrete inputs without relaxation of the categorical variables. The surrogate is integrated in the Efficient Global Optimization method based on the maximization of the Expected Improvement criterion. This maximization is a Mixed Integer Non-Linear problem which we tackle with an adequate optimizer : the Mesh Adaptive Direct Search, integrated in the NOMAD library. We introduce a random exploration of the categorical space with a data-based probability distribution and we illustrate the full strategy accuracy on a toy problem. Finally we compare our approach with other optimizers on a benchmark of functions.

Phillipe Rodrigues Sampaio, Veolia Research and Innovation (joint work with Stephane Couturier, Thomas Lecomte, Vincent Martin, David Mouquet, Gabriela Naves Maschietto)
Optimization of district heating networks using a grey-box MINLP approach

District heating networks (DHN) are a driving force for decarbonization and energy efficiency. A DHN produces thermal energy and delivers it over distribution networks to buildings. We propose a production scheduling optimization tool that considers heat production and distribution. We use mixed-integer nonlinear models where heat-only and cogeneration units are handled. The network dynamics is addressed by a black-box simulation model. We employ RBF models for time series forecasting that replace the black-box function to obtain an approximate solution. Results on a real case study are shown.

GLO

Tue.4 H 1012

Techniques in Global Optimization

Organizers: Jon Lee, Emily Speakman
Chair: Jon Lee

Daphne Skipper, United States Naval Academy (joint work with Jon Lee, Emily Speakman)
Gaining and losing perspective

We discuss MINLO formulations of the disjunction $x \in \{0\} \cup [l,u]$, where z is a binary indicator of $x \in [l,u]$, and y captures the behavior of x^p, for $p > 1$. This model is useful when activities have operating ranges and we pay a fixed cost for carrying out each activity. Using volume as a measure to compare convex bodies, we investigate a family of relaxations for this model, employing the inequality $yz^q \geq x^p$, parameterized by the "lifting exponent" $q \in [0, p-1]$. We analytically determine the behavior of these relaxations as functions of l, u, p and q.

Claudia D'Ambrosio, CNRS / École Polytechnique (joint work with Jon Lee, Daphne Skipper, Dimitri Thomopulos)
Handling separable non-convexities with disjunctive cuts

The Sequential Convex Mixed Integer Non Linear Programming (SC-MINLP) method is an algorithmic approach for handling separable nonconvexities in the context of global optimization. The algorithm is based on a sequence of convex MINLPs providing lower bounds on the optimal solution value. Solving at each iteration a convex MINLP is the main bottleneck of SC-MINLP. We propose to improve this phase by employing disjunctive cuts and solving instead a sequence of convex NLPs. Computational results show the viability of our approach.

Leo Liberti, CNRS / École Polytechnique (joint work with Claudia D'Ambrosio, Pierre-Louis Poirion, Ky Vu)
Random projections for quadratic optimization

Random projections are used as dimensional reduction techniques in many situations. They project a set of points in a high dimensional space to a lower dimensional one while approximately preserving all pairwise Euclidean distances. Usually, random projections are applied to numerical data. In this talk we present a successful application of random projections to quadratic programming problems. We derive approximate feasibility and optimality results for the lower dimensional problem, and showcase some computational experiments illustrating the usefulness of our techniques.

MUL

Tue.4 H 3013

Recent Developments in Set Optimization (Part IV)

Organizers: Akhtar A. Khan, Elisabeth Köbis, Christiane Tammer
Chair: Elisabeth Köbis

Radu Strugariu, Gheorghe Asachi Technical University of Iasi (joint work with Marius Durea, Marian Pantiruc)
Stability of the directional regularity

We introduce a type of directional regularity for mappings, making use of a special kind of minimal time function. We devise a new directional Ekeland Variational Principle, which we use to obtain necessary and sufficient conditions for directional regularity, formulated in terms of generalized differentiation objects. Stability of the directional regularity with respect to compositions and sums is analyzed. Finally, we apply this study to vector and scalar optimization problems with single and set-valued maps objectives.

Teodor Chelmus, Alexandru Ioan Cuza University of Iasi (joint work with Marius Durea, Elena-Andreea Florea)
Directional Pareto efficiency

We study a notion of directional Pareto minimality that generalizes the classical concept of Pareto efficiency. Then, considering several situations concerning the objective mapping and the constraints, we give necessary and sufficient conditions for the directional efficiency. We investigate different cases and we propose some adaptations of well-known constructions of generalized differentiation. In this way, the connections with some recent directional regularities come into play. As a consequence, several techniques from the study of genuine Pareto minima are considered in our setting.

Diana Maxim, Alexandru Ioan Cuza University of Iasi (joint work with Elena-Andreea Florea)
Directional minimality concepts in vector optimization

We study sufficient conditions for directional metric regularity of an epigraphical mapping in terms of generalized differentiation objects. The main feature proposed by our approach is the possibility to avoid the demanding assumption on the closedness of the graph of such a mapping. To this aim, we prove a version of Ekeland Variational Principle adapted to the situation we consider. Then, we apply our directional openness result to derive optimality conditions for directional Pareto minimality.

IMP

Tue.4 H 0111

Computational Optimization

Chair: Spyridon Pougkakiotis

Steven Diamond, Stanford University (joint work with Akshay Agrawal)

A Rewriting System for Convex Optimization Problems

We present a modular rewriting system for translating optimization problems written in a domain-specific language to forms compatible with low-level solver interfaces. Translation is facilitated by reductions, which accept a category of problems and transform instances of that category to equivalent instances of another category. The proposed system is implemented in version 1.0 of CVXPY, a widely used domain-specific language for convex optimization. We illustrate how the system facilitated CVXPY's extension to disciplined geometric programming, a generalization of geometric programming.

Spyridon Pougkakiotis, University of Edinburgh (joint work with Jacek Gondzio, Kresimir Mihic, John Pearson)

Exploiting Circulant Properties of Matrices in Structured Optimization Problems

Circulant matrices are prevalent in many areas of mathematics. Their eigenvalue decomposition can be computed expeditiously, using the Fast Fourier Transform (FFT). In this talk, we discuss advantages of exploiting circulant properties of matrices arising in certain structured optimization problems.

Harun Aydilek, Gulf University for Science and Technology (joint work with Ali Allahverdi, Asiye Aydilek)

[moved] Minimizing Total Tardiness in a No-Wait Flowshop Scheduling Problem with Separate Setup Times with bounded Makespan

No-wait flowshop scheduling problem is addressed to minimize total tardiness where the Cmax is bounded. A new simulated annealing algorithm (NSA) utilizing a block insertion and exchange operators is proposed. NSA is combined with an iterated search where the block SA explores the search space for a smaller total tardiness while the iterated search satisfies the constraint, called PA. PA is compared with 6 closely related and best algorithms. Computational experiments based on simulations reveal that PA reduces the error of the best algorithm by 50 %. The results are statistically tested.

PDE

Tue.4 H 0106

Computational Design Optimization (Part IV)

Organizers: Martin Siebenborn, Kathrin Welker

Chair: Kathrin Welker

Martin Berggren, Umeå Universitet (joint work with Anders Bernland, André Massing, Eddie Wadbro)

3D acoustic shape optimization including visco-thermal boundary-layer losses

When applying shape optimization to design certain acoustic devices, a challenge is to account for effects of the viscothermal boundary layers that appear in narrow channels and cavities. An accurate model of this phenomenon uses a so-called Wentzell boundary condition together with the Helmholtz equation for the acoustic pressure. For the first time, this model is here used to successfully design such a device, a compression driver feeding a loudspeaker horn. The computations make use of a level-set description of the geometry and the CutFEM framework implemented in the FEniCS platform.

Martin Siebenborn, Universität Hamburg (joint work with Andreas Vogel)

A shape optimization algorithm for cellular composites

In this talk we present a mesh deformation technique for PDE constrained shape optimization. Introducing a gradient penalization to the inner product for linearized shape spaces, mesh degeneration can be prevented and the scalability of employed solvers can be retained. We illustrate the approach by a shape optimization for cellular composites with respect to linear elastic energy under tension. The influence of the gradient penalization is evaluated and the parallel scalability of the approach demonstrated employing a geometric multigrid solver on hierarchically distributed meshes.

Christian Vollmann, Trier University (joint work with Volker Schulz)

Shape optimization for interface identification in nonlocal models

Shape optimization has been proven useful for identifying interfaces in models governed by partial differential equations. For instance, shape calculus can be exploited for parameter identification of problems where the diffusivity is structured by piecewise constant patches. On the other hand, nonlocal models, which are governed by integral operators instead of differential operators, have attracted increased attention in recent years. We bring together these two fields by considering a shape optimization problem which is constrained by a nonlocal convection-diffusion equation.

PDE

Tue.4 H 0107

Optimal Control and Dynamical Systems (Part IV)

Organizers: Cristopher Hermosilla, Michele Palladino
Chair: Cristopher Hermosilla

Maria Soledad Aronna, Fundação Getúlio Vargas (joint work with Monica Motta, Franco Rampazzo)

A higher-order maximum principle for impulsive optimal control problem

We consider a nonlinear control system, affine with respect to an unbounded control u taking values in a closed cone of Rm , and with drift depending on a second, ordinary control a, ranging inn a bounded set. We provide first and higher order necessary optimality conditions for a Bolza problem associated to this system. We illustrate how the chance of using impulse perturbations, makes it possible to derive a Maximum Principle which includes both the usual maximum condition and higher order conditions involving Lie brackets of drift and non-drift vector fields

Jorge Becerril, Universidade do Porto

On optimal control problems with irregular mixed constraints

First order necessary conditions for optimal control problems with mixed constraints are well-known when a regularity criterion is satisfied. On the contrary, problems involving nonregular mixed constraints have received little attention, except for some isolated works, despite being relevant in many areas such as robotics and problems involving sweeping systems. We present necessary conditions for problems involving nonregular mixed constraints derived via infinite dimensional optimization. Moreover, we present a form of regularity which leads to the usual first order necessary conditions.

Michele Palladino, Gran Sasso Science Institute

Handling Uncertainty in Optimal Control

The talk discusses one possible model problem for certain tasks in reinforcement learning. The model provides a framework to deal with situations in which the system dynamics are not known and encodes the available information about the state dynamics as a measure on the space of functions. Such a measure updates in time, taking into account all the previous measurements and extracting new information from them. Technical results about the value function of such a problem are stated, and several possible applications to reinforcement learning and the exploration-exploitation tradeoff are discussed.

PDE

Tue.4 H 0112

Fractional/Nonlocal PDEs: Applications, Control, and Beyond (Part I)

Organizers: Harbir Antil, Carlos Rautenberg, Mahamadii Warma
Chair: Harbir Antil

Ekkehard Sachs, Universität Trier

Economic Models with Nonlocal Operators

The Ramsey model is one of the most popular neoclassical growth models in economics. The basic time-dependent model has been extended by a spatial component in recent years, i.e. capital accumulation is modeled as a process not only in time but in space as well. We consider a Ramsey economy where the value of capital depends not only on the respective location but is influenced by the surrounding areas as well. Here, we do not only take spatially local effects modeled by a diffusion operator into account but we also include a nonlocal diffusion term in integral form leading to control PIDEs.

Mahamadii Warma, University of Puerto Rico, Rio Piedras Campus

Controllability of fractional heat equations under positivity constraints

We analyze the controllability properties under positivity constraints of the heat equation involving the fractional Laplacian on the interval $(-1, 1)$. We prove the existence of a minimal (strictly positive) time $T_{\min}$ such that the fractional heat dynamics can be controlled from any non-negative initial datum to a positive steady state, when $s > 1/2$. Moreover, we prove that in this minimal time constrained, controllability can also be achieved through a control that belongs to a certain space of Radon measures. We also give some numerical results.

Carlos Rautenberg, Humboldt-Universität zu Berlin / WIAS

A nonlocal variational model in image processing associated to the spatially variable fractional Laplacian

We propose a new variational model in weighted Sobolev spaces with non-standard weights and applications to image processing. We show that these weights are, in general, not of Muckenhoupt type and therefore the classical analysis tools may not apply. For special cases of the weights, the resulting variational problem is known to be equivalent to the fractional Poisson problem. We propose a finite element scheme to solve the Euler-Lagrange equations, and for the image denoising application we propose an algorithm to identify the unknown weights. The approach is illustrated on several test problems and it yields better results when compared to the existing total variation techniques.

ROB

Tue.4 H 1058

Recent Advances in Distributionally Robust Optimization

Organizer: Peyman Mohajerin Esfahani
Chair: Peyman Mohajerin Esfahani

Jose Blanchet, Stanford University (joint work with Peter Glynn, Zhengqing Zhou)

Distributionally Robust Performance Analysis with Martingale Constraints

We consider distributionally robust performance analysis of path-dependent expectations over a distributional uncertainty region which includes both a Wasserstein ball around a benchmark model, as well as martingale constraints. These types of constraints arise naturally in the context of dynamic optimization. We show that these problems (which are infinite dimensional in nature) can be approximated with a canonical sample complexity (i.e. square root in the number of samples). We also provide various statistical guarantees (also in line with canonical statistical rates).

John Duchi, Stanford University (joint work with Hongseok Namkoong)

Distributional Robustness, Uniform Predictions, and applications in Machine Learning

A common goal in statistics and machine learning is to learn models that can perform well against distributional shifts, such as latent heterogeneous subpopulations, unknown covariate shifts, or unmodeled temporal effects. We develop and analyze a distributionally robust stochastic optimization framework that learns a model that provides good performance against perturbations to the data-generating distribution. We give a convex optimization formulation for the problem, providing several convergence guarantees, including finite sample upper and lower minimax bounds.

Peyman Mohajerin Esfahani, TU Delft (joint work with Daniel Kuhn, Viet Anh Nguyen, Soroosh Shafieezadeh Abadeh)

Wasserstein Distributionally Robust Optimization: Theory and Applications in Machine Learning

In this talk, we review recent developments in the area of distributionally robust optimization, with particular emphasis on a data-driven setting and robustness to the so-called Wasserstein ambiguity set. We argue that this approach has several conceptual and computational benefits. We will also show that Wasserstein distributionally robust optimization has interesting ramifications for statistical learning and motivates new approaches for fundamental learning tasks such as classification, regression, maximum likelihood estimation or minimum mean square error estimation, among others.

ROB

Tue.4 H 2053

Robust Optimization: Theory and Applications

Organizer: Vineet Goyal
Chair: Vineet Goyal

Chaithanya Bandi, Kellogg School of Management, Northwestern University

Using RO for Simulation Optimization using the Method of Types

The method of types is one of the key technical tools in Information Theory with applications to Shannon theory, hypothesis testing and large deviations theory. In this talk, we present results using this approach to construct generalized typical sets that allow us analyze and optimize the expected behavior of stochastic systems. We then use the idea of Averaged RO approach developed by Bertsimas and Youssef (2019) to approximate and optimize the expected behavior. We illustrate our approach by finding optimal control policies for multi-class queueing networks arising in data centers.

Daniel Zhuoyu Long, CUHK (joint work with Jin Qi, Aiqi Zhang)

The Supermodularity in Two-Stage Distributionally Robust Optimization

We solve a class of two-stage distributionally robust optimization problems which are with the property of supermodular. We apply the monotone coupling results and derive the worst-case distribution precisely, which leads to the tractability of this two-stage distributionally robust optimization problem. Furthermore, we provide a necessary and sufficient condition to check if any given problem has supermodular property. We apply this framework to classical problems including multi-item newsvendor problems, general assemble-to-order (ATO) systems and the appointment scheduling problem.

Vineet Goyal, Columbia University (joint work with Omar El Housni)

Beyond Worst Case: A Probabilistic Analysis of Affine Policies in Dynamic Optimization

Affine policies are widely used in dynamic optimization where computing an optimal adjustable solution is often intractable. While the worst case performance of affine policies is significantly bad, the observed empirical performance is near-optimal for a large class of instances. In this paper, we aim to address this stark-contrast between the worst-case and the empirical performance of affine policies, and show that affine policies give a provably good approximation for two-stage robust optimization problem with high probability on random instances for a large class of distributions.

ROB

Tue.4 H 3012

Embracing Extra Information in Distributionally Robust Models

Organizer: Rui Gao
Chair: Rui Gao

Zhenzhen Yan, Nanyang Technological University (joint work with Louis Chen, Will Ma, Karthik Natarajan, David Simchi-Levi)

Distributionally Robust Linear and Discrete Optimization with Marginals

In this paper, we study the class of linear and discrete optimization problems in which the objective coefficients are chosen randomly from a distribution, and the goal is to evaluate robust bounds on the expected optimal value as well as the marginal distribution of the optimal solution. The set of joint distributions is assumed to be specified up to only the marginal distributions. Though the problem is NP-Hard, we establish a primal-dual analysis that yields sufficiency conditions for poly-time solvability as well as computational procedures. Application problems are also explored.

Mathias Pohl, University of Vienna

Robust risk aggregation with neural networks

We consider settings in which the distribution of a multivariate random variable is partly ambiguous: The ambiguity lies on the level of dependence structure, and that the marginal distributions are known. We work with the set of distributions that are both close to a given reference measure in a transportation distance and additionally have the correct marginal structure. The goal is to find upper and lower bounds for integrals of interest with respect to distributions in this set. The described problem appears naturally in the context of risk aggregation.

Zhiping Chen, Xi'an Jiaotong University

Stability analysis of optimization problems with distributionally robust dominance constraints induced by full random recourse

We derive the quantitative stability results, under the appropriate pseudo metric, for stochastic optimization problems with distributionally robust dominance constraints induced by full random recourse. To this end, we first establish the qualitative and quantitative stability results of the optimal value function and the optimal solution set for optimization problem with k-th order stochastic dominance constraints under the Hausdorff metric, which extend the present results to the locally Lipschitz continuity case.

SPA

Tue.4 H 2033

Sparse Optimization and Information Processing - Contributed Session I

Organizer: Shoham Sabach
Chair: Jordan Ninin

Nikolaos Ploskas, University of Western Macedonia (joint work with Nikolaos Sahinidis, Nikolaos Samaras)

An advanced initialization procedure for the simplex algorithm

This paper addresses the computation of an initial basis for the simplex algorithm for linear programming. We propose six algorithms for constructing an initial basis that is sparse and will reduce the fill-in and computational effort during LU factorization and updates. Over a set of 62 large benchmarks, the best proposed algorithm produces remarkably sparse starting bases. Taking into account only the hard instances, the proposed algorithm results in 23% and 30% reduction of the geometric mean of the execution time of CPLEX's primal and dual simplex algorithm, respectively.

Jordan Ninin, ENSTA-Bretagne (joint work with Ramzi Ben Mhenni, Sebastien Bourguignon)

Global Optimization for Sparse Solution of Least Squares Problems

Finding low-cardinality solutions to least-squares problems has found many applications in signal processing. We propose a branch-and-bound algorithm for global optimization of cardinality-constrained and cardinality-penalized least-squares, and cardinality minimization under quadratic constraints. A tree-search exploration strategy is built based on forward selection heuristics, and the continuous relaxation problems are solved with a dedicated algorithm inspired by homotopic methods. On all conducted experiments, our algorithms at least equal and often outperform the MIP solver CPLEX.

Montaz Ali, WITS (joint work with Ahdam Stoltz)

Call Center's Optimization Problem

The special and unique features of this problem are then shown to be: the need to perform scheduling on a batch basis every day, without knowledge of what will occur the following day and also the requirement that resources (call centre capacity) are fully utilized and not exceeded. The result of the research is that a new mathematical model called the Critical Time Window Resource Levelling Problem (CTWRLP) with the Continual Rescheduling method is developed and proposed as a method for solving the real world scheduling problem.

SPA

Tue.4 H 3007

Nonlinear Optimization Algorithms and Applications in Data Analysis (Part III)

Organizers: Xin Liu, Cong Sun
Chair: Cong Sun

Geovani Grapiglia, Universidade Federal do Paraná (joint work with Yurii Nesterov)

Regularized Tensor Methods for Minimizing Functions with Hölder Continuous Higher-Order Derivatives

In this work, we propose p-order methods for minimization of convex functions that are p-times differentiable with ν-Hölder continuous p-th derivatives. For the schemes without acceleration, we establish iteration complexity bounds of $O(\epsilon^{-1/(p+\nu-1)})$. Assuming that ν is known, we obtain an improved complexity bound of $O(\epsilon^{-1/(p+\nu)})$ for the corresponding accelerated scheme. For the case in which ν is unknown, we present a universal accelerated tensor scheme with complexity of $O(\epsilon^{-p/(p+1)(p+\nu-1)})$. A lower complexity bound is also obtained.

Yadan Chen, Academy of Mathematics and System Science, Chinese Academy of Sciences (joint work with Xin Liu, Yaxiang Yuan)

Alternating Direction Method of Multipliers to Solve Two Continuous Models for Graph-based Clustering

Clustering is an important topic in data science. The popular approaches including K-means algorithm and nonnegative matrix factorization (NMF) directly use data points as input and consider problems in Euclidean space. In this paper, we propose a new approach which considers Gaussian kernel based on graph construction. Moreover, the final cluster labels can be directly obtained without post-processing. The experimental results on real data sets have shown that the proposed approach achieves better clustering results in terms of accuracy and mutual information.

Wed.1 11:30–12:45

APP

Wed.1 H 3004

Structural Design Optimization (Part I)

Organizer: Tamás Terlaky
Chair: Tamás Terlaky

Jacek Gondzio, The University of Edinburgh (joint work with Alemseged Gebrehiwot Weldeyesus)

Computational Challenges in Structural Optimization

We address challenges related to solving real world problems in structural optimization. Such problems arise for example in layout optimization of tall buildings, long bridges or large spanning roofs. We propose to solve such problems with a highly specialized primal-dual interior point method. The problems may be formulated as (very large) linear or, if additional stability concerns are addressed, semidefinite programs. In this talk we will focus on computational challenges arising in such problems and efficient ways to overcome them.

Alexander Brune, University of Birmingham (joint work with Michal Kočvara)

Modified Barrier Multigrid Methods for Topology Optimization

One of the challenges of topology optimization lies in the size of the problems, which easily involve millions of variables. We consider the example of the variable thickness sheet (VTS) problem and propose a Penalty-Barrier Multiplier (PBM) method to solve it. In each iteration, we minimize a generalized augmented Lagrangian by the Newton method. The arising large linear systems are reduced to systems suitable for a standard multigrid method. We apply a multigrid preconditioned MINRES method. The algorithm is compared with the optimality criteria (OC) method and an interior point (IP) method.

Tamás Terlaky, Lehigh University, Bethlehem, PA (joint work with Ramin Fakhimi, Sicheng He, Weiming Lei, Joaquim Martins, Mohammad Shahabsafa, Luis Zuluaga)

Truss topology design and sizing optimization with kinematic stability

We propose a novel mathematical optimization model for Truss Topology Design and Sizing Optimization (TTDSO) problem with Euler buckling constraints. We prove that the proposed model, with probability 1, is delivering a kinematicly stable structure. Computational experiments, using an adaptation of our MILO-moving neighborhood search strategy, shows that our model and computational approach is superior when compared to other approaches.

APP

Wed.1 H 3025

Mathematical Optimization in Signal Processing (Part I)

Organizers: Ya-Feng Liu, Zhi-Quan Luo
Chair: Zhi-Quan Luo

Sergiy A. Vorobyov, Aalto University (joint work with Mihai I. Florea)

Accelerated majorization based optimization for large-scale signal processing: Some new theoretical concepts and applications

Numerous problems in signal processing are cast or approximated as large-scale convex optimization problems. Because of their size, such problems can be solved only using first-order methods. Acceleration is then becomes the main feature of the methods. We will overview some our recent results on the topic (the majorization minimization framework appears to be an umbrella for many such methods including Nesterov's FGM, FISTA, our ACGM, and others) and give a number of successful applications in signal processing (LASSO, NNLS, L1LR, RR, EN, radar waveform design with required properties).

Yang Yang, Fraunhofer ITWM (joint work with Marius Pesavento)

Parallel best-response algorithms for nonsmooth nonconvex optimization with applications in matrix factorization and network anomaly detection

Block coordinate descent algorithms based on nonlinear best-response, or Gauss-Seidel algorithm, is one of the most popular algorithm in large-scale nonsmooth optimization. In this paper, we propose a parallel (Jacobi) best-response algorithm, where a stepsize is introduced to guarantee the convergence. Although the original problem is nonsmooth, we propose a simple line search method carried out over a properly designed smooth function. The proposed algorithm, evaluated for the nonsmooth nonconvex sparsity-regularized rank minimization problem, exhibts fast convergence and low complexity.

Bo Jiang, Nanjing Normal University (joint work with Shiqian Ma, Anthony Man-Cho So, Shuzhong Zhang)

Vector Transport-Free SVRG with General Retraction for Riemannian Optimization: Complexity Analysis and Practical Implementation

We propose a vector transport-free stochastic variance reduced gradient (TF-SVRG) method for empirical risk minimization over Riemannian manifold. The TF-R-SVRG we propose handles general retraction operations, and does not need additional vector transport evaluations as done by most existing manifold SVRG methods. We analyze the iteration complexity of TF-R-SVRG for obtaining an ϵ-stationary point and its local linear convergence by assuming the Lojasiewicz inequality. We also incorporate the Barzilai-Borwein step size and design a very practical TF-R-SVRG-BB method.

BIG

Wed.1 H 0104

Distributed Algorithms for Constrained Nonconvex Optimization: Clustering, Network Flows, and Two-Level Algorithms

Organizers: Andy Sun, Wotao Yin
Chair: Wotao Yin

Kaizhao Sun, Georgia Institute of Technology (joint work with Andy Sun)

A two-level distributed algorithm for constrained nonconvex programs with global convergence

This work is motivated by the desire to solve network constrained nonconvex programs with convergence guarantees. We propose a two-level algorithm with an inner level of ADMM in an augmented Lagrangian framework that can guarantee global convergence for a wide range of smooth and nonsmooth nonconvex constrained programs. We demonstrate the effectiveness of the algorithm with comparison to existing algorithms on some important classes of problems and discuss its convergence rate properties.

Tsung-Hui Chang, The Chinese University of Hong Kong, Shenzhen

Large-Scale Clustering by Distributed Orthogonally Constrained NMF Model

The non-negative matrix factorization (NMF) model with an additional orthogonality constraint on one of the factor matrices, called the orthogonal NMF (ONMF), has been found to provide improved clustering performance over the K-means. We propose an equivalent problem reformulation that transforms the orthogonality constraint into a set of norm-based non-convex equality constraints. We then apply one smooth and one non-smooth penalty approach to handle these non-convex constraints, which result in desirable separable structures for efficient parallel computations.

Tao Jiang, University of Waterloo (joint work with Stephen Vavasis, Chen Wen (Sabrina) Zhai)

Recovery of a mixture of Gaussians by sum-of-norms clustering

Sum-of-norms clustering is a novel clustering method using convex optimization. Recently, Panahi et al. proved that sum-of norms clustering is guaranteed to recover a mixture of Gaussians under the restriction that the sample size is not too large. This paper lifts the restriction and shows that sum-of-norms clustering with equal weights recovers a mixture of Gaussians even as the number of samples tends to infinity. Our proof relies on an interesting characterization of clusters computed by sum-of-norms clustering developed inside a proof of the agglomeration conjecture by Chiquet et al.

BIG

Wed.1 H 0110

Modern Optimization Methods in Machine Learning

Organizer: Qingna Li
Chair: Qingna Li

Chengjing Wang, Southwest Jiaotong University (joint work with Defeng Sun, Peipei Tang, Kim-Chuan Toh)

A sparse semismooth Newton based proximal majorization-minimization algorithm for nonconvex square-root-loss regression problems

In this paper, we consider high-dimensional nonconvex square-root-loss regression problems. We shall introduce a proximal majorization-minimization (PMM) algorithm for these problems. Our key idea for making the proposed PMM to be efficient is to develop a sparse semismooth Newton method to solve the corresponding subproblems. By using the Kurdyka-Lojasiewicz property exhibited in the underlining problems, we prove that the PMM algorithm converges to a d-stationarity point. Extensive numerical experiments are presented to demonstrate the high efficiency of the proposed PMM algorithm.

Peipei Tang, Zhejiang University City College (joint work with Dunbiao Niu, Enbin Song, Chengjing Wang, Qingsong Wang)

A semismooth Newton based augmented Lagrangian method for solving the support vector machine problems

In this talk, we propose a highly efficient semismooth Newton based augmented Lagrangian method for solving a large-scale convex quadratic programming problem generated by the dual of the SVM with constraints consisting of one linear equality constraint and a simple box constraint. By leveraging on available error bound results to realize the asymptotic superlinear convergence property of the augmented Lagrangian method, and by exploiting the second-order sparsity of the problem through the semismooth Newton method, the algorithm we propose can efficiently solve these difficult problems.

Qingna Li, Beijing Institute of Technology (joint work with Juan Yin)

A Semismooth Newton Method for Support Vector Classification and Regression

SVM is an important and fundamental technique in machine learning. In this talk, we apply a semismooth Newton method to solve two typical SVM models: the L^2-loss SVC model and the ϵ-L^2-loss SVR model. A common belief on the semismooth Newton method is its fast convergence rate as well as high computational complexity. Our contribution is that by exploring the sparse structure of the models, we significantly reduce the computational complexity, meanwhile keeping the quadratic convergence rate. Extensive numerical experiments demonstrate the outstanding performance of the method.

VIS

Wed.1 H 3008

Complementarity and Variational Inequalities - Contributed Session I

Chair: Felipe Lara

Gayatri Pany, Singapore University of Technology and Design

A variational inequality approach to model green transport network

We aim to develop a transport network model that maximizes societal benefits and minimizes environmental effects in terms of energy use and GHG emissions. The model pertains to the use of different modes of transport, like automated vehicles, electric vehicles. Based on different modes of travel, a multi-criteria transport model will be formulated. The proposed approach will be to derive the optimality and the equilibrium conditions, which will satisfy a variational inequality. The equilibrium will be characterized by analyzing the continuity and strict monotonicity of the underlying operator.

Pankaj Gautam, Indian Institute of Technology (BHU) Varanasi (joint work with Tanmoy Som Tanmoy)

Common zero of lower semicontinuous function and monotone operator

In this talk, we consider the problem to find the common zero of a non-negative lower semicontinuous function and a maximal monotone operator in a real Hilbert space. Algorithms permit us to solve the problem when the operators are not the projection operator, or the projection is not easy to compute. As an application, the result presented is used to study the strong convergence theorem for split equality variational problem. Some numerical examples are included to demonstrate the efficiency and applicability of the method.

Felipe Lara, Getulio Vargas Foundation

Existence results for equilibrium problems and mixed variational inequalities

We use asymptotic analysis for studying noncoercive pseudomonotone equilibrium problems and noncoercive mixed variational inequalities, both in the nonconvex case. We provide general necessary and sufficient optimality conditions for the set of solutions to be nonempty and compact for both problems. As a consequence, a characterization of the nonemptiness and compactness of the solution sets is given. Finally, a comparison between our results with previous ones presented in the literature is given.

This talk is based on two papers in collaboration with Alfredo Iusem from IMPA, Brazil.

VIS

Wed.1 H 3013

Semismoothness for Set-Valued Mappings and Newton Method (Part II)

Organizer: Helmut Gfrerer
Chair: Helmut Gfrerer

Martin Brokate, TU München

Sensitivity of rate-independent evolutions

Rate independent evolutions are inherently nonsmooth. In this talk we present results concerning weak differentiability properties of such evolutions resp. the solution operator of the associated variational inequality. In particular, we discuss whether these operators are semismooth.

Nico Strasdat, TU Dresden (joint work with Andreas Fischer)

A Newton-type method for the solution of complementarity problems

Recently, a Newton-type method for the solution of Karush-Kuhn-Tucker system has been developed, that builds on the reformulation of the system as system of nonlinear equations by means of the Fischer-Burmeister function. Based on a similar idea, we propose a constrained Levenberg-Marquardt-type method for solving a general nonlinear complementarity problem. We show that this method is locally superlinear convergent under certain conditions which allow nonisolated and degenerate solutions.

Anna Walter, TU Darmstadt (joint work with Stefan Ulbrich)

Numerical Solution Strategies for the Elastoplasticity Problem with Finite Deformations

We consider the optimal control of elastoplasticity problems with large deformations motivated by engineering applications. To solve the optimal control problem, we need to handle the occurring flow rule within the simulation. Therefore we analyze different solution approaches which are motivated by methods applied in linear elastoplasticity but extended to the case of a multiplicative split of the deformation gradient. Due to the high complexity of the resulting model, we include reduced order models to speed up the simulation process. We present theoretical as well as computational aspects.

CON

Wed.1 H 0107

Semidefinite Approaches to Combinatorial Optimization

Organizer: Renata Sotirov
Chair: Renata Sotirov

Hao Hu, Tilburg University (joint work with Renata Sotirov, Henry Wolkowicz)

Combining symmetry reduction and facial reduction for semidefinite programming

For specially structured SDP instances, symmetry reduction is an application of representation theory to reduce the dimension of the feasible set. For an SDP instance that fails Slater's condition, facial reduction technique can be employed to find the smallest face of the PSD cone containing the feasible region. The resulting SDP instance is of smaller dimension and satisfies Slater's condition. In this talk, we show that symmetry reduction and facial reduction can be exploited at the same time. Our method is simple to implement, and is applicable for a wide variety of applications of SDPs.

Christian Truden, Alpen-Adria-Universität Klagenfurt (joint work with Franz Rendl, Renata Sotirov)

Lower Bounds for the Bandwidth Problem

The bandwidth problem asks for a simultaneous permutation of the rows and columns of the adjacency matrix of a graph such that all nonzero entries are as close as possible to the diagonal. We present novel approaches to obtain lower bounds on the bandwidth problem and introduce a vertex partition problem to bound the bandwidth of a graph. By varying sizes of partitions, we have a trade-off between quality of bounds and efficiency of computing them. To compute lower bounds, we derive several SDP relaxations. Finally, we evaluate our approach on a carefully selected set of benchmark instances.

Daniel Brosch, Tilburg University (joint work with Etienne de Klerk)

A new look at symmetry reduction of semidefinite relaxations of the quadratic assignment problem

The Jordan reduction, a symmetry reduction method for semidefinite programming, was recently introduced for symmetric cones by Parrilo and Permenter. We extend this method to the doubly nonnegative cone and investigate its application to a strong relaxation of the quadratic assignment problem. This reduction is then used to efficiently calculate better bounds for certain discrete energy minimization problems, which initially have the form of semidefinite programs too large to be solved directly.

CON

Wed.1 H 2032

Polynomial Optimization (Part I)

Organizer: Grigoriy Blekherman
Chair: Grigoriy Blekherman

Oguzhan Yuruk, TU Braunschweig (joint work with E. Feliu, N. Kaihnsa, B. Sturmfels, Timo de Wolff)

An analysis of multistationarity in n-site phosphorylation cycle using circuit polynomials

Parameterized ordinary differential equation systems are crucial for modeling in biochemical reaction networks under the assumption of mass-action kinetics. Various questions concerning the signs of multivariate polynomials in positive orthant arise from studying the solutions' qualitative behavior with respect to parameter values. In this work, we utilize circuit polynomials to find symbolic certificates of nonnegativity to provide further insight into the number of positive steady states of the n-site phosphorylation cycle model.

João Gouveia, University of Coimbra (joint work with Mina Saee Bostanabad, Alexander Kovacec)

Matrices of bounded factor width and sums of k-nomial squares

In 2004, Boman et al introduced the concept of factor width of a semidefinite matrix A. This is the smallest k for which one can write the matrix as $A = VV^T$ with each column of V containing at most k non-zeros. In the polynomial optimization context, these matrices can be used to check if a polynomial is a sum of squares of polynomials of support at most k. We will prove some results on the geometry of the cones of matrices with bounded factor widths and their

Grigoriy Blekherman, Georgia Institute of Technology

Symmetry and Nonnegativity

I will discuss several recent results on symmetric nonnegative polynomials and their approximations by sums of squares. I will consider several types of symmetry, but the situation is especially interesting in the limit as the number of variables tends to infinity. There are diverse applications to quantum entanglement, graph density inequalities and theoretical computer science.

CNV

Wed.1 H 1028

New Frontiers in Splitting Algorithms for Optimization and Monotone Inclusions (Part I)

Organizer: Patrick L. Combettes
Chair: Patrick L. Combettes

Bang Cong Vu, École Polytechnique Fédérale de Lausanne (EPFL)

A splitting method for three operators involving Lipschitzian operators

We investigate the problem of finding a zero point of the sum of 3 operators where one of them is monotone Lipschitzian. We propose a new splitting method for solving this inclusion in real Hilbert spaces. The proposed framework unifies several splitting method existing in the literature. The weak convergence of the iterates is proved. The strong convergence is also obtained under an additional assumptions. Applications to sums of composite monotone inclusions and composite minimization problems are demonstrated.

Saverio Salzo, Istituto Italiano di Tecnologia

Parallel random block-coordinate forward-backward algorithm: A complete convergence analysis

We study the block coordinate forward-backward algorithm where the blocks are updated in a random and possibly parallel manner. We consider the convex case and provide a unifying analysis of the convergence under different hypotheses, advancing the state of the art in several aspects.

Patrick L. Combettes, North Carolina State University (joint work with Minh N. Bui)

A general Bregman-based splitting scheme for monotone inclusions

We present a unifying framework for solving monotone inclusions in general Banach spaces using Bregman distances. This is achieved by introducing a new property that includes in particular the standard cocoercivity property. Several classical and recent algorithms are featured as special cases of our framework. The results are new even in standard Euclidean spaces. Applications are discussed as well.

CNV

Wed.1 H 1058

Convex and Nonsmooth Optimization - Contributed Session I

Chair: Vladimir Shikhman

Igor Konnov, Kazan Federal University

Gradient Methods with Regularization for Optimization Problems in Hilbert spaces

We suggest simple implementable modifications of gradient type methods for smooth convex optimization problems in Hilbert spaces, which may be ill-posed. At each iteration, the selected method is applied to some perturbed optimization problem, but we change the perturbation only after satisfying a simple estimate inequality, which allows us to utilize mild rules for the choice of the parameters. Within these rules we prove strong convergence and establish complexity estimates for the methods. Preliminary results of computational tests confirm efficiency of the proposed modification.

Ali Dorostkar, Isfahan Mathematics House (IMH)

An Introduction to Fractional Dimensional Optimization Problem

A general framework for fractional dimensional optimization method is introduced. It is shown that there is a tangent line of function in fractional dimensions which directly passes through the root. The method is presented to investigate a possibility of direct solution of optimization problem, however; analysis of fractional dimension needs further investigation. Beside method has a possibility to use for convex and non-convex and also local and global optimization problems. As a point, fractional dimensional optimization method opens a different view and direction for optimization problem.

Vladimir Shikhman, Chemnitz University of Technology (joint work with David Müller, Yurii Nesterov)

Discrete choice prox-functions on the simplex

We derive new prox-functions on the simplex from additive random utility models of discrete choice. They are convex conjugates of the corresponding surplus functions. We explicitly derive the convexity parameter of discrete choice prox-functions associated with generalized extreme value models, and specifically with generalized nested logit models. Incorporated into subgradient schemes, discrete choice prox-functions lead to natural probabilistic interpretations of the iteration steps. As illustration we discuss an economic application of discrete choice prox-functions in consumption cycle.

DER

Wed.1 H 2033

Emerging Trends in Derivative-Free Optimization (Part II)

Organizers: Ana Luisa Custodio, Sébastien Le Digabel, Margherita Porcelli, Francesco Rinaldi, Stefan Wild
Chair: Nikolaus Hansen

Anne Auger, Inria (joint work with Dimo Brockhoff, Nikolaus Hansen, Cheikh Touré)

COMO-CMA-ES: a linearly convergent derivative free multi-objective solver

We present a new multi-objective optimization solver, COMO-CMA-ES that aim at converging towards p points of the Pareto set solution of a multi-objective problem. Denoting n the search space dimension, the solver approaches the $p \times n$-dimensional problem of finding p solutions maximizing the hypervolume by a dynamic subspace optimization. Each subspace optimization is performed with the CMA-ES solver. We show empirically that COMO-CMA-ES converges linearly on bi-convex-quadratic problems and that it has better performance than the MO-CMA-ES, NSGA-II and SMS-EMOA algorithms.

Ludovic Salomon, Polytechnique Montréal (joint work with Jean Bigeon, Sébastien Le Digabel)

MADMS: Mesh adaptive direct multisearch for blackbox constrained multiobjective optimization

Derivative-free multiobjective optimization involves the presence of two or more conflicting objective functions, considered as blackboxes for which no derivative information is available. This talk describes a new extension of the Mesh Adaptive Direct Search (MADS) algorithm, called MADMS. This algorithm keeps a list of non-dominated points which converges to the Pareto front. As for the single-objective MADS algorithm, this method is built around an optional search step and a poll step. Convergence results and promising computational experiments will be described.

Ana Luisa Custodio, Universidade Nova de Lisboa (joint work with Maria do Carmo Brás)

On the use of quadratic polynomial models in multiobjective directional direct search

Polynomial interpolation or regression models are an important tool in Derivative-free Optimization, acting as surrogates of the real function. In this work we propose the use of these models in a multiobjective framework, namely the one of Direct Multisearch. Previously evaluated points are used to build quadratic polynomial models, which are minimized in an attempt of generating nondominated points of the true function, defining a search step for the algorithm. We will detail the proposed methodology and report compelling numerical results, stating its competitiveness.

MUL

Wed.1 H 3002

Algorithmic Approaches to Multi-Objective Optimization

Organizers: Gabriele Eichfelder, Alexandra Schwartz
Chair: Christian Günther

Yousuke Araya, Akita Prefectural University

Nonlinear scalarizations in set optimization problems

The investigation of nonlinear scalarizing functions for sets began around twenty years ago. Recently, many authors have investigated nonlinear scalarization techniques for set optimization problems. In this presentation, first we look back into the history of nonlinear scalarization techniques for sets, and introduce three important papers published in the 2000s. Afterwards, we present recent advances on this topic.

Christian Günther, Martin Luther University Halle-Wittenberg (joint work with Ali Farajzadeh, Bahareh Khazayel, Christiane Tammer)

Relationships between Clarke-Ye type penalization and vectorial penalization in multi-objective optimization

Penalization approaches in multi-objective optimization aim to replace the original constrained optimization problem by some related problems with an easier structured feasible set (e.g., unconstrained problems). One approach, namely the Clarke-Ye type penalization method, consists of adding a penalization term with respect to the feasible set in each component function of the objective function. In contrast, the vectorial penalization approach is based on the idea to add a new penalization (component) function to the vector-valued objective function. In this talk, we compare both approaches.

Stefan Banholzer, Universität Konstanz

Convex Multiobjective Optimization by the Reference Point Method

This talk discusses the application of the reference point method to convex multiobjective optimization problems with arbitrarily many cost functions. The main challenge of the reference point method in the case of more than two cost functions is to find reference points which guarantee a uniform approximation of the whole Pareto front. In this talk we develop a theoretical description of the set of 'suitable' reference points, and show how this can be used to construct an iterative numerical algorithm for solving the multiobjective optimization problem.

NON

Wed.1 H 0105

Geometry in Non-Convex Optimization (Part I)

Organizers: Nicolas Boumal, André Uschmajew, Bart Vandereycken
Chair: André Uschmajew

Suvrit Sra, MIT

Riemannian optimization for some problems in probability and statistics

Non-convex optimization is typically intractable. This intractability can be surmounted if the problem possesses enough structure. This talk focuses on "geodesic convexity" as this structure. This hidden convexity not only yields proofs not only of tractability but also suggests practical algorithmic approaches. I will highlight several examples from machine learning and statistics, where non-Euclidean geometry plays a valuable role in obtaining efficient solutions to fundamental tasks (e.g., eigenvector computation, gaussian mixtures, Wasserstein barycenters, etc.).

Nick Vannieuwenhoven, KU Leuven (joint work with Paul Breiding)

Riemannian optimization for computing canonical polyadic decompositions

The canonical tensor rank approximation problem consists of approximating a real-valued tensor by one of low canonical rank, which is a challenging non-linear, non-convex, constrained optimization problem, where the constraint set forms a non-smooth semi-algebraic set. We discuss Riemannian optimization methods for solving this problem for small-scale, dense tensors. The proposed method displayed up to two orders of magnitude improvements in computational time for challenging problems, as measured by the condition number of the tensor rank decomposition.

Nicolas Boumal, Princeton University

Complexity of optimization on manifolds, and cubic regularization

Unconstrained optimization can be framed generally within the framework of optimization on Riemannian manifolds. Over the years, standard algorithms such as gradient descent, trust regions and cubic regularization (to name a few) have been extended to the Riemannian setting, with excellent numerical success. I will show how, under appropriately chosen assumptions, their worst-case iteration complexity analyses carry over seamlessly from the Euclidean to the Riemannian case, then I will discuss finer points related to these assumptions.

NON

Wed.1 H 1012

Nonlinear Optimization Methods and Their Global Rates of Convergence

Organizer: Geovani Grapiglia
Chair: Geovani Grapiglia

Oliver Hinder, Stanford Univ. (joint work with Yair Carmon, John Duchi, Aaron Sidford)

The complexity of finding stationary points of nonconvex functions

We investigate the complexity of finding stationary points of smooth (potentially) nonconvex functions. We provide both new algorithms, adapting Nesterov's accelerated methods to the nonconvex setting (achieving faster convergence than gradient descent), and fundamental algorithm-independent lower bounds on the complexity of finding stationary points. Our bounds imply that gradient descent and cubic-regularized Newton's method are optimal within their natural function classes.

Philippe L. Toint, University of Namur (joint work with Stefania Bellavia, Coralia Cartis, Nick Gould, Gianmarco Gurioli, Bendetta Morini)

Recent results in worst-case evaluation complexity for smooth and non-smooth, exact and inexact, nonconvex optimization

We present a review of results on the worst-case complexity of minimization algorithm for nonconvex problems using potentially high-degree models. Global complexity bound are presented that are valid for any model's degree and any order of optimality, thereby generalizing known results for first- and second-order methods. An adaptive regularization algorithm using derivatives up to degree p will produce an ϵ-approximate q-th order minimizer in at most $O(\epsilon^{(p+1)/(p-q+1)})$ evaluations. We will also extend these results to the case of inexact objective function and derivatives.

Ernesto G. Birgin, Universidade de São Paulo (joint work with J. M. Martínez)

A Newton-like method with mixed factorizations and cubic regularization and its usage in an Augmented Lagrangian framework

A Newton-like method for unconstrained minimization is introduced that uses a single cheap factorization per iteration. Convergence and complexity results, even in the case in which the subproblems' Hessians are far from being Hessians of the objective function, are presented. When the Hessian is Lipschitz-continuous, the proposed method enjoys $O(\varepsilon^{-3/2})$ evaluation complexity for first-order optimality and $O(\varepsilon^{-3})$ for second-order optimality. The usage of the introduced method for bound-constrained minimization and for nonlinear programming is reported.

NON

Wed.1 H 1029

Practical Aspects of Nonlinear Optimization
Organizer: Coralia Cartis
Chair: Tim Mitchell

Hiroshige Dan, Kansai University (joint work with Koei Sakiyama)
Automatic Differentiation Software for Large-scale Nonlinear Optimization Problems

Automatic differentiation (AD) is essential for solving large-scale nonlinear optimization problems. In this research, we implement an AD software which is particularly designed for large-scale nonlinear optimization problems (NLPs). Large-scale NLPs are usually expressed by indexed variables and functions and our AD software can deal with such indexed elements effectively. Numerical experiments show the superiority of our AD software for large-scale NLPs. Moreover, our AD software can compute partial derivatives with arbitrary precision arithmetic.

Michael Feldmeier, The University of Edinburgh
structure detection in generic quadratic programming

Benders' decomposition is a popular choice when solving optimization problems with complicating variables. Implementations are often problem dependent, or at least require the user to specify the master and sub-problems. In the past, attempts have been made to detect automatically suitable structure in the constraint matrix of generic (mixed-integer) linear programmes. In this talk we discuss an extension of this approach to quadratic programming and will cover different approaches to finding suitable structure in the constraint and Hessian matrices. Initial numerical results will be given.

Tim Mitchell, Max Planck Institute for Dynamics of Complex Technical Systems (joint work with Frank E. Curtis, Michael Overton)
Relative Minimization Profiles: A Different Perspective for Benchmarking Optimization and Other Numerical Software

We present relative minimization profiles (RMPs) for benchmarking general optimization methods and other numerical algorithms. Many other visualization tools, e.g., performance profiles, consider success as binary: was a problem "solved" or not. RMPs instead consider degrees of success, from obtaining solutions to machine precision to just finding feasible ones. RMPs concisely show how methods compare in terms of the amount of minimization or accuracy attained, finding feasible solutions, and speed of progress, i.e., how overall solution quality changes for different computational budgets.

NON

Wed.1 H 2013

New Trends in Optimization Methods and Machine Learning (Part I)
Organizers: El houcine Bergou, Aritra Dutta
Chair: Aritra Dutta

Vyacheslav Kungurtsev, Czech Technical University in Prague (joint work with El houcine Bergou, Youssef Diouane, Clément Royer)
A Subsampling Line-Search Method with Second-Order Results

Optimization of a large finite sum of nonconvex functions, such as appearing in the training of deep neural network architectures, suffers from two main challenges: 1) slow progress near saddle points and 2) required a priori knowledge of problem constants to define a learning rate. In this talk we present a stochastic line search method for finite sum optimization, in which first and second order information is sampled to define the step. We show thoretically that the method enjoys a favorable complexity rate and numerical tests validate the performance of the method.

El houcine Bergou, INRA-KAUST (joint work with Eduard Gorbunov, Peter Richtárik)
Stochastic Three Points Method for Unconstrained Smooth Minimization

In this paper we consider the unconstrained minimization problem of a smooth function in a setting where only function evaluations are possible. We design a novel randomized derivative-free algorithm-the stochastic three points (STP) method and analyze its iteration complexity. Given a current iterate x, STP compares the objective function at three points: x, x+αs and x-αs, where $\alpha > 0$ is a stepsize parameter and s is the random search direction. The best of these three points is the next iterate. We analyze the method STP under several stepsize selection schemes.

Xin Li, University of Central Florida
Remarks on a Greedy Randomized Kaczmarz Algorithm

After the randomized Kaczmarz algorithm of Thomas Strohmer and Roman Vershynin was introduced, there have been many research papers on improving the algorithm further. What exactly is the role of randomness in all the effort? We will first give a brief survey on some recent works and point out that in some cases, randomness is not needed at all. Then we will present a new modification of the algorithm that can help us to accelerate the convergence of the algorithm where randomness is needed.

NON

Wed.1 H 2053

Efficient Numerical Solution of Nonconvex Problems

Organizers: Serge Gratton, Elisa Riccietti
Chair: Elisa Riccietti

Serge Gratton, INP-IRIT

Minimization of nonsmooth nonconvex functions using inexact evaluations and its worst-case complexity

An adaptive regularization algorithm using inexact function and derivatives evaluations is proposed for the solution of composite nonsmooth nonconvex optimization. It is shown that this algorithm needs at most $O(|\log(\epsilon)|\epsilon^{-2})$ evaluations of the problem's functions and their derivatives for finding an ϵ-approximate first-order stationary point. This complexity bound is within a factor $|\log(\epsilon)|$ of the optimal bound known for smooth and nonsmooth nonconvex minimization with exact evaluations.

Selime Gurol, IRT Saint Exupéry / CERFACS (joint work with Francois Gallard, Serge Gratton, Benoit Pauwels, Philippe L. Toint)

Preconditioning of the L-BFGS-B algorithm for aerodynamic shape design

The classical L-BFGS-B algorithm, used to minimize an objective function depending on variables that must remain within given bounds, is generalized to the case where the algorithm accepts a general preconditioner. We will explain the main ingredients of the preconditioned algorithm especially focusing on the efficient computation of the so-called generalized Cauchy point. This algorithm is implemented in Python and is applied to the aerodynamic shape design problem, which consists of solving several optimization problems, to reduce the number of expensive objective function evaluations.

Elisa Riccietti, University of Toulouse (joint work with Henri Calandra, Serge Gratton, Xavier Vasseur)

Multilevel optimization methods for the training of artificial neural networks

We investigate the use of multilevel methods (recursive procedures that exploit the knowledge of a sequence of approximations to the original objective function, defined on spaces of reduced dimension, to build alternative models to the standard Taylor one, cheaper to minimize) to solve problems that do not have an underlying geometrical structure. Specifically, we focus on an important class of such problems, those arising in the training of artificial neural networks. We propose a strategy based on algebraic multigrid techniques to build the sequence of coarse problems.

PDE

Wed.1 H 0106

Optimal Control of Nonsmooth Systems (Part I)

Organizers: Constantin Christof, Christian Clason
Chair: Christian Clason

Daniel Walter, RICAM

Accelerated generalized conditional gradient methods

We present a generalized version of the well-known Frank-Wolfe method for minimizing a composite functional $j(u) = f(u) + g(u)$. Here, f is a smooth function and g is in general nonsmooth but convex. The optimization space is given as the dual space of a separable, generally non-reflexive, Banach space . We address theoretical properties of the method, such as worst-case convergence rates and mesh-independence results. For specific instances of the problem we further show how additional acceleration steps eventually lead to optimal convergence rates.

Lukas Hertlein, Technische Universität München (joint work with Michael Ulbrich)

Optimal control of elliptic variational inequalities using bundle methods in Hilbert space

Motivated by optimal control problems for elliptic variational inequalities we develop an inexact bundle method for nonsmooth nonconvex optimization subject to general convex constraints. The proposed method requires only inexact evaluations of the cost function and of an element of Clarke's subdifferential. A global convergence theory in a suitable infinite-dimensional Hilbert space setting is presented. We discuss the application of our framework to optimal control of the (stochastic) obstacle problem and present numerical results.

Sebastian Engel, Technische Universität München (joint work with Philip Trautmann, Boris Vexler)

Variational discretization for an optimal control problem governed by the wave equation with time depending BV controls

We will consider a control problem (P) for the wave equation with a standard tracking-type cost functional and a semi-norm in the space of functions with bounded variations (BV) in time. The considered controls in BV act as a forcing function on the wave equation. This control problem is interesting for practical applications because the semi-norm enhances optimal controls which are piecewise constant. In this talk we focus on a variationally discretized version of (P). Under specific assumptions we can present optimal convergence rates for the controls, states, and cost functionals.

PDE

Wed.1 H 0111

Optimal Control and Dynamical Systems (Part V)

Organizers: Cristopher Hermosilla, Michele Palladino
Chair: Michele Palladino

Franco Rampazzo, University of Padova
Infimum gap phenomena, set separation, and abnormality.

A general sufficient condition for avoiding infimum-gaps when the domain of an optimal control problem is densely embedded in a larger family of processes is here presented. This condition generalizes some recently estalished cryteria for convex or impulsive embedding, and is based on "abundantness" a dynamics-related notion of density introduced by J. Warga.

Peter Wolenski, Louisiana State University
Optimality conditions for systems with piecewise constant dynamics

We will present results on the minimal time function where the velocity sets are locally the same.

Piernicola Bettiol, Université de Bretagne Occidentale (joint work with Carlo Mariconda)
Some regularity results for minimizers in dynamic optimization

We consider the classical problem of the Calculus of Variations, and we formulate of a new Weierstrass-type condition for local minimizers of the reference problem. It allows to derive important properties for a broad class of problems involving a nonautonomous, possibly extended-valued, Lagrangian. A first consequence is the validity of a Du Bois-Reymond type necessary condition, expressed in terms of convex subgradients. If the Lagrangian satisfies an additional growth condition (weaker than coercivity), this Weierstrass-type condition yields the Lipschitz regularity of the minimizers.

PDE

Wed.1 H 0112

Fractional/Nonlocal PDEs: Applications, Control, and Beyond (Part II)

Organizers: Harbir Antil, Carlos Rautenberg, Mahamadii Warma
Chair: Mahamadii Warma

Deepanshu Verma, George Mason University (joint work with Harbir Antil, Mahamadii Warma)
External optimal control of fractional parabolic PDEs

We consider external optimal control with fractional parabolic PDEs as constraints. The need stems from the fact that the classical PDE models only allow placing the source either on the boundary or in the interior whereas the nonlocal behavior of the fractional operator allows placing the control in the exterior. We introduce the notions of weak and very-weak solutions to the parabolic Dirichlet problem and then approximate its solutions by the parabolic Robin solutions. The numerical examples confirm our theoretical findings and further illustrate the potential benefits of nonlocal models.

Benjamin Manfred Horn, Technische Universität Darmstadt (joint work with Stefan Ulbrich)
A Bundle Trust-Region Method for Constrained Nonsmooth Problems applied to a Shape Optimization for Frictional Contact Problems

We present an optimization approach for nonsmooth, nonconvex and constraint optimization problems. The approach has been developed in the context of shape optimization governed by a contact problem with Coulomb friction including state gradient constraints. For the solution operator of the weak formulation of the underlying variational inequality, we prove the local Lipschitz continuity with respect to the geometry. The shape optimization problem is solved with a bundle trust-region algorithm, whereas the handling of the nonlinear constraints is motivated by a constraint linearization method.

ROB

Wed.1 H 3006

Statistical Methods for Optimization Under Uncertainty
Organizer: Henry Lam
Chair: Henry Lam

Fengpei Li,
Parametric Scenario Optimization under Limited Data: A Distributionally Robust Optimization View

We show ways to leverage parametric information and Monte Carlo to obtain certified feasible solutions for chance-constrained problems under limited data. Our approach makes use of distributionally robust optimization (DRO) that translates the data size requirement in scenario optimization into a Monte Carlo size requirement drawn from a generating distribution. We show that, while the optimal choice for such distribution is in a sense, the baseline from a distance-based DRO, it is not necessarily so in the parametric case, and leads us to procedures that improve upon these basic choices.

Huajie Qian, Columbia University (joint work with Henry Lam)
Statistical calibration for robust optimization

Optimization formulations to handle data-driven decision-making under uncertain constraints, such as robust optimization, often encounter a statistical trade-off between feasibility and optimality that potentially leads to over-conservative solutions. We exploit the intrinsic low dimensionality of the solution sets possibly output from these formulations to enhance this trade-off. For several common paradigms of data-driven optimization, we demonstrate the dimension-free performance of our strategy in obtaining solutions that are, in a sense, both feasible and asymptotically optimal.

Yuanlu Bai, Columbia University (joint work with Henry Lam)
Extreme Event Estimation via Distributionally Robust Optimization

A bottleneck in analyzing extreme events is that, by their own nature, tail data are often scarce. Conventional approaches fit data using justified parametric distributions, but often encounter difficulties in confining both estimation biases and variances. We discuss approaches using distributionally robust optimization as a nonparametric alternative that, through a different conservativeness-variance tradeoff, can mitigate some of the statistical challenges in estimating tails. We explain the statistical connections and comparisons of our framework with conventional extreme value theory.

ROB

Wed.1 H 3007

Recent Development in Applications of Distributionally Robust Optimization
Organizer: Zhichao Zheng
Chair: Zhichao Zheng

Zhenzhen Yan, Nanyang Technological University
Data Driven Approach for Full Cut Promotion in E-commerce

Full-cut promotion is a type of promotion where customers spend a minimum threshold amount in a single order to enjoy a fixed amount of discount for that order. In this paper, we propose a sequential choice model to model consumer's choice of multiple items in a single transaction, which generalizes the traditional choice model which assumes at most one item chosen in one transaction. Base on the sequential choice model, we further propose a data driven approach to optimize the cut amount. We test the approach using both synthetic data and a real transaction data set from an e-commerce company

Guanglin Xu,
Data-Driven Distributionally Robust Appointment Scheduling [canceled]

We study a single-server appointment scheduling problem with a fixed sequence of appointments, for which we must determine the arrival time for each appointment. We specifically examine two stochastic models. In the first model, we assume that all appointees show up at the scheduled arrival times yet their service durations are random. In the second model, we assume that appointees have random no-show behaviors and their service durations are random given that they show up at the appointments. In both models, we assume that the probability distribution of the uncertain parameters is unknown but can be partially observed via a set of historical observations. In view of the distributional ambiguity, we propose a data-driven distributionally robust optimization approach to determine an appointment schedule such that the worst-case (i.e., maximum) expectation of the system total cost is minimized. A key feature of this approach is that the optimal value and the set of optimal schedules thus obtained provably converge to those of the "true" model, i.e., the stochastic appointment scheduling model with regard to the true probability distribution of the stochastic parameters. While the resulting optimization problems are computationally intractable, we reformulate them to copositive programs, which are amenable to tractable semidefinite programming problems with high-quality approximations. Furthermore, under some mild conditions, we reformulate the distributioanlly robust appointment scheduling problems to polynomial-sized linear programs. Through an extensive numerical study, we demonstrate that our approach yields better out-of-sample performance than two state-of-the-art methods.

Yini Gao, Singapore Management University (joint work with Chung-Piaw Teo, Huan Zheng)
Disaster Relief Resource Preposition and Redeployment Facing the Adversarial Nature

Large-scale natural disaster management is among the top list of worldwide challenges. One of the difficulties faced is that minimal historical information is present for future disaster prediction and risk assessment, making it challenging to construct proper ambiguity sets. In our paper, we model the natural disaster as an adversary and adopt a game theoretical framework to characterize the interactions between the adversarial nature and a decision maker. We show that the interaction can be fully captured by a conic program in general and obtain a closed-form solution to a symmetric problem.

SPA

Wed.1 H 2038

Complexity of Sparse Optimization for Subspace Identification

Organizer: Julien Mairal
Chair: Julien Mairal

Guillaume Garrigos, Université Paris Diderot (joint work with Jalal Fadili, Jerome Malick, Gabriel Peyré)

Model Consistency for Learning with low-complexity priors

We consider supervised learning problems where the prior on the coefficients of the estimator is an assumption of low complexity. An important question in that setting is the one of model consistency, which consists of recovering the correct structure by minimizing a regularized empirical risk. Under some conditions, it is known that deterministic algorithms succeed in recovering the correct structure, while a simple stochastic gradient method fails to do so. In this talk, we provide the theoretical underpinning of this behavior using the notion of mirror-stratifiable regularizers.

Yifan Sun, UBC Vancouver (joint work with Halyun Jeong, Julie Nutini, Mark Schmidt)

Are we there yet? Manifold identification of gradient-related proximal methods

In machine learning, models that generalize better often generate outputs that lie on a low-dimensional manifold. Recently, several works have shown finite-time manifold identification by proximal methods. In this work, we provide a unified view by giving a simple condition under which any proximal method using a constant step size can achieve finite-iteration manifold detection. We provide iteration bounds for several key methods such as (FISTA, DRS, ADMM, SVRG, SAGA, and RDA).

Julien Mairal, Inria (joint work with Andrei Kulunchakov)

Estimate Sequences for Stochastic Composite Optimization: Variance Reduction, Acceleration, and Robustness to Noise

We propose a unified view of gradient-based algorithms for stochastic convex composite optimization based on estimate sequences. This point of view covers stochastic gradient descent (SGD), the variance-reduction approaches SAGA, SVRG, MISO, their proximal variants, and has several advantages: (i) we provide a generic proof of convergence for the aforementioned methods; (ii) we obtain new algorithms with the same guarantees (iii) we derive generic strategies to make these algorithms robust to stochastic noise (iv) we obtain new accelerated algorithms.

STO

Wed.1 H 3012

Stochastic Optimization and Its Applications (Part I)

Organizer: Fengmin Xu
Chair: Fengmin Xu

Xiaojun Chen, Hong Kong Polytechnic University

Two-stage stochastic variational inequalities and non-cooperative games

The two-stage stochastic variational inequality (SVI) provides a powerful modeling paradigm for many important applications in which uncertainties and equilibrium are present. This talk reviews some new theory and algorithms for the two-stage SVI. Moreover, we formulate a convex two-stage non-cooperative multi-agent game under uncertainty as a two-stage SVI. Numerical results based on historical data in crude oil market are presented to demonstrate the effectiveness of the two-stage SVI in describing the market share of oil producing agents.

Jianming Shi, Tokyo University of Science

A Facet Pivoting Algorithm for Solving Linear Programming with Box Constraints

Linear programming (LP) is fundamentally important in mathematical optimization. In this talk, we review the following two methods: the LP-Newton method for LPs with box constraints proposed by Fujishige et al. , LPS-Newton method proposed by Kitahara et al. Inspired by the methods we develop a new method that uses facets information of the constraints for solving PLs with box constraints because an optimal solution can be found at an intersection between a zonotope and a line. We also report several results of preliminary experiments showing the efficiency of the proposed algorithm.

Fengmin Xu, Xi'an Jiaotong University

Worst-case CVaR portfolio rebalancing with cardinality and diversification constraints

In this paper, we attempt to provide a decision-practical foundation for optimal rebalancing strategies of an existing financial portfolio. our main concern is the development of a sparse and diversified portfolio rebalancing model in the worst-case CVaR framework, considering transaction costs and double cardinality constraints that trade off between the limits of investment scale and industry coverage requirements simultaneously. We propose an efficient ADMM to conduct out-of-sample performance analysis of our proposed strategy on actual data from the Chinese stock market.

Wed.2 14:15–15:30

APP

Wed.2 H 3004

Structural Design Optimization (Part II)

Organizer: Tamás Terlaky
Chair: Tamás Terlaky

Michael Stingl, Friedrich-Alexander-Universität (FAU) Erlangen-Nürnberg (joint work with Lukas Pflug)

A new stochastic descent method for the efficient solution of structural optimization problems with infinitely many load cases

A stochastic gradient method for the solution of structural optimization problems for which the objective function is given as an integral of a desired property over a continuous parameter set is presented. While the application of a quadrature rule leads to undesired local minima, the new stochastic gradient method does not rely on an approximation of the integral, requires only one state solution per iteration and utilizes gradients from previous iterations in an optimal way. Convergence theory and numerical examples including comparisons to the classical SG and SAG method are shown.

Alemseged Gebrehiwot Weldeyesus, The University of Edinburgh (joint work with Jacek Gondzio)

Re-optimization and warm-starting in semidefinite programming

We focus on a semidefinite program arising in optimization of globally stable truss structures. These problems are known to be large-scale and very challenging to standard solution techniques. We solve the problems using a primal-dual interior point method, coupled with column generation procedure and warm-start strategy. The implementation of the algorithm extensively exploits the sparsity structure and low rank property of the involved matrices. We report on a solution of very large problems which otherwise would be prohibitively expensive for existing semidefinite programming solvers.

Jonas Holley, Robert Bosch GmbH (joint work with Michael Hintermüller)

Topological Derivatives for the Optimization of an Electrical Machine

This talk is concerned with an adjoint-based topology optimization method for designing an electrical machine. In order to meet the requirements of real industrial applications, different objectives regarding energy efficiency, as well as mechanical robustness need to be addressed. The resulting optimization problem is challenging due to pointwise state constraints, which are tackled by a penalization approach. A line search type gradient descent scheme is presented for the numerical solution of the optimization problem, where the topological derivative serves as a descent direction.

APP

Wed.2 H 3025

Mathematical Optimization in Signal Processing (Part II)

Organizers: Ya-Feng Liu, Zhi-Quan Luo
Chair: Ya-Feng Liu

Zhi-Quan Luo, The Chinese University of Hong Kong, Shenzhen (joint work with Hamid Farmanbar, Navid Reyhanian)

A Decomposition Method for Optimal Capacity Reservation in Stochastic Networks

We consider the problem of reserving link capacity/resources in a network in such a way that a given set of scenarios (possibly stochastic) can be supported. In the optimal capacity/resource reservation problem, we choose the reserved link capacities to minimize the reservation cost. This problem reduces to a large nonlinear program, with the number of variables and constraints on the order of the number of links times the number of scenarios. We develop an efficient decomposition algorithm for the problem with a provable convergence guarantee.

Ya-Feng Liu, Chinese Academy of Sciences

Semidefinite Relaxations for MIMO Detection: Tightness, Tighterness, and Beyond

Multiple-input multi-output (MIMO) detection is a fundamental problem in modern digital communications. Semidefinite relaxation (SDR) based algorithms are a popular class of approaches to solving the problem. In this talk, we shall first develop two new SDRs for MIMO detection and show their tightness under a sufficient condition. This result answers an open question posed by So in 2010. Then, we shall talk about the tighterness relationship between some existing SDRs for the problem in the literature. Finally, we shall briefly talk about the global algorithm based on the newly derived SDR.

BIG

Wed.2 H 0104

Recent Advancements in Optimization Methods for Machine Learning (Part III)

Organizers: Albert Berahas, Martin Takáč
Chair: Martin Takáč

Peter Richtárik, King Abdullah University of science and technology (KAUST) (joint work with Filip Hanzely, Konstantin Mishchenko)

SEGA: Variance Reduction via Gradient Sketching

We propose a randomized first order optimization method –SEGA (SkEtched GrAdient method)– which progressively throughout its iterations builds a variance-reduced estimate of the gradient from random linear measurements (sketches) of the gradient obtained from an oracle. In each iteration, SEGA updates the current estimate of the gradient through a sketch-and-project operation using the information provided by the latest sketch, and this is subsequently used to compute an unbiased estimate of the true gradient through a random relaxation procedure.

Aaron Defazio, Facebook

Optimization, Initialization and Preconditioning of Modern ReLU Networks [canceled]

In this talk I will discuss a number of issues encountered when optimizing modern ReLU based deep neural networks such as the ResNet-50 model, and suggest some solutions. Topics include:

- Improving the conditioning of the Hessian using a careful initialization scheme.
- Guiding the design of networks by following a scaling rule that improves the conditioning of the Hessian, resulting in less guess work and faster optimization.
- Avoiding instability at the beginning of learning by using balanced ReLUs.
- Variance reduction for deep learning

Aurelien Lucchi, ETH Zürich

Continuous-time Models for Accelerated Stochastic Optimization Algorithms

We focus our discussion on accelerated methods for non-convex and stochastic optimization problems. The choice of how to memorize information to build the momentum has a significant effect on the convergence properties of an accelerated method. We first derive a general continuous-time model that can incorporate arbitrary types of memory. We then demonstrate how to discretize such process while matching the same rate of convergence as the continuous-time model. We will also discuss modern optimization techniques used in machine learning such as Adam and RMSprop.

BIG

Wed.2 H 0110

Recent Advances in Convex and Non-Convex Optimization and Their Applications in Machine Learning (Part I)

Organizers: Qihang Lin, Tianbao Yang
Chair: Qihang Lin

Yiming Ying, SUNY Albany

Stochastic Optimization for AUC Maximization in Machine Learning

In this talk, I will present our recent work on developing novel SGD-type algorithms for AUC maximization. Our new algorithms can allow general loss functions and penalty terms which are achieved through the innovative interactions between machine learning and applied mathematics. Compared with the previous literature which requires high storage and per-iteration costs, our algorithms have both space and per-iteration costs of one datum while achieving optimal convergence rates.

Niao He, University of Illinois at Urbana-Champaign

Sample Complexity of Conditional Stochastic Optimization

We study a class of compositional stochastic optimization involving conditional expectations, which finds a wide spectrum of applications, particularly in reinforcement learning and robust learning. We establish the sample complexities of a modified Sample Average Approximation (SAA) and a biased Stochastic Approximation (SA) for such problems, under various structural assumptions such as smoothness and quadratic growth conditions. Our analysis shows that both modified SAA and biased SA achieve the same complexity bound, and our experiments further demonstrate that these bounds are tight.

Javier Pena, Carnegie Mellon University

A unified framework for Bregman proximal methods

We propose a unified framework for analyzing the convergence of Bregman proximal first-order algorithms for convex minimization. Our framework hinges on properties of the convex conjugate and gives novel proofs of the convergence rates of the Bregman proximal subgradient, Bregman proximal gradient, and a new accelerated Bregman proximal gradient algorithm under fairly general and mild assumptions. Our accelerated Bregman proximal gradient algorithm attains the best-known accelerated rate of convergence when suitable relative smoothness and triangle scaling assumptions hold.

VIS

Wed.2 H 3013

Quasi-Variational Inequalities and Generalized Nash Equilibrium Problems (Part II)

Organizers: Amal Alphonse, Carlos Rautenberg
Chair: Amal Alphonse

Abhishek Singh, Indian Institute of Technology (BHU) Varanasi (joint work with Debdas Ghosh)

Generalized Nash Equilibrium problems with Inexact line search Newton method

In this paper, we study an inexact line search Newton method to solve a generalized Nash equilibrium problem (GNEP). The GNEP is an extension of classical Nash equilibrium problem, where feasible set depends on the strategies of the other players. In this paper, we have taken a particular class of GNEP in which the objective function and the constraint mappings are convex. The proposed method converges globally and also has a faster rate of convergence as compared to previous methods.

Jo Andrea Brüggemann, Weierstrass Institute for Applied Analysis and Stochastics (WIAS) (joint work with Michael Hintermüller, Carlos Rautenberg)

Solution methods for a class of obstacle-type quasi variational inequalities with volume constraints

We consider compliant obstacle problems, where two elastic membranes enclose a constant volume. The existence of solutions to this quasi-variational inequality (QVI)is established building on fixed-point arguments and partly on Mosco-convergence. Founded on the analytical findings, the solution of the QVI is approached by solving a sequence of variational inequalities (VIs). Each of these VIs is tackled in function space via a path-following semismooth Newton method. The numerical performance of the algorithm is enhanced by using adaptive finite elements based on a posteriori error estimation.

Ruchi Sandilya, Weierstrass Institute for Applied Analysis and Stochastics (WIAS) (joint work with Sarvesh Kumar, Ricardo Ruiz-Baier)

Error bounds for discontinuous finite volume discretisations of Brinkman optimal control problems

We introduce a discontinuous finite volume method for the approximation of distributed optimal control problems governed by the Brinkman equations, where a force field is sought such that it produces a desired velocity profile. The discretisation of state and co-state variables follows a lowest-order scheme, whereas three different approaches are used for the control representation: a variational discretisation and approximation through piecewise constant or piecewise linear elements. We employ the optimise-then-discretise approach, resulting in a non-symmetric discrete formulation. A priori error estimates for velocity, pressure, and control in natural norms are derived, and a set of numerical examples is presented to illustrate the performance of the method and to confirm the predicted accuracy of the generated approximations under various scenarios.

CON

Wed.2 H 0107

Advances in Convex Optimization

Organizer: Negar Soheili
Chair: Negar Soheili

Robert Freund, Massachusetts Institute of Technology (joint work with Jourdain Lamperski, Michael Todd)

An oblivious ellipsoid algorithm for solving a system of (in)feasible linear inequalities

Consider the ellipsoid method applied to compute a point in P where P is represented as the feasible solutions of a system of linear inequalities. When P is empty, there exists a certificate of infeasibility (via a theorem of the alternative), yet the standard ellipsoid method does not automatically furnish such a certificate. In this talk we present a modified version of the ellipsoid method that computes a point in P when P is nonempty, and computes a certificate of infeasibility when P is empty, and whose complexity depends on $max(m, n)$ and on a natural condition number of the problem.

Michael Friedlander, University of British Columbia

Polar duality and atomic alignment

The aim of structured optimization is to assemble a solution, using a given set of atoms, to fit a model to data. Polarity, which generalizes the notion of orthogonality from linear sets to general convex sets, plays a special role in a simple and geometric form of convex duality. The atoms and their implicit "duals" share a special relationship, and their participation in the solution assembly depends on a notion of alignment. This geometric perspective leads to practical algorithms for large-scale problems.

Negar Soheili, University of Illinois at Chicago (joint work with Qihang Lin, Selva Nadarajah, Tianbao Yang)

A Feasible Level Set Method for Stochastic Convex Optimization with Expectation Constraints

Stochastic optimization problems with expectation constraints (SOEC) arise in several applications. Only recently has an efficient stochastic subgradient method been developed for solving a SOEC defined by an objective and a single inequality constraint, where both are defined by expectations of stochastic convex functions. We develop a level-set method to compute near-optimal solutions to a generalization of this SOEC containing multiple inequality constraints, each involving an expectation of a stochastic convex function. We establish convergence guarantees for this method.

CON

Wed.2 H 2032

Polynomial Optimization (Part II)
Organizer: Grigoriy Blekherman
Chair: Grigoriy Blekherman

Etienne de Klerk, Tilburg University (joint work with Monique Laurent)
Convergence analysis of a Lasserre hierarchy of upper bounds for polynomial minimization on the sphere

We study the convergence rate of a hierarchy of upper bounds for polynomial minimization problems, proposed by Lasserre (2011), for the special case when the feasible set is the unit (hyper)sphere. The upper bound at level r of the hierarchy is defined as the minimal expected value of the polynomial over all probability distributions on the sphere, when the probability density function is a sum-of-squares polynomial of degree at most $2r$ with respect to the surface measure. We show that the exact rate of convergence is of order $1/r^2$. (Joint work with Monique Laurent.)

Cordian Riener, Uit (joint work with J. Rolfes, F. Vallentin, David de Laat)
Lower bounds for the covering problem of compact metric spaces

Let (X, d) be a compact metric space. For a given positive number r we are interested in the minimum number of balls of radius r needed to cover X. We provide a sequence of infinite-dimensional conic programs each of which yields a lower bound for this number and show that the resulting sequence of lower bounds converges in finitely many steps to the minimal number of balls needed. These programs satisfy strong duality and we can derive a finite dimensional semidefinite program to approximate the optimal solution to arbitrary precision.

Victor Magron, LAAS-CNRS (joint work with Jean-Bernard Lasserre, Mohab Safey El Din)
Two-player games between polynomial optimizers, semidefinite solvers and certifiers

We interpret some wrong results, due to numerical inaccuracies, observed when solving semidefinite programming (SDP) relaxations for polynomial optimization. The SDP solver performs robust optimization and the procedure can be viewed as a max-min problem with two players. Next, we consider the problem of finding exact sums of squares (SOS) decompositions with SDP solvers. We provide a perturbation-compensation algorithm computing exact decompositions for elements in the interior of the SOS cone. We prove that this algorithm has a polynomial boolean running time w.r.t. the input degree.

CNV

Wed.2 H 1028

New Frontiers in Splitting Algorithms for Optimization and Monotone Inclusions (Part II)
Organizer: Patrick L. Combettes
Chair: Patrick L. Combettes

Calvin Wylie, Cornell University (joint work with Adrian S. Lewis)
Partial smoothness, partial information, and fast local algorithms

The idea of partial smoothness unifies active-set and constant-rank properties in optimization and variational inequalities. We sketch two local algorithmic schemes in partly smooth settings. One promising heuristic solves finite minimax subproblems using only partial knowledge of the component functions. The second, more conceptual, approach relies on splitting schemes for variational inequalities.

Isao Yamada, Tokyo Institute of Technology (joint work with Masao Yamagishi)
Global optimization of sum of convex and nonconvex functions with proximal splitting techniques

In sparsity aware signal processing and machine learning, ideal optimization models are often formulated as a minimization of a cost function defined as the sum of convex and possibly nonconvex terms of which the globally optimal solution is hard to compute in general. We present a unified translation of a certain class of such convex optimization problems into monotone inclusion problems and propose iterative algorithms of guaranteed convergence to a globally optimal solution.

Christian L. Müller, Flatiron Institute (joint work with Patrick L. Combettes)
Perspective maximum likelihood-type estimation via proximal decomposition

We introduce an optimization model for general maximum likelihood-type estimation (M-estimation). The model leverages the observation that convex M-estimators with concomitant scale as well as various regularizers are instances of perspective functions. Such functions are amenable to proximal analysis and solution methods via splitting techniques. Using a geometrical approach based on duality, we derive novel proximity operators for several perspective functions. Numerical examples are provided.

CNV

Wed.2 H 1058

Algorithms for Large-Scale Convex and Nonsmooth Optimization (Part I)

Organizer: Daniel Robinson
Chair: Daniel Robinson

Guilherme Franca, Johns Hopkins University (joint work with Daniel Robinson, Rene Vidal)

Conformal Symplectic Optimization

A promising direction to study accelerated methods has been emerging through connections with continuous dynamical systems. However, it is unclear whether main properties of the dynamical system is preserved by such algorithms. We will show that the classical momentum method is a conformal symplectic integrator, i.e. it preserves the symplectic structure of the dynamical system. On the other hand, Nesterov's accelerated gradient is not a structure preserving discretization. We will comment on generalizations of these methods and introduce a symplectic alternative to Nesterov's method.

Zhihui Zhu, Johns Hopkins University (joint work with Daniel Robinson, Manolis Tsakiris, Rene Vidal)

A Linearly Convergent Method for Nonsmooth Nonconvex Optimization on the Sphere with Applications to Robust PCA and Orthogonal Dictionary Learning

We consider the minimization of a general nonsmooth function over the unit sphere. We show that if the objective satisfies a certain Riemannian regularity condition relative to a set B, a Riemannian subgradient method with an appropriate initialization and geometrically diminishing step size converges at a linear rate to the set B. We also show that this regularity condition holds for orthogonal dictionary learning (ODL) and Dual Principal Component Pursuit (DPCP) under suitable choices of B. This leads to important improvements upon the known convergence results for both ODL and DPCP.

Sergey Guminov, IITP, Russian Academy of Sciences (joint work with Vladislav Elsukov, Alexander Gasnikov)

Accelerated Alternating Minimization

Alternating minimization (AM) optimization algorithms have known for a long time. These algorithms assume that the decision variable is divided into several blocks and minimization in each block can be done explicitly. AM algorithms have a number of applications in machine learning problems. In this paper, we are mostly motivated by optimal transport applications, which have become important for the machine learning community. The ubiquitous Sinkhorn algorithm can be seen as an alternating minimization algorithm for the dual to the entropy-regularized optimal transport problem. Sublinear $1/k$ convergence rate was proved for AM algorithm. Despite the same convergence rate as for the gradient descent method, AM-algorithms typically converge faster in practice as they are free of the choice of the step-size and are adaptive to the local smoothness of the problem. At the same time, there are accelerated gradient methods which use a momentum term to have a faster convergence rate of $1/k^2$. We introduce an accelerated alternating minimization method with $1/k^2$ convergence rate, where k is the iteration counter. We also show that the proposed method is primal-dual, meaning that if we apply it to a dual problem, we can reconstruct the solution of the primal problem with the same convergence rate. We apply our method to the entropy regularized optimal transport problem and show experimentally, that it outperforms Sinkhorn's algorithm.

DER

Wed.2 H 2033

Model-Based Derivative-Free Optimization Methods

Organizers: Ana Luisa Custodio, Sébastien Le Digabel, Margherita Porcelli, Francesco Rinaldi, Stefan Wild
Chair: Margherita Porcelli

Raghu Pasupathy, Purdue University

Stochastic Trust Region Methods ASTRO and ASTRO-DF: Convergence, Complexity, and Numerical Performance

ASTRO is an adaptive sampling trust region algorithm designed to solve (unconstrained) smooth stochastic optimization problems with a first-order oracle constructed using a Monte Carlo simulation or a large dataset of "scenarios." Like its derivative-free counterpart ASTRO-DF, ASTRO adaptively constructs a stochastic local model, which is then optimized and updated iteratively. Crucially and unlike ASTRO-DF, however, the extent of sampling in ASTRO is directly proportional to the inverse squared norm of the sampled gradient at the incumbent point, leading to clearly observable gains in numerical performance. The sequence of (true) gradient norms measured at ASTRO's iterates converges almost surely to zero. We also characterize a work complexity result that expresses ASTRO's convergence rate in terms of the total number of oracle calls (as opposed to the total number of iterations). This appears to be one of the few results of its kind and confirms the strong numerical performance observed in practice.

Lindon Roberts, University of Oxford (joint work with Coralia Cartis, Jan Fiala, Benjamin Marteau)

Improving the scalability of derivative-free optimization for nonlinear least-squares problems

In existing techniques for model-based derivative-free optimization, the computational cost of constructing local models and Lagrange polynomials can be high. As a result, these algorithms are not as suitable for large-scale problems as derivative-based methods. In this talk, I will introduce a derivative-free method based on exploration of random subspaces, suitable for nonlinear least-squares problems. This method has a substantially reduced computational cost (in terms of linear algebra), while still making progress using few objective evaluations.

Liyuan Cao, Lehigh University (joint work with Albert Berahas, Katya Scheinberg)

Derivative Approximation of some Model-based Derivative Free Methods

To optimize a black-box function, gradient-based methods can be used in conjunction with finite difference methods. Alternatively, optimization can be done with polynomial interpolation models that approximate the black-box function. A class of random gradient-free algorithms based on Gaussian smoothing of the objective function was analyzed by Yurii Nesterov in 2011. Similar random algorithms were implemented and discussed in the machine learning community in more recent years. We compare these methods on their accuracy of gradient approximation and the overall performance.

GLO

Wed.2 H 3008

Global Optimization - Contributed Session I

Chair: Syuuji Yamada

Kuan Lu, Tokyo Institute of Technology (joint work with Shinji Mizuno, Jianming Shi)

Solving Optimization over the Efficient Set of a Multiobjective Linear Programming Problem as a Mixed Integer Problem

This research concerns an optimization problem over the efficient set of a multiobjective linear programming problem. We show that the problem is equivalent to a mixed integer programming (MIP) problem, and we propose to compute an optimal solution by solving the MIP problem. Compared with the previous mixed integer programming approach, the proposed approach relaxes a condition for the multiobjective linear programming problem and reduces the size of the MIP problem. The MIP problem can be efficiently solved by current MIP solvers when the objective function is convex or linear.

Francesco Romito, Sapienza University of Rome (joint work with Giampaolo Liuzzi, Stefano Lucidi, Veronica Piccialli)

Exploiting recursive non-linear transformations of the variables space in global optimization problems

Solving a global optimization problem is a hard task. We define recursive non-linear equations that are able to transform the variables space and allow us to tackle the problem in an advantageous way. The idea is to exploit the information obtained during a multi-start approach in order to define a sequence of transformations in the variables space. The aim is that of expanding the basin of attraction of global minimizers while shrinking those of already found local minima.

Syuuji Yamada, Niigata University

A global optimization algorithm by listing KKT points for a quadratic reverse convex programming problem

In this paper, we propose a procedure for listing KKT points of a quadratic reverse convex programming problem (QRC) whose feasible set is expressed as the area excluded the interior of a convex set from another convex set. Since it is difficult to solve (QRC), we transform (QRC) into a parametric quadratic programming problem (QP). In order to solve (QP) for each parameter, we introduce an algorithm for listing KKT points. Moreover, we propose an global optimization algorithm for (QRC) by incorporating our KKT listing algorithm into a parametric optimization method.

NON

Wed.2 H 0105

Geometry in Non-Convex Optimization (Part II)

Organizers: Nicolas Boumal, André Uschmajew, Bart Vandereycken

Chair: Bart Vandereycken

Marco Sutti, University of Geneva

Multilevel optimization on low-rank manifolds for optimal control problems

Large-scale finite-dimensional optimization problems sometimes admit solutions that can be well approximated by low-rank matrices and tensors. In this talk, we will exploit this low-rank approximation property by solving the optimization problem directly over the set of low rank matrices and tensors. In particular, we introduce a new multilevel algorithm, where the optimization variable is constrained to the Riemannian manifold of fixed-rank matrices, allowing to keep the ranks (and thus the computational complexity) fixed throughout the iterations. This is a joint work with Bart Vandereycken.

Max Pfeffer, Max Planck Institute for Mathematics in the Sciences

Optimization methods for computing low rank eigenspaces

We consider the task of approximating the eigenspace belonging to the lowest eigenvalues of a self adjoint operator on a space of matrices, with the condition that it is spanned by low rank matrices that share a common row space of small dimension. Such a problem arises for example in the DMRG algorithm in quantum chemistry. We propose a Riemannian optimization method based on trace minimization that takes orthogonality and low rank constraints into account simultaneously, and shows better numerical results in certain scenarios compared to other current methods.

Yuqian Zhang, Cornell University

Nonconvex geometry and algorithms for blind deconvolution

Blind deconvolution is an ill-posed problem aiming to recover a convolution kernel and an activation signal from their convolution. We focus on the short and sparse variant, where the convolution kernel is short and the activation signal is sparsely and randomly supported. This variant models convolutional signals in several important application scenarios. The observation is invariant up to some mutual scaling and shift of the convolutional pairs. This scaled-shift symmetry is intrinsic to the convolution operator and imposes challenges for reliable algorithm design. We normalize the convolution kernel to have unit Frobenius norm and then cast the blind deconvolution problem as a nonconvex optimization problem over the sphere. We demonstrate that (i) under conditions, every local optimum is close to some shift truncation of the ground truth, and (ii) for a generic filter of length k, when the sparsity of activation signal satisfies $\theta < k^{3/4}$ and number of measurements $m > \mathrm{poly}(k)$, provable recovery of the ground truth signals can be obtained.

NON

Wed.2 H 1012

Developments in Structured Nonconvex Optimization (Part I)

Organizers: Jun-ya Gotoh, Yuji Nakatsukasa, Akiko Takeda
Chair: Yuji Nakatsukasa

Jun-ya Gotoh, Chuo University (joint work with Takumi Fukuda)

Sparse recovery with continuous exact k-sparse penalties

This paper presents efficient algorithms for k-sparse recovery problem on the basis of the Continuous Exact k-Sparse Penalties (CXPs). Each CXP is defined by a non-convex but continuous function and the equality forcing the function value to be zero is known to be equivalent to the k-sparse constraint defined with the so-called ℓ_0-norm. Algorithms based on the proximal maps of the ℓ_1-norm or ℓ_2-norm based CXPs will be examined for the sparse recovery problems with/without noise.

Shummin Nakayama, Chuo University

Inexact proximal memoryless quasi-Newton methods based on Broyden family for minimizing composite functions

In this talk, we consider proximal Newton-type methods for the minimization of a composite function that is the sum of a smooth function and a nonsmooth function. Proximal Newton-type methods make use of weighted proximal mappings whose calculations are much expensive. Accordingly, some researchers have proposed inexact Newton-type proximal methods, which calculate the proximal mapping inexactly. To calculate proximal mappings more easily, we propose an inexact proximal method based on memoryless quasi-Newton methods with the Broyden family. We analyze global and local convergence properties.

Takayuki Okuno, RIKEN AIP (joint work with Akihiro Kawana, Akiko Takeda)

Hyperparameter optimization for lq regularizer via bilevel optimization

We propose a bilevel optimization strategy for selecting the best hyperparameter value for the nonsmooth lp regularizer with $0 < p \leq 1$. The concerned bilevel optimization problem has a nonsmooth, possibly nonconvex, ℓ_p-regularized problem as the lower-level problem. For solving this problem, we propose a smoothing-type algorithm and show that a sequence generated by the proposed method converges to a point satisfying certain optimality conditions. We also conducted some numerical experiments to exhibit the efficiency by comparing it with Bayesian optimization.

NON

Wed.2 H 1029

Advances in Nonlinear Optimization Algorithms (Part I)

Chair: Mehiddin Al-Baali

Johannes Brust, Argonne National Laboratory (joint work with Roummel Marcia, Cosmin Petra)

Large-Scale Quasi-Newton Trust-Region Methods with Low-Dimensional Equality Constraints

For large-scale optimization problems, limited-memory quasi-Newton methods are efficient means to estimate Hessian matrices. We present two L-BFGS trust-region methods for large optimization problems with a low number of linear equality constraints. Both methods exploit a compact representation of the $(1, 1)$ block of the inverse KKT matrix. One of the proposed methods uses an implicit eigendecomposition in order to compute search directions by an analytic formula, and the other uses a 1D root solver. We compare the methods to alternative quasi-Newton algorithms on a set of CUTEst problems.

Hardik Tankaria, Kyoto University (joint work with Nobuo Yamashita)

Non-monotone regularized limited memory BFGS method with line search for unconstrained optimization

Recently, Sugimoto and Yamashita proposed the regularized limited memory BFGS (RL-BFGS) with non-monotone technique for unconstrained optimization and reported that it is competitive to the standard L-BFGS. However, RL-BFGS does not use line search; hence it cannot take longer step. In order to take longer step, we propose to use line search with Wolfe condition when iteration of RL-BFGS is successful and the search direction is still descent direction. The numerical results shows that RL-BFGS with the proposed technique is more efficient and stable than the standard L-BFGS and RL-BFGS method.

Mehiddin Al-Baali, Sultan Qaboos University

Conjugate Gradient Methods with Quasi-Newton Features for Unconstrained Optimization

The recent class of symmetric conjugate gradient methods for large-scale unconstrained optimization will be considered. The quasi-Newton like condition will be introduced to this class of methods in a sense to be defined. It will be shown that the proposed methods converge globally and has some useful features. Numerical results will be described to illustrate the behavior of some new techniques for improving the performance of several conjugate gradient methods substantially.

NON

Wed.2 H 2013

New Trends in Optimization Methods and Machine Learning (Part II)

Organizers: El houcine Bergou, Aritra Dutta
Chair: El houcine Bergou

Aritra Dutta, King Abdullah University of Science and Technology (KAUST) (joint work with Boqing Gong, Xin Li, Mubarak Shah)

On a Weighted Singular Value Thresholding Algorithm

Sparse and low-rank approximation problems have many crucial applications in computer vision and recommendation systems. In this paper, we formulate and study a weighted singular value thresholding (WSVT) problem. Unlike many papers in the literature on generalized SVT methods such as generalized SVT and weighted nuclear norm minimization, we do not modify the nuclear norm in SVT. Instead, we use a weighted Frobenius norm combined with the nuclear norm. We present an algorithm to numerically solve our WSVT problem and establish the convergence of the algorithm. As a proof of concept, we extensively apply WSVT to a variety of applications, including removal of shadows, inlier detection, and background estimation and demonstrate that the weighted Frobenius norm in our WSVT can work as efficiently as the L^1 norm used in the Robust PCA algorithms. Moreover, we match or outperform state-of-the-art principal component pursuit (PCP) algorithms in almost all quantitative and qualitative measures and in fractions of their execution time. This indicates that with a properly inferred weight matrix, our computationally inexpensive WSVT algorithm can serve as a natural alternative to the PCP problem.

Michel Barlaud, University of Nice Sophia Antipolis (joint work with Jean-Baptiste Caillau, Antonin Chambolle)

Robust supervised classification and feature selectionusing a primal-dual method

This paper deals with supervised classification and feature selection in high dimensional space. A classical approach is to project data on a low dimensional space and classify by minimizing an appropriate quadratic cost. It is well known that using a quadratic cost is not robust to outliers. We cope with this problem by using an ℓ_1 norm both for the constraint and for the loss function. In this paper, we provide a novel tailored constrained primal-dual method with tconvergence proofs to compute jointly selected features and classifiers.

Jakub Mareček, IBM Research

Time-varying Non-convex Optimisation: Three Case Studies

We consider three prominent examples of non-convex optimisation in power systems (e.g., alternating current optimal power flow), low-rank modelling (e.g., background subtraction in computer vision), and learning linear dynamical systems (e.g., time-series forecasting). There has been a considerable recent progress in tackling such problems, via hierarchies of convexifications or otherwise, at a price of non-trivial run-time. We study the three examples in a setting, where a sequence of time-varying instances is available. We showcase tracking results and regret bounds.

NON

Wed.2 H 2053

Recent Trends in Large Scale Nonlinear Optimization (Part I)

Organizers: Michal Kočvara, Panos Parpas
Chair: Michal Kočvara

Derek Driggs, University of Cambridge (joint work with Matthias Ehrhardt, Carola-Bibiane Schönlieb)

Stochastic Optimisation for Medical Imaging

Stochastic gradient methods have cemented their role as workhorses for solving problems in machine learning, but it is still unclear if they can have the same success solving inverse problems in imaging. In this talk, we explore the unique challenges that stochastic gradient methods face when solving imaging problems. We also propose a family of accelerated stochastic gradient methods with fast convergence rates. Our numerical experiments demonstrate that these algorithms can solve imaging and machine learning problems faster than existing methods.

Zhen Shao, University of Oxford (joint work with Coralia Cartis, Jan Fiala)

Sketching for sparse linear least squares

We discuss sketching techniques for sparse Linear Least Squares (LLS). We give theoretical bounds for the accuracy of the sketched solution/residual when hashing matrices are used for sketching, quantifying carefully the trade-off between the coherence of the original matrix and the sparsity of the hashing matrix. We use these to quantify the success of our algorithm that employs a sparse factorisation of the sketched matrix as a preconditioner for the original LLS before applying LSQR. We extensively compare our algorithm to state-of-the-art direct and iterative solvers for large sparse LLS.

Panos Parpas, Imperial College London

Distributed optimization with probabilistically consistent models

We introduce a framework for developing and analyzing distributed optimization algorithms that are guaranteed to converge under very general conditions. The conditions we consider include the use of reduced order and approximate models, and we only assume that the approximate models are consistent with a certain probability. To motivate the theory, we report preliminary results from using a particular instance of the proposed framework for solving large scale non-convex optimization models.

PDE

Wed.2 H 0106

Optimal Control of Nonsmooth Systems (Part II)

Organizers: Constantin Christof, Christian Clason
Chair: Constantin Christof

Dorothee Knees, University of Kassel (joint work with Stephanie Thomas)

Optimal control of rate-independent systems

Rate independent systems can be formulated based on an energy functional and a dissipation potential that is assumed to be convex, lower semicontinuous and positively homogeneous of degree one. Here, we will focus on the nonconvex case meaning that the energy is not convex. In this case, the solution typically is discontinuous in time. There exist several (in general not equivalent) notions of weak solutions. We focus on so-called balanced viscosity solutions, discuss the properties of solution sets and discuss the well posedness of an optimal control problem for such systems.

Vu Huu Nhu, University of Duisburg-Essen (joint work with Christian Clason, Arnd Rösch)

Optimal control of a non-smooth quasilinear elliptic equation

This talk is concerned with an optimal control problem governed by a non-smooth quasilinear elliptic equation with a nonlinear coefficient in the principal part that is locally Lipschitz continuous and directionally but not Gâteaux differentiable. Based on a suitable regularization scheme, we derive C- and strong stationarity conditions. Under the additional assumption that the nonlinearity is a PC^1 function with countably many points of nondifferentiability, we show that both conditions are equivalent and derive a relaxed optimality system that is amenable to numerical solution using SSN.

Livia Betz, Universität Duisburg-Essen

Strong stationarity for the optimal control of non-smooth coupled systems

This talk is concerned with an optimal control problem governed by a non-smooth coupled system of equations. The non-smooth nonlinearity is Lipschitz-continuous and directionally differentiable, but not Gâteaux-differentiable. We derive a strong stationary optimality system, i.e., an optimality system which is equivalent to the purely primal optimality condition saying that the directional derivative of the reduced objective in feasible directions is nonnegative.

PDE

Wed.2 H 0111

Optimal Control and Dynamical Systems (Part VI)

Organizers: Cristopher Hermosilla, Michele Palladino
Chair: Michele Palladino

Paloma Schäfer Aguilar, TU Darmstadt (joint work with Stefan Ulbrich)

Numerical approximation of optimal control problems for conservation laws

We study the consistent numerical approximation of optimal boundary control problems for scalar hyperbolic conservation laws. We consider conservative finite difference schemes with corresponding sensitivity and adjoint schemes. To analyze the convergence of the adjoint schemes, we propose two convenient characterizations of reversible solutions for the adjoint equation in the case of boundary control, which are suitable to show that the limit of discrete adjoints is in fact the correct reversible solution.

Laurent Pfeiffer, University of Graz

Analysis of the Receding Horizon Control method for stabilization problems

The talk is dedicated to the analysis of the Receding-Horizon Control (RHC) method for a class of infinite dimensional stabilisation problems. An error estimate, bringing out the effect of the prediction horizon, the sampling time, and the terminal cost used for the truncated problems will be provided.

Reference: Karl Kunisch and Laurent Pfeiffer. The effect of the Terminal Penalty in Receding Horizon Control for a Class of Stabilization Problems. ArXiv preprint, 2018.

Caroline Löbhard, Weierstrass Institute for Applied Analysis and Stochastics (WIAS)

Space-time discretization for parabolic optimal control problems with state constraints

The first order system of a regularized version of the control problem is reformulated as an optimality condition in terms of only the state variable, which renders an elliptic boundary value problem of second order in time, and of fourth order in space. We suggest a C^0 interior penalty method on the space-time domain with tailored terms that enforce suitable regularity in space direction. A combined numerical analysis leads to a solution algorithm that intertwines mesh refinement with an update strategy for the regularization parameter.

PDE

Wed.2 H 0112

Decomposition-Based Methods for Optimization of Time-Dependent Problems (Part I)

Organizers: Matthias Heinkenschloss, Carl Laird
Chair: Carl Laird

Sebastian Götschel, Zuse Institute Berlin (joint work with Michael L. Minion)

Towards adaptive parallel-in-time optimization of parabolic PDEs

Time-parallel methods have received increasing interest in recent years as they allow to obtain speedup when spatial parallelization saturates. In this talk, we exploit the state-of-the art "Parallel Full Approximation Scheme in Space and Time" (PFASST) for the time-parallel solution of optimization problems with parabolic PDEs. As PFASST is based on spectral deferred correction methods their iterative nature provides additional flexibility, e.g., by re-using previously computed solutions. We focus especially on adapting the accuracy of state and adjoint solves to the optimization progress.

Stefan Ulbrich, TU Darmstadt

Time-domain decomposition for PDE-constrained optimization

We consider optimization problems governed by time-dependent parabolic PDEs and discuss the construction of parallel solvers based on time-domain decomposition. We propose an ADMM-based approach to decompose the problem in independent subproblems and combine it with a multigrid strategy. Moreover, we discuss a preconditioner for the solution of the subproblems that decouples into a forward and backward PDE solve on the time-subdomains. Numerical results are presented.

Denis Ridzal, Sandia National Laboratories (joint work with Eric Cyr)

A multigrid-in-time augmented-Lagrangian method for constrained dynamic optimization

To address the serial bottleneck of forward and adjoint time integration in solving dynamic optimization problems, we propose a parallel multigrid-in-time technique for the solution of optimality systems in a matrix-free trust-region sequential quadratic programming method for equality-constrained optimization. Additionally, to handle general inequality constraints, we develop and analyze an augmented-Lagrangian extension, which only augments simple bound constraints. We present scaling studies for large-scale fluid dynamics control problems and inverse problems involving Maxwell's equations.

ROB

Wed.2 H 3006

Recent Advances in Theories of Distributionally Robust Optimization (DRO)

Organizer: Zhichao Zheng
Chair: Zhichao Zheng

Karthyek Murthy, Singapore University of Technology and Design (joint work with Karthik Natarajan, Divya Padmanabhan)

Exploiting Partial Correlations in Distributionally Robust Optimization

We aim to identify partial covariance structures that allow polynomial-time instances for evaluating the worst-case expected value of mixed integer linear programs with uncertain coefficients. Assuming only the knowledge of mean and covariance entries restricted to block-diagonal patterns, we develop a reduced SDP formulation whose complexity is characterized by a suitable projection of the convex hull of rank 1 matrices formed by extreme points of the feasible region. These projected constraints lend themselves to polynomial-time instances in appointment scheduling and PERT network contexts.

Jingui Xie, University of Science and Technology of China (joint work with Melvyn Sim, Taozeng Zhu)

Joint Estimation and Robustness Optimization

Many real-world optimization problems have input parameters estimated from data whose inherent imprecision can lead to fragile solutions that may impede desired objectives and/or render constraints infeasible. We propose a joint estimation and robustness optimization (JERO) framework to mitigate estimation uncertainty in optimization problems by seamlessly incorporating both the parameter estimation procedure and the optimization problem.

Grani A. Hanasusanto, The University of Texas at Austin (joint work with Guanglin Xu)

Improved Decision Rule Approximations for Multi-Stage Robust Optimization via Copositive Programming

We study decision rule approximations for multi-stage robust linear optimization problems. We examine linear decision rules for the generic problem instances and quadratic decision rules for the case when only the problem right-hand sides are uncertain. The decision rule problems are amenable to exact copositive programming reformulations that yield tight, tractable semidefinite programming solution schemes. We prove that these new approximations are tighter than the state-of-the-art schemes and demonstrate their superiority through numerical experiments.

ROB

Wed.2 H 3007

Decision-Dependent Uncertainty and Bi-Level Optimization

Organizers: Chrysanthos Gounaris, Anirudh Subramanyam
Chair: Chrysanthos Gounaris

Anirudh Subramanyam, Argonne National Laboratory (joint work with Chrysanthos Gounaris, Nikolaos Lappas)

A Generalized Cutting Plane Algorithm for Robust Optimization with Decision-dependent Uncertainty Sets

We propose a primal branch-and-bound algorithm that generalizes the well-known cutting plane method of Mutapcic and Boyd to the case of decision-dependent uncertainty sets. A comprehensive computational study showcases the advantages of the proposed algorithm over that of existing methods that rely on classical duality-based reformulations.

Mathieu Besançon, INRIA Lille Nord-Europe (joint work with Miguel Anjos, Luce Brotcorne)

Near-optimal robust bilevel optimization

Bilevel optimization corresponds to integrating the optimal response to a lower-level problem in a problem. We introduce near-optimal robustness for bilevel problems, building on existing concepts from the literature. This model generalizes the pessimistic approach, protecting the decision-maker from limited deviations of the lower level. This models finds intuitive interpretations in various optimization settings modelled as bilevel problems. We develop a duality-based solution method for cases where the lower-level is convex, leveraging the methodology from robust and bilevel optimization.

Omid Nohadani, Northwestern University (joint work with Kartikey Sharma)

Optimization Under Decision-dependent Uncertainty

The efficacy of robust optimization spans a variety of settings with predetermined uncertainty sets. In many applications, uncertainties are affected by decisions and cannot be modeled with current frameworks. This talk takes a step towards generalizing robust optimization to problems with decision-dependent uncertainties, which we show are NP-complete. We introduce a class of uncertainty sets whose size depends on decisions, and proposed reformulations that improve upon alternative techniques. In addition, the proactive uncertainty control mitigates over conservatism of current approaches.

SPA

Wed.2 H 2038

Primal-Dual Methods for Structured Optimization

Organizer: Mathias Staudigl
Chair: Mathias Staudigl

Robert Ernö Csetnek, University of Vienna

The proximal alternating minimization algorithm for two-block separable convex optimization problems with linear constraints

The Alternating Minimization Algorithm has been proposed by Paul Tseng to solve convex programming problems with two-block separable linear constraints and objectives, whereby (at least) one of the components of the latter is assumed to be strongly convex. The fact that one of the subproblems to be solved within the iteration process of this method does not usually correspond to the calculation of a proximal operator through a closed formula affects the implementability of the algorithm. In this talk, we allow in each block of the objective a further smooth convex function and propose a proximal version of the algorithm, which is achieved by equipping the algorithm with proximal terms induced by variable metrics. For suitable choices of the latter, the solving of the two subproblems in the iterative scheme can be reduced to the computation of proximal operators. We investigate the convergence of the proposed algorithm in a real Hilbert space setting and illustrate its numerical performances on two applications in image processing and machine learning.

Darina Dvinskikh, Weierstrass Institute for Applied Analysis and Stochastics (WIAS)

Complexity rates for accelerated primal-dual gradient method for stochastic optimisation problem

We study the optimal complexity bounds of first-order methods for the convex finite-sum minimization problem. To address this problem, we appeal to distributed optimization and consider the network of multiple agents (processors) which cooperatively minimize the target function. We compare two different approaches toward the finding of the minimum depending on the functions properties in terms of oracle calls and communication rounds of distributed system: primal approach and dual approach which is based on the assumption of existence of the Fenchel-Legendre transform for the objective.

Kimon Antonakopoulos, University Grenoble Alpes/Inria (joint work with Panayotis Mertikopoulos)

Primal-dual methods for Stochastic Variational Inequalities with Unbounded Operators

Motivated by applications in machine learning and imaging, we study a class of variational inequality problems with possibly unbounded operators. In contrast to their classical counterparts, these problems could exhibit singularities near the boundary of the problem domain, thus precluding the use of standard first-order methods. To circumvent this difficulty, we introduce a family of local norms adapted to the problem's singularity landscape, and we derive a class of Bregman proximal methods that exploit this structure and provide optimal convergence rates in this setting.

STO

Wed.2 H 3012

Stochastic Optimization and Its Applications (Part II)

Organizer: Fengmin Xu
Chair: Fengmin Xu

Sunho Jang, Seoul National University (joint work with Insoon Yang)

Stochastic Subgradient Methods for Dynamic Programming in Continuous State and Action Spaces

To solve dynamic programs with continuous state and action spaces, we first approximate the output of the Bellman operator as a convex program with uniform convergence. This convex program is then solved using stochastic subgradient descent. To avoid the full projection onto the high-dimensional feasible set, we develop an algorithm that samples, in a coordinated fashion, a mini-batch for a subgradient and another for projection. We show several properties of this algorithm, including convergence, and a reduction in the feasibility error and in the variance of the stochastic subgradient.

Jussi Lindgren, Aalto University School of Science (joint work with Jukka Liukkonen)

Stochastic optimization, Quantum Dynamics and Information Theory

We present a new approach to foundations of quantum mechanics via stochastic optimization. It is shown that the Schrödinger equation can be interpreted as an optimal dynamic for the value function for a coordinate-invariant linear-quadratic stochastic control problem. The optimal path for the quantum particle obeys a stochastic gradient descent scheme, which minimizes relative entropy or the free energy. This in turn allows for a new interpretation for quantum mechanics through the tools of non-equilibrium statistical mechanics and information theory vis-a-vis the path integral formulation.

Luis Espath, King Abdullah University of science and technology (KAUST) (joint work with Andre Carlon, Ben Dia, Rafael Lopez, Raul Tempone)

Nesterov-aided Stochastic Gradient Methods using Laplace Approximation for Bayesian Design Optimization

We focus on the Optimal Experimental Design OED problem of finding the setup that maximizes the expected information gain. We augment the stochastic gradient descent with the Nesterov's method and the restart technique, as O'Donoghue and Candes originally proposed for deterministic optimization. We couple the stochastic optimization with three estimators for OED: the double-loop Monte Carlo estimator DLMC, the Monte Carlo estimator using the Laplace approximation for the posterior distribution MCLA and the double-loop Monte Carlo estimator with Laplace-based importance sampling DLMCIS.

Wed.3 16:00–17:15

APP

Wed.3 H 2053

Applications in Finance and Real Options

Chair: Luis Zuluaga

Daniel Ralph, University of Cambridge (joint work with Rutger-Jan Lange, Kristian Støre)

"POST", a robust method for Real-Option Valuation in Multiple Dimensions Using Poisson Optional Stopping Times

We provide a new framework for valuing multidimensional real options where opportunities to exercise the option are generated by an exogenous Poisson process; this can be viewed as a liquidity constraint on decision times. This approach, which we call the Poisson optional stopping times (POST) method, finds the value function as a monotone and linearly convergent sequence of lower bounds. In a case study, we demonstrate the effectiveness of POST by comparing it to the frequently used quasi-analytic method, showing some difficulties that arise when using the latter. POST has a clear convergence analysis, is straightforward to implement and robust in analysing multidimensional option-valuation problems of modest dimension.

Peter Schütz, Norwegian University of Science and Technology NTNU (joint work with Sjur Westgaard)

Optimal hedging strategies for salmon producers

We use a multistage stochastic programming model to study optimal hedging decisions for risk-averse salmon producers. The objective is to maximize the weighted sum of expected revenues from selling salmon either in the spot market or in futures contracts and Conditional Value-at-Risk (CVaR) of the revenues over the planning horizon. The scenario tree for the multistage model is generated based on a procedure that combines Principal Component Analysis and state space modelling. Results indicate that salmon producers should hedge price risk already at fairly low degrees of risk aversion.

Luis Zuluaga, Lehigh University (joint work with Onur Babat, Juan Vera)

Computing near-optimal Value-at-Risk portfolios using integer programming techniques

Value-at-Risk (VaR) is one of the main regulatory tools used for risk management purposes. However, it is difficult to compute optimal VaR portfolios; that is, an optimal risk-reward portfolio allocation using VaR as the risk measure. This is due to VaR being non-convex and of combinatorial nature. Here, we present an algorithm to compute near-optimal VaR portfolios that takes advantage of a MILP formulation of the problem and provides a guarantee of the solution's near-optimality.

BIG

Wed.3 H 0104

Recent Advancements in Optimization Methods for Machine Learning (Part IV)

Organizers: Albert Berahas, Martin Takáč

Chair: Albert Berahas

Martin Jaggi, EPFL

Decentralized Learning with Communication Compression

We consider decentralized stochastic optimization, as in training of machine learning and deep learning models, where the training data remains separated over many user devices. We propose a new communication-efficient decentralized algorithm based on gradient compression (sparsification and quantization) for SGD as in https://arxiv.org/abs/1902.00340 , while also providing faster consensus algorithms under communication compression. Finally we discuss flexible decentralized learning of generalized linear models as in https://arxiv.org/abs/1808.0488

Robert Gower, Telecom Paris Tech

Expected smoothness is the key to understanding the mini-batch complexity of stochastic gradient methods

Wouldn't it be great if there was automatic way of setting the optimal mini-batch size? In this talk I will present a rather general approach for choosing the optimal mini-batch size based on how smooth is the mini-batch function. For this I will introduce the notation of expected smoothness, and show our we are using this notation to choose the mini-batch size and stepsize in SVRG, SGD, and SAG. I will most likely focus on SVRG.

Ahmet Alacaoglu, EPFL (joint work with Volkan Cevher, Olivier Fercoq, Ion Necoara)

Almost surely constrained convex optimization

We propose a stochastic gradient framework for solving stochastic composite convex optimization problems with (possibly) infinite number of linear inclusion constraints that need to be satisfied almost surely. We use smoothing and homotopy techniques to handle constraints without the need for matrix-valued projections. We show for our stochastic gradient algorithm optimal rates up to logarithmic factors even without constraints, for general convex and restricted strongly convex problems. We demonstrate the performance of our algorithm with numerical experiments.

BIG

Wed.3 H 0110

Recent Advances in Convex and Non-Convex Optimization and Their Applications in Machine Learning (Part II)

Organizers: Qihang Lin, Tianbao Yang
Chair: Tianbao Yang

Yuejie Chi, Carnegie Mellon University
Implicit Regularization in Nonconvex Low-Rank Matrix Completion

We show that factored gradient descent with spectral initialization converges linearly for noisy and 1-bit low-rank matrix completion in terms of both Frobenius and infinity norms, without the need of explicitly promoting incoherence via regularizations, at near-optimal sample and computational complexities. This is achieved by establishing an "implicit regularization" phenomenon of the algorithm via a leave-one-out perturbation argument.

Praneeth Netrapalli, Microsoft Corporation (joint work with Chi Jin, Michael Jordan)
Nonconvex-Nonconcave Minmax Optimization: Stable Limit Points of Gradient Descent Ascent are Locally Optimal

Minimax optimization, especially in its general nonconvex-nonconcave formulation, has found extensive applications in modern machine learning frameworks. While gradient descent ascent (GDA) is widely used in practice to solve these problems its theoretical behavior has been considered highly undesirable due to the possibility of convergence to non local-Nash equilibria. In this talk, we introduce the notion of local minimax as a more suitable alternative to the notion of local Nash equilibrium and show that up to some degenerate points, stable limit points of GDA are exactly local minimax.

Raef Bassily, The Ohio State University (joint work with Mikhail Belkin)
On the Effectiveness of SGD in Modern Over-parameterized Machine Learning

I will talk about recent advances in understanding Stochastic Gradient Descent and its effectiveness in modern machine learning. I will discuss linear convergence of SGD for a broad class of convex as well as non-convex problems in the interpolated (over-parametrized) regime. I will also discuss some practical and theoretical implications pertaining to training neural networks.

BIG

Wed.3 H 3002

Recent Advances in Distributed Optimization

Organizers: Pavel Dvurechensky, Cesar A Uribe
Chair: Cesar A Uribe

Alex Olshevsky, Boston University (joint work with Ioannis Paschalidis, Artin Spiridonoff)
Asymptotic Network Independence for Stochastic Gradient Descent

We consider stochastic gradient descent in a network of n nodes: every node knows a strongly convex function, and the goal is to compute the minimizer of the sum of these n functions. At each time step, every node can broadcast a message to its neighbors in a (directed) network and query its own function for a noisy gradient. We describe a method which has the property that we call asymptotic network independence: in the limit, the distributed system converges to the global minimizer as fast as a centralized method that can obtain all of the n of the noisy gradients at every time step.

Alexander Gasnikov, Moscow Institute of Physics and Technology (joint work with Darina Dvinskikh, Pavel Dvurechensky, Alexey Kroshnin, Nazarii Tupitsa, Cesar A Uribe)
On the Complexity of Approximating Wasserstein Barycenters

We study two distributed algorithms for approximating Wasserstein barycenter of a set of discrete measures. The first approach is based on the Iterative Bregman Projections (IBP) algorithm for which our novel analysis gives a complexity bound proportional to mn^2/e^2 to approximate the original non-regularized barycenter. Using an alternative accelerated-gradient-descent-based approach, we obtain a complexity proportional to $mn^{2.5}/e$.

Jingzhao Zhang, (joint work with Ali Jadbabaie, Aryan Mokhtari, Suvrit Sra, Cesar A Uribe)
Direct Runge-Kutta discretization achieves acceleration

We study gradient-based optimization methods obtained by directly discretizing a second-order heavy-ball ordinary differential equation (ODE). When the function is smooth enough and convex, we show that acceleration can be achieved by a stable discretization using standard Runge-Kutta integrators. Furthermore, we introduce a new local flatness condition under which rates even faster than Nesterov's method can be achieved with low-order integrators. Similar techniques can be applied to strongly convex first order optimization problems and distributed optimization problems.

VIS

Wed.3 H 1058

Complementarity: Extending Modeling and Solution Techniques (Part I)

Organizer: Michael Ferris
Chair: Michael Ferris

Olivier Huber, Humboldt-Universität zu Berlin
On Solving Models with Optimal Value Function

We look at solving mathematical programs that contain other optimization problems, specifically containing Optimal Value Functions (OVF). In general, problems with OVF are feature non-smoothness, that is both hard to model and solve. Rather than designing specific algorithms for this kind of problem, we propose an approach based on reformulations. In this talk we first focus the conditions for such reformulations to be applicable. Secondly, we present ReSHOP, an implementation of those procedures, as well as its Julia interface.

Youngdae Kim, Argonne National Laboratory
SELKIE: a model transformation and distributed solver for structured equilibrium problems

We introduce SELKIE, a general-purpose solver for equilibrium problems described by a set of agents. It exploits problem structures, such as block structure and cascading dependencies of interacting agents, in a flexible and adaptable way to achieve a more robust and faster solution path. Various decomposition schemes can be instantiated in a convenient and computationally efficient manner. SELKIE has been implemented and is available within GAMS/EMP. Examples illustrating the flexibility and effectiveness of SELKIE are given, including a Dantzig Wolfe method for Variational Inequalities.

Michael Ferris, University of Wisconsin-Madison (joint work with Andy Philpott)
Capacity expansion and operations tradeoffs in renewable electricity

Various countries have announced target dates for a 100% renewable electricity system. Such targets require long-term investment planning, medium-term storage management (including batteries and pumped storage), as well as a short-term analysis of demand-response, involuntary load curtailment and transmission congestion. We consider using complementarity models of dynamic risked equilibria to formulate these problems, the implications of stochasticity, and demonstrate the application of additional modeling constructs and distributed algorithms for their solution.

CON

Wed.3 H 0111

Theoretical Aspects of Conic Optimization

Organizer: Roland Hildebrand
Chair: Roland Hildebrand

Naomi Shaked-Monderer, The Max Stern Yezreel Valley College
On the generalized inverse of a copositive matrix

We take a closer look at copositive matrices satisfying a known condition for the copositivity of the (Moore-Penrose generalized) inverse of the matrix.

Takashi Tsuchiya, National Graduate Institute for Policy Studies (joint work with Bruno Figueira Lourenço, Masakazu Muramatsu)
Duality theory of SDP revisited: most primal-dual weakly feasible SDPs have finite nonzero duality gaps

We analyze the duality of SDP to understand how positive duality gaps arise. We show that there exists a relaxation of the dual whose optimal value coincides with the primal, whenever the primal and dual are weakly feasible. The relaxed dual is constructed by removing several linear constraints from the dual, and therefore is likely to have a larger optimal value generically, leading to a positive duality gap. The analysis suggests that positive duality gap is a rather generic phenomenon when both the primal and dual are weakly feasible.

Roland Hildebrand, Laboratoire Jean Kuntzmann / CNRS
Towards optimal barriers for convex cones

Self-concordant barriers are essential for interior-point algorithms in conic programming. To speed up the convergence it is of interest to find a barrier with the lowest possible parameter for a given cone. The barrier parameter is a non-convex function on the set of self-concordant barriers, and finding an optimal barrier amounts to a non-convex infinite-dimensional optimization problem. We describe this problem and show how it can be convexified at the cost of obtaining sub-optimal solutions with guaranteed performance. Finite-dimensional approximations yield lower bounds on the parameter.

CON

Wed.3 H 2032

Conic Optimization and Machine Learning

Organizer: Amir Ali Ahmadi
Chair: Amir Ali Ahmadi

Pablo Parrilo, MIT
TBA [canceled]

TBA

Pravesh Kothari, Carnegie Mellon University
Average-Case Algorithm Design Using Sum-of-Squares

I will explain how a primal-dual viewpoint on Sum-of-Squares method and its proof-complexity interpretation provides a general blueprint for parameter estimation problems arising in machine learning/average-case complexity. As a consequence, we will be able to obtain state-of-the-art algorithms for basic problems in theoretical machine learning/statistics including estimating components of gaussian mixtures, robust estimation of moments of distributions, robust independent component analysis and regression, tensor decomposition, tensor completion and dictionary learning.

Amir Ali Ahmadi, Princeton University (joint work with Bachir El Khadir)
Learning Dynamical Systems with Side Information

We present a mathematical framework for learning a dynamical system from a limited number of trajectory observations but subject to contextual information. We show that sum of squares optimization is a particularly powerful tool for this task.

CNV

Wed.3 H 1028

New Frontiers in Splitting Algorithms for Optimization and Monotone Inclusions (Part III)

Organizer: Patrick L. Combettes
Chair: Patrick L. Combettes

Nimit Nimana, Khon Kaen University (joint work with Narin Petrot)
Generalized forward-backward splitting with penalty terms for monotone inclusion problems

We introduce generalized forward-backward splitting methods with penalty terms for solving monotone inclusion problems involving the sum of a finite number of maximally monotone operators and the normal cone to the nonempty set of zeros of another maximally monotone operator. We show convergences of the iterates, provided that the condition corresponding to the Fitzpatrick function of the operator describing the set of the normal cone is fulfilled. We illustrate the functionality of the methods through some numerical experiments

Dang-Khoa Nguyen, University of Vienna (joint work with Radu Boţ, Robert Ernö Csetnek)
A proximal minimization algorithm for structured nonconvex and nonsmooth problems

We propose a proximal algorithm for minimizing objective functions consisting of three summands: the composition of a nonsmooth function with a linear operator, another nonsmooth function and a smooth function which couples the two block variables. The algorithm is a full splitting method. We provide conditions for boundedness of the sequence and prove that any cluster point is a KKT point of the minimization problem. In the setting of the Kurdyka-Lojasiewicz property, we show global convergence and derive converge rates for the iterates in terms of the Lojasiewicz exponent.

Marcel Jacobse, Universität Bremen (joint work with Christof Büskens)
Examining failure of a Mehrotra predictor-corrector method on minimal examples

Mehrotra's predictor-corrector method for linear and convex quadratic programming is well known for its great practical performance. Strictly speaking it does lack a convergence theory however. As a result, there are examples for which Mehrotra-type algorithms fail to converge. In the talk, divergence on particularly small quadratic programs is examined. Different strategies and safe guards for promoting convergence are discussed.

CNV

Wed.3 H 3025

Algorithms for Large-Scale Convex and Nonsmooth Optimization (Part II)

Chair: Daniel Robinson

Masoud Ahookhosh, KU Leuven (joint work with Panagiotis Patrinos, Andreas Themelis)

A superlinearly convergent Bregman forward-backward method for nonsmooth nonconvex optimization

A superlinearly convergent Bregman forward-backward method for solving sum of two nonconvex functions is proposed, where the first function is relatively smooth and the second one is (nonsmooth) nonconvex. We first introduce the Bregman forward-backward envelope (BFBE), verify its first- and second-order properties under some mild assumptions, and develop a newton-type forward-backward method using BFBE that only needs first-order black-box oracle. After giving the global and local superlinear convergence of the method, we will present encouraging numerical results from several applications.

Avinash Dixit, Indian Institute of Technology (BHU) Varanasi (joint work with Tanmoy Som)

A new accelerated algorithm to solve convex optimization problems

We consider the convex minimization problems of the sum of two convex functions, in which one is differentiable. In the present research work, we used the iterative technique to solve the minimization problem. The recent trend is to introduce techniques having greater convergence speed. Firstly, we introduce an accelerated algorithm to find minimization of a nonexpansive mapping and corresponding proximal gradient algorithm to solve convex optimization problems. Later on, the proposed algorithm is compared with already existing algorithms on the basis of convergence speed and accuracy.

Ewa Bednarczuk, Warsaw University of Technology (joint work with Krzysztof Rutkowski)

[moved] On Lipschitzness of projections onto convex sets given by systems of nonlinear inequalities and equations under relaxed constant rank condition

When approaching convex optimization problems from continuous perspective the properties of related dynamical systems often depend on behavior of projections, In particular, when investigating continuous variants of primal-dual best approximation methods, projections onto moving convex sets appear. We investigate lipschitzness of projection onto moving convex sets. To this aim we use the relaxed constant rank condition, introduced by Minchenko and Stakhovski.

DER

Wed.3 H 2033

Derivative-Free Optimization Under Uncertainty (Part II)

Organizers: Ana Luisa Custodio, Sébastien Le Digabel, Margherita Porcelli, Francesco Rinaldi, Stefan Wild

Chair: Stefan Wild

Fani Boukouvala, Georgia Institute of Technology (joint work with Jianyuan Zhai)

Data-driven branch-and-bound algorithms for derivative-free optimization

Use of high-fidelity simulations is common for computer-aided design, but lack of analytical equations creates challenges. One main challenge in derivative-free optimization is the variability in the incumbent solution, when (a) the problem is stochastic; (b) different initial samples or surrogate models are used to guide the search. We propose to mitigate this lack of robustness in globally convergent behavior, through a surrogate-based spatial branch-and-bound method. We derive bounds for several surrogate models and use them to cleverly partition and prune the space for faster convergence.

Friedrich Menhorn, Technical University of Munich (joint work with Hans-Joachim Bungartz, Michael S. Eldred, Gianluca Geraci, Youssef M. Marzouk)

Near-optimal noise control in derivative-free stochastic optimization

We present new developments for near-optimal noise control in the stochastic nonlinear derivative-free constrained optimization method SNOWPAC. SNOWPAC estimates measures of robustness or risk, appearing in the optimization objective and/or constraints, using Monte Carlo sampling. It also employs a derivative-free trust region approach that is regularized by the resulting sampling noise. We describe how to use Gaussian processes as control variates to decrease this noise in a nearly optimal fashion, thus improving the trust region approximation and the convergence of the method.

Morteza Kimiaei, University of Vienna (joint work with Arnold Neumaier)

Efficient noisy black box optimization

We present a new algorithm for unconstrained noisy black box optimization in high dimension, based on low rank quadratic models for efficiency, and on techniques for guaranteeing good complexity results. A comparison of our algorithm with some solvers from the literature will be given.

GLO

Wed.3 H 3008

Generalized Distances and Envelope Functions

Organizer: Ting Kei Pong
Chair: Ting Kei Pong

Scott B. Lindstrom, The Hong Kong Polytechnic University (joint work with Regina S. Burachik, Minh N. Dao)

The Fitzpatrick Distance

Recently, Burachik and Martinez-Legaz introduced a distance constructed from a representative function for a maximally monotone operator. This distance generalizes the Bregman distance, and we name it the Fitzpatrick distance. We explore the properties of its variants.

Andreas Themelis, KU Leuven (joint work with Panagiotis Patrinos)

A universal majorization-minimization framework for the convergence analysis of nonconvex proximal algorithms

We provide a novel unified interpretation of nonconvex splitting algorithms as compositions of Lipschitz and set-valued majorization-minimization mappings. A convergence analysis is established based on proximal envelopes, a generalization of the Moreau envelope. This framework also enables the integration with fast local methods applied to the nonlinear inclusion encoding optimality conditions. Possibly under assumptions to compensate the lack of convexity, this setting is general enough to cover ADMM as well as forward-backward, Douglas-Rachford and Davis-Yin splittings.

Ting Kei Pong, The Hong Kong Polytechnic University (joint work with Michael Friedlander, Ives Macedo)

Polar envelope and polar proximal map

Polar envelope is a convolution operation specialized to gauges, and is analogous to Moreau envelope. In this talk, we discuss important properties of polar envelope and the corresponding polar proximal map. These include smoothness of the envelope function, and uniqueness and continuity of the proximal map. We also highlight the important roles the polar envelope plays in gauge duality and the construction of algorithms for gauge optimization.

NON

Wed.3 H 0105

Geometry and Optimization

Organizer: Coralia Cartis
Chair: Coralia Cartis

Florentin Goyens, University of Oxford

Nonlinear matrix recovery

We investigate the recovery of a partially observed high-rank matrix whose columns obey a nonlinear structure. The structures covered are unions of clusters and algebraic varieties, which include unions of subspaces. Using a nonlinear lifting to a space of features, as proposed by Ongie et al. in 2017, we reduce the problem to a constrained nonconvex optimization formulation, which we solve using Riemannian optimization methods. We give theoretical convergence and complexity guarantees and provide encouraging numerical results for low dimensional varieties and clusters.

Erlend Skaldehaug Riis, University of Cambridge

A geometric integration approach to nonsmooth, nonconvex optimisation

Discrete gradient methods are popular numerical methods from geometric integration for solving systems of ODEs. They are known for preserving structures of the continuous system, e.g. energy dissipation, making them interesting for optimisation problems. We consider a derivative-free discrete gradient applied to dissipative ODEs such as gradient flow, thereby obtaining optimisation schemes that are implementable in a black-box setting and retain favourable properties of gradient flow. We give a theoretical analysis in the nonsmooth, nonconvex setting, and conclude with numerical results.

Mario Lezcano Casado, University of Oxford

Optimization in compact matrix Lie groups, with applications to machine learning

We present and analyze a novel approach to perform first-order optimization with orthogonal and unitary constraints. This approach is based on a parametrization stemming from Lie group theory through the exponential map. The parametrization transforms the constrained optimization problem into an unconstrained one over a Euclidean space, for which common first-order optimization methods can be used. The theoretical results presented are general enough to cover the special orthogonal group, the unitary group and, in general, any connected compact Lie group.

NON

Wed.3 H 1012

Developments in Structured Nonconvex Optimization (Part II)

Organizers: Jun-ya Gotoh, Yuji Nakatsukasa, Akiko Takeda
Chair: Jun-ya Gotoh

Nikitas Rontsis, University of Oxford (joint work with Paul Goulart, Yuji Nakatsukasa)

An eigenvalue based active-set solver for norm-constrained quadratic problems, with applications to extended trust region subproblems and sparse PCA

We present an active-set algorithm for the minimisation of a non-convex quadratic function subject to linear constraints and a single norm constraint. The suggested algorithm works by solving a series of Trust Region Subproblems (TRS) the global solution of which has been studied extensively in the literature. We extend these results by showing that non-global minima of the TRS, or a certificate of their absence, can be also calculated efficiently by solving a single eigenproblem. We demonstrate the usefulness of the algorithm in solving Sparse PCA and extended Trust Region Subproblems

André Uschmajew, Max Planck Institute for Mathematics in the Sciences (joint work with Felix Krahmer, Max Pfeffer)

A Riemannian optimization approach to sparse low-rank recovery

The problem of recovering a row or column sparse low-rank matrix from linear measurements arises for instance in sparse blind deconvolution. We consider non-convex optimization algorithms for such problems that combine the idea of an ADMM method for sparse recovery with Riemannian optimization on the low-rank manifold and thresholding.

Tianxiang Liu, RIKEN Center for Advanced Intelligence Project (AIP) (joint work with Ivan Markovsky, Ting Kei Pong, Akiko Takeda)

A successive difference-of-convex approximation method with applications to control problems

In this talk, we consider a class of nonconvex nonsmooth optimization problems whose objective is the sum of a smooth function and several nonsmooth functions, some of which are composed with linear maps. This includes the problems arising from system identification with multiple rank-constraints, each of which involves Hankel structure. To solve it, we propose a successive DC approximation method, which makes use of the DC structure of the Moreau envelope. We prove the convergence of the method under suitable assumptions and discuss how it can be applied to concrete applications.

NON

Wed.3 H 1029

Advances in Nonlinear Optimization Algorithms (Part II)

Chair: Mehiddin Al-Baali

Erik Berglund, KTH Royal University of Technology (joint work with Mikael Johansson)

An Eigenvalue Based Limited Memory BFGS Method

Many matrix update formulas in quasi-Newton methods can be derived as solutions to nearest-matrix problems. In this talk, a similar idea is proposed for developing limited memory quasi-Newton methods. We characterize a class of symmetric matrices that can be stored with limited memory. We then derive an efficient way to find the closest member of this class to any symmetric matrix and propose a trust region method that makes use of it. Numerical experiments show that our algorithm has superior performance on large logistic regression problems, compared to a regular L-BFGS trust region method.

Wenwen Zhou, SAS Institute Inc. (joint work with Joshua Griffin, Riadh Omheni)

A modified projected gradient method for bound constrained optimization problems

This talk will focus on solving bound constrained nonconvex optimization problems with expensive-to-evaluate functions. The motivation for this research was from collaborations with members from the statistics community seeking better handling of their optimization problems. The method first solves a QP using the projected gradient method to improve the active set estimate. The method next uses a modified conjugate gradient method applied to the corresponding trust region subproblem to leverage second order information. The numerical results will be provided.

Hao Wang, ShanghaiTech University

An inexact first-order method for constrained nonlinear optimization

We propose inexact first-order methods for solving constrained nonlinear optimization problems. By controlling the inexactness of the subproblem solution, we can significantly reduce the computational cost needed for each iteration. A penalty parameter updating strategy during the subproblem solve enables the algorithm to automatically detect infeasibility. Global convergence for both feasible and infeasible cases are proved. Complexity analysis for the KKT residual is also derived under loose assumptions. Performance of proposed methods is demonstrated by numerical experiments.

NON

Wed.3 H 2013

New Trends in Optimization Methods and Machine Learning (Part III)

Chair: El houcine Bergou

Saeed Ghadimi, Princeton University (joint work with Krishnakumar Balasubramanian)

Zeroth-order Nonconvex Stochastic Optimization: Handling Constraints, High-Dimensionality, and Saddle-Points

We analyze zeroth-order stochastic approximation algorithms for nonconvex optimization with a focus on addressing constrained optimization, high-dimensional setting, and saddle-point avoiding. In particular, we generalize the conditional stochastic gradient method under zeroth-order setting and also highlight an implicit regularization phenomenon where the stochastic gradient method adapts to the sparsity of the problem by just varying the step-size. Furthermore, we provide a zeroth-order variant of the cubic regularized Newton method and discuss its rate of convergence to local minima.

Hien Le, University of Mons (joint work with Nicolas Gillis, Panagiotis Patrinos)

Inertial Block Mirror Descent Method for Non-convex Non-smooth Optimization

We propose inertial versions of block coordinate descent methods for solving nonconvex nonsmooth composite optimization problems. Our methods do not require a restarting step, allow using two different extrapolation points, and take advantage of randomly shuffled. To prove the convergence of the whole generated sequence to a critical point, we modify the well-known proof recipe of Bolte, Sabach and Teboulle, and incorporate it with using auxiliary functions. Applied to solve nonnegative matrix factorization problems, our methods compete favourably with the state-of-the-art NMF algorithms.

NON

Wed.3 H 3007

Recent Trends in Large Scale Nonlinear Optimization (Part II)

Organizers: Michal Kočvara, Panos Parpas

Chair: Panos Parpas

Filippo Pecci, Imperial College London (joint work with Panos Parpas, Ivan Stoianov)

Non-linear inverse problems via sequential convex optimization

We focus on inverse problems for physical systems subject to a set of non-linear equations and formulate a generic sequential convex optimization solution method. The proposed algorithm is implemented for fault estimation in water supply networks. Previous literature has solved this combinatorial problem using evolutionary approaches. We show that the considered problem can be approximated by a non-linear inverse problem with L^1 regularization and solved using sequential convex optimization. The developed method is tested using a large operational water network as case study.

Michal Kočvara, University of Birmingham (joint work with Chin Pang Ho, Panos Parpas)

On Newton-type multilevel optimization methods

Building upon multigrid methods, a framework of multilevel optimization methods was developed to solve structured optimization problems, including problems in optimal control, image processing, etc. In this talk, we give a broader view of the multilevel framework and establish some connections between multilevel algorithms and the other approaches. By studying a case study of the so-called Newton-type multilevel model, we take the first step to show how the structure of optimization problems could improve the convergence of multilevel algorithms.

Man Shun Ang, UMONS (joint work with Nicolas Gillis)

Accelerating Nonnegative-X by extrapolation, where X $\in$ Least Square, Matrix Factorization, Tensor Factorization

Non-negativity constraint is ubiquitous. A family of non-negativity constrained problems (NCP) are the non-negative least squares (NNLS), the non-negative matrix factorization (NMF) and the non-negative tensor factorization (NTF). The goal of these NCP problems in general is to fit an given object (vector, matrix, or tensor) by solving an optimization problem with non-negativity constraints. Various algorithms are proposed to solve the NCP. In this talk, we introduce an general extrapolation-based acceleration scheme that that can significantly accelerate the algorithm for NNLS, NMF and NTF.

PDE

Wed.3 H 0106

Optimal Control of Nonsmooth Systems (Part III)

Organizers: Constantin Christof, Christian Clason
Chair: Christian Clason

Gerd Wachsmuth, BTU Cottbus-Senftenberg (joint work with Constantin Christof)

Second-order conditions for optimal control of the obstacle problem

In this talk, we consider second-order optimality conditions for the optimal control of the obstacle problem. In particular, we are interested in sufficient conditions which guarantee the local/global optimality of the point of interest. Our analysis extends and refines existing results from the literature. We present three counter-examples which illustrate that rather peculiar effects can occur in the analysis of second-order optimality conditions for optimal control problems governed by the obstacle problem.

Anne-Therese Rauls, TU Darmstadt (joint work with Stefan Ulbrich)

Subgradient Calculus for the Obstacle Problem

In this talk, we discuss differentiability properties of a general class of obstacle problems and characterize generalized derivatives from the Bouligand subdifferential of the solution operator for the obstacle problem in all points of its domain. The subgradients we obtain are determined by solution operators of Dirichlet problems on quasi-open domains. To use the derived subgradients in practice within nonsmooth optimization methods, a discretization of the obstacle problem is necessary. We investigate how the respective subgradients can be approximated in this case.

Georg Müller, Universität Konstanz (joint work with Constantin Christof)

Multiobjective Optimal Control of a Non-Smooth Semi-Linear Elliptic PDE

The understanding of and the techniques for dealing with non-smoothness in scalar optimization with PDEs have increased drastically over the last years. In multiobjective non-smooth optimization, however, few results are known.

This talk addresses the multiobjective optimal control of a non-smooth semi-linear elliptic PDE with max-type nonlinearity. First results are focused on first order optimality condition based on multiple adjoint equations. Additionally, we discuss the numeric characterization of the Pareto front for few objectives using scalarization techniques and regularization.

PDE

Wed.3 H 0107

Optimal Control and Dynamical Systems (Part VII)

Organizers: Cristopher Hermosilla, Michele Palladino
Chair: Michele Palladino

Emilio Vilches, Universidad de O'Higgins

Some results on the optimal control of implicit sweeping processes

In this talk, we present some results on the optimal control of implicit sweeping processes such as characterization of nonsmooth Lyapunov pairs and parametric stability. Some applications to implicit evolution variational inequalities are given.

Cristopher Hermosilla, Universidad Tecnica Federico Santa Maria

Hamilton-Jacobi-Bellman approach for optimal control problems of sweeping processes

This talk is concerned with a state constrained optimal control problem governed by a perturbed Moreau's sweeping process. The focus of the talk is on the Bellman approach for an infinite horizon problem. In particular, we focus on the regularity of the value function and on the Hamilton-Jacobi-Bellman equation it satisfies. We discuss a uniqueness result and we make a comparison with standard state constrained optimal control problem to highlight a regularizing effect that the sweeping process induces on the value function.

Fernando Lobo Pereira, Universidade do Porto Faculdade de Engenharia (joint work with Ismael Pena, Geraldo Nunes Silva)

A Predictive Control Framework for the Sustainable Management of Resources

This article concerns a predictive control framework to support decision-making in the context of resources management in which sustainability is achieved by deconflicting short-term – usually profit-seeking – goals of multiple agents, and the goal of seeking the the collective equilibrium in the sense of preserving the required production efficiency level.

This class of problems arise in a very large spectrum of contexts such as agriculture, oceanic biomass exploitation, manufacturing, and services systems. In each one of these contexts, the competition among the multiple decision-makers often entails that each one adopts control strategies maximizing his/her profit in the short term, and, as a consequence, a long term depletion of the ingredients required to sustain the production efficiency of the overall system.

Given the usual complexity of any realistic scenario, we consider an abstract context clarifying the core mathematical issues of a bi-level control architecture that, under some reasonable general assumptions, generates control strategies ensuring the asymptotic convergence to a sustainable global equilibrium while ensuring the economic (and, thus, social) short term sustainability.

PDE

Wed.3 H 0112

Decomposition-Based Methods for Optimization of Time-Dependent Problems (Part II)

Organizers: Matthias Heinkenschloss, Carl Laird
Chair: Matthias Heinkenschloss

Nicolas Gauger, TU Kaiserslautern (joint work with Eric Cyr, Stefanie Günther, Lars Ruthotto, Jacob B. Schroder)
Layer-parallel training of deep residual neural networks

Residual neural networks (ResNets) are a promising class of deep neural networks that have shown excellent performance for a number of learning tasks, e.g., image classification and recognition. Mathematically, ResNet architectures can be interpreted as forward Euler discretizations of a nonlinear initial value problem whose time-dependent control variables represent the weights of the neural network. Hence, training a ResNet can be cast as an optimal control problem of the associated dynamical system. For similar time-dependent optimal control problems arising in engineering applications, parallel-in-time methods have shown notable improvements in scalability. In this talk, we demonstrate the use of those techniques for efficient and effective training of ResNets. The proposed algorithms replace the classical (sequential) forward and backward propagation through the network layers by a parallel nonlinear multigrid iteration applied to the layer domain. This adds a new dimension of parallelism across layers that is attractive when training very deep networks. From this basic idea, we derive multiple layer-parallel methods.The most efficient version employs a simultaneous optimization approach where updates to the network parameters are based on inexact gradient information in order to speed up the training process. Using numerical examples from supervised classification, we demonstrate that the new approach achieves similar training performance to traditional methods, but enables layer-parallelism and thus provides speedup over layer-serial methods through greater concurrency.

Alexander Engelmann, Karlsruhe Institute of Technology (joint work with Timm Faulwasser)
Decomposition of optimal control problems using bi-level distributed ALADIN

We explore the decomposition of optimal control problems using a recently proposed decentralized variant of the Augmented Lagrangian Alternating Direction Inexact Newton (ALADIN) method. Specifically we consider a bi-level distributed variant of ALADIN, wherein the outer ALADIN structure is combined with a second inner level of distribution handling the coupling QP by means of decentralized ADMM or similar algorithms. We draw upon case studies from energy systems and from predictive control to illustrate the efficacy of the proposed framework.

Carl Laird, Sandia National Laboratories (joint work with Michael Bynum, Bethany Nicholson, Jose Santiago Rodriguez, John Siirola, Victor Zavala)
Schur-complement and ADMM approaches for Time-Domain Decomposition in Optimization with PyNumero

PyNumero is a Python package based on Pyomo that supports development of numerical optimization algorithms. Using MPI, PyNumero has been used to develop decomposition algorithms for structured nonlinear programming problems, including problem-level decomposition approaches (e.g., ADMM) and approaches that decompose the linear algebra in the inner SQP step. In this presentation, we will show computational performance of Schur-complement based approaches and ADMM approaches on with time-domain decomposition for dynamic optimization problems.

ROB

Wed.3 H 3004

Robust Nonlinear Optimization

Organizer: Frans de Ruiter
Chair: Frans de Ruiter

Oleg Kelis, Technion -Israel Instutute of Tecnology (joint work with Valery Glizer)
Finite-horizon singular H_∞ control problem: a regularization method

We consider an finite horizon singular H_∞ control problem. A regularization of this problem is proposed leading to a new H_∞ problem with a partial cheap control. The latter is solved by adapting a perturbation technique. Then, it is shown on how accurately the controller, solving this H_∞ partial cheap control problem, solves the original singular H_∞ control problem.

Jianzhe (Trevor) Zhen, EPFL (joint work with Daniel Kuhn, Wolfram Wiesemann)
Distributionally Robust Nonlinear Optimization

Leveraging a generalized ‘primal-worst equals dual-best’ duality scheme for robust optimization, we derive from first principles a strong duality result that relates distributionally robust to classical robust optimization problems and that obviates the need to mobilize the machinery of abstract semi-infinite duality theory. In order to illustrate the modeling power of the proposed approach, we present convex reformulations for data-driven distributionally robust optimization problems whose ambiguity sets constitute type-p Wasserstein balls for any $p \in [1, \infty]$.

Frans de Ruiter, Tilburg University, The Netherlands (joint work with Aharon Ben-Tal, Ernst Roos, Jianzhe (Trevor) Zhen, Dick den Hertog)
Effective approach for hard uncertain convex inequalities

In many problems the uncertain parameters appear in a convex way, which is problematic as no general techniques exist for such problems. In this talk, we provide a systematic way to construct safe approximations to such constraints when the uncertainty set is polyhedral. We reformulate the original problem as a linear adjustable robust optimization problem in which the nonlinearity of the original problem is captured by the new uncertainty set. We demonstrate the quality of the approximations with a study of geometric programming problems and numerical examples from radiotherapy optimization.

ROB

Wed.3 H 3006

Algorithms and Applications of Robust Optimization

Organizer: William Haskell
Chair: William Haskell

Napat Rujeerapaiboon, National University of Singapore (joint work with Cagil Kocyigit, Daniel Kuhn)
Robust Multidimensional Pricing: Separation without Regret

We study a robust monopoly pricing problem with a minimax regret objective, where a seller endeavors to sell multiple goods to a single buyer, only knowing that the buyer's values for the goods range over a rectangular uncertainty set. We interpret this problem as a zero-sum game between the seller, who chooses a selling mechanism, and a fictitious adversary, who chooses the buyer's values. We prove that this game admits a Nash equilibrium that can be computed in closed form. We further show that the deterministic restriction of the problem is solved by a deterministic posted price mechanism.

Wolfram Wiesemann, Imperial College Business School (joint work with Zhi Chen, Daniel Kuhn)
Data-Driven Chance Constrained Programs over Wasserstein Balls

We provide an exact deterministic reformulation for data-driven chance constrained programs over Wasserstein balls. For individual chance constraints as well as joint chance constraints with right-hand side uncertainty, our reformulation amounts to a mixed-integer conic program. In the special case of a Wasserstein ball with the 1-norm or the ∞-norm, the cone is the nonnegative orthant, and the chance constrained program can be reformulated as a mixed-integer linear program.

William Haskell, Purdue University (joint work with Hien Le Thi Khanh, Renbo Zhao)
An Inexact Primal-Dual Smoothing Framework with Applications to Robust Optimization

We propose an inexact primal-dual smoothing framework to solve a strongly-convex- generally-concave saddle point problem with non-bilinear structure, with potentially a large number of component functions. We develop a probabilistic version of our smoothing framework, which allows each sub-problem to be solved by randomized algorithms inexactly in expectation. In addition, we extend both our deterministic and probabilistic frameworks to solve generally convex-concave saddle point problems. We comment on the application of this method to robust data-driven optimization.

SPA

Wed.3 H 2038

Block Alternating Schemes for Nonsmooth Optimization at a Large Scale

Organizer: Emilie Chouzenoux
Chair: Jean-Christophe Pesquet

Krzysztof Rutkowski, Warsaw University of Technology (joint work with Ewa Bednarczuk)
On projected dynamical system related to best approximation primal-dual algorithm for solving maximally monotone operators inclusion problem

In this talk we discuss Projected Dynamical System (PDS) associated with the proximal primal-dual algorithm for solving maximally monotone inclusions problem. We investigate the discretized version of (PDS) with the aim of giving an insight into the relationships between the trajectories solving (PDS) and sequences generated by proximal primal-dual algorithm. We relate the discretization of (PDS) with Haugazeau-based proximal primal-dual algorithms and discuss its block versions. The talk is based on the common work with Ewa Bednarczuk.

Marco Prato, Università degli Studi di Modena e Reggio Emilia (joint work with Silvia Bonettini, Simone Rebegoldi)
A variable metric nonlinear Gauss-Seidel algorithm for nonconvex nonsmooth optimization

We propose a block coordinate forward-backward algorithm aimed at minimizing functions defined on disjoint blocks of variables. The proposed approach is characterized by the possibility of performing several variable metric forward-backward steps on each block of variables, in combination with an Armijo backtracking linesearch to ensure the sufficient decrease of the objective function. The forward-backward step may be computed approximately, according to an implementable stopping criterion, and the parameters defining the variable metric may be chosen using flexible desired adaptive rules.

Jean-Christophe Pesquet, University Paris Saclay (joint work with Luis Briceño-Arias, Giovanni Chierchia, Emilie Chouzenoux)
A Random Block-Coordinate Douglas-Rachford Splitting Method with Low Computational Complexity for Binary Logistic Regression

In this talk, we introduce a new optimization algorithm for sparse logistic regression based on a stochastic version of the Douglas Rachford splitting method. Our algorithm sweeps the training set by randomly selecting a mini-batch of data at each iteration, and it allows us to update the variables in a block coordinate manner. Our approach leverages the proximity operator of the logistic loss, which is expressed with the generalized Lambert W function. Experiments carried out on standard datasets demonstrate the efficiency of our approach w.r.t. stochastic gradient-like methods.

STO

Wed.3 H 3012

Stochastic Optimization and Its Applications (Part III)

Organizer: Fengmin Xu
Chair: Fengmin Xu

Christian Bayer, WIAS (joint work with Raul Tempone, Sören Wolfers)

Pricing American options by exercise rate optimization

We consider the pricing American basket options in a multivariate setting, including the Heston and the rough Bergomi models. In high dimensions, nonlinear PDEs methods for solving the problem become prohibitively costly due to the curse of dimensionality. Our novel method uses Monte Carlo simulation and the optimization of exercise strategies parametrized as randomized exercise strategies. Integrating analytically over the random exercise decision yields an objective function that is differentiable with respect to perturbations of the exercise rate, even for finitely many sampled paths.

Xiaobo Li, National University of Singapore (joint work with Saif Benjaafar, Daniel Jiang, Xiang Li)

Inventory Repositioning in On-Demand Product Rental Networks

We consider a product rental network with a fixed number of rental units distributed across multiple locations. Because of the randomness in demand and in the length of the rental periods and in unit returns, there is a need to periodically reposition inventory. We formulate the problem as a Markov Decision Process and offer a characterization of the optimal policy. In addition, we propose a new cutting-plane-based approximate dynamic programming algorithm that leverages the structural properties. A novel convergence analysis, together with promising numerical experiments, is provided.

Thu.1 09:00–10:15

APP

Thu.1 H 3004

Applications in Logistics and Supply Chain Management

Chair: Ali Ekici

Okan Ozener, Ozyegin University (joint work with Basak Altan)

A Game Theoretical Approach for Improving the Operational Efficiencies of Less-than-truckload Carriers Through Load Exchanges

Less-than-truckload (LTL) transportation offers fast, flexible and relatively low cost transportation services to shippers. In order to cope with the effects of economic recessions, LTL industry implemented ideas such as reducing excess capacity and increasing revenues through better yield management. In this paper, we extend these initiatives beyond the reach of individual carriers and propose a collaborative framework that facilitates load exchanges to reduce the operational costs of the collaborating LTL carriers.

Mingyu Li, Department of Industrial Economics and Technology Management, NTNU (joint work with Peter Schütz)

Decision support for ship routing in dynamic and stochastic ice conditions

We discuss the problem of finding the optimal route for a ship sailing in non-stationary ice conditions, with uncertainty resulted from poor quality of ice conditions forecasts. We formulate the problem as a shortest path problem with uncertain and time-dependent travel times but alternative objective can be risk or cost. We consider a 15-day planning horizon, with new ice information updated regularly and reconsider decisions accordingly. We present the look-ahead model formulation, a stochastic dynamic programming based solution method and preliminary results.

Ali Ekici, Ozyegin University (joint work with Serhan Duran, Okan Ozener)

Ordering from Capacitated Suppliers under Cycle Time Limitation

We study the ordering policy of a retailer which procures a single item from multiple capacitated suppliers and satisfies an exogenous demand. Retailer's objective is to minimize total fixed, variable and inventory holding cost. We develop cyclic ordering policies for the retailer with limited cycle time. We propose a novel iterative-natured heuristic framework which looks for the best cycle time while selecting suppliers and allocating orders. Computational experiments show that the proposed heuristic framework provides better results compared to other methods in the literature.

BIG

Thu.1 H 0105

Distributed and Decentralized Optimization: Learning, Lower-Complexity Bounds, and Communication-Efficiency

Organizers: Andy Sun, Wotao Yin

Chair: Kaizhao Sun

Qing Ling, Sun Yat-Sen University

RSA: Byzantine-Robust Stochastic Aggregation Methods for Distributed Learning from Heterogeneous Datasets

We propose a class of robust stochastic methods for distributed learning from heterogeneous datasets at presence of an unknown number of Byzantine workers. The key is a regularization term incorporated with the cost function to robustify the learning task. In contrast to most of the existing algorithms, the resultant Byzantine-Robust Stochastic Aggregation (RSA) methods do not rely on the assumption that the data are i.i.d. on the workers. We show that the RSA methods converge to a near-optimal solution with the learning error dependent on the number of Byzantine workers.

Mingyi Hong, University of Minnesota (joint work with Haoran Sun)

Distributed Non-Convex First-Order Optimization and Information Processing: Lower Complexity Bounds and Rate Optimal Algorithms

We consider a distributed non-convex optimization problems, in which a number of agents collectively optimize a sum of smooth local objective functions. We address the question: What is the fastest rate that any distributed algorithms can achieve, and how to achieve those rates. We develop a lower bound analysis, and show that in the worst-case it takes any first-order algorithm $O(1/(\epsilon * \sqrt(k)))$ iterations to achieve some ϵ-solution, where k is the network spectrum gap. We also develop a rate-optimal distributed method whose rate matches the lower bound. The algorithm combines ideas from distributed consensus, as well as classical fast solvers for linear systems.

Wotao Yin, University of California, Los Angeles

LAG: Lazily Aggregated Gradient is Communication-Efficient in Distributed and Decentralized Optimization

In Lazily Aggregated Gradient (LAG), the nodes in a distributed or decentralized algorithm can choose to use outdated gradient information, therefore, reduce communication. This is also called gradient censoring. Surprisingly, the original convergence rates remain the same in the strongly-convex, convex, and nonconvex cases while communication is reduced. When local Lipschitz constants are heterogeneous, communication is reduced significantly. Numerical experiments with synthetic and real data will demonstrate this significant communication reduction. This talk combines different recent works.

BIG

Thu.1 H 3006

Large-Scale Optimization for Statistical Learning

Organizer: Paul Grigas
Chair: Paul Grigas

Rahul Mazumder, Massachusetts Institute of Technology
Algorithmic approaches for Nonparametric Function estimation with Shape Constraints [canceled]

Nonparametric function estimation is a quintessential problem in statistical data-analysis with widespread applications in online advertising, econometrics, operations research, etc. We consider the problem of estimating functions are (a) smooth and have (b) shape constraints (monotonicity, convexity, etc.). This leads to an infinite-dimensional convex quadratic optimization problem posing computational challenges. We propose a framework to jointly achieve goals (a), (b). Time permitting, we will discuss the problem of fitting a multivariate convex function to data.

Hussein Hazimeh, MIT (joint work with Rahul Mazumder)
Learning Hierarchical Interactions at Scale [canceled]

In many learning settings, it is beneficial to augment the main features with pairwise interactions. Such interaction models can be enhanced by performing variable selection under the so-called “strong hierarchy” constraint. Existing convex optimization based algorithms face difficulties in handling problems where the number of main features is beyond a thousand. We propose convex first order algorithms to exactly solve the problem with up to a billion variables on a single machine. We also discuss how to solve the original nonconvex problem via a tailored branch-and-bound algorithm.

BIG

Thu.1 H 3007

Big Data and Machine Learning - Contributed Session I

Chair: Guozhi Dong

Scindhiya Laxmi, Indian institute of Technology Roorkee (joint work with S. K. Gupta)
Human Activity Recognition using Intuitionistic Fuzzy Proximal Support Vector Machines

Human activity recognition is an active area of research in Computer Vision. One of the difficulties of an activity recognition system is the presence of noises in the training data. We addressed this problem by assigning membership and hesitation degrees to the training instances according to its contribution to the classification problem. In this way, the impact of noises and outliers has been reduced to some extent. The methodology intuitionistic fuzzy proximal support vector machine for human activity is proposed to speed up the training phase and to increase the classification accuracy.

Robert Ravier, Duke University (joint work with Vahid Tarokh)
Online Optimization for Time Series of Parametrizable Objective Functions

The time-varying component of many objective functions of practical interest in online optimization is fully contained in a finite number of parameters. This allows us to use methods from standard time series analysis in order to predictively optimize. We investigate the theoretical and computational effects of using these methods. In particular, we focus on both the potential improvements of regret upper bounds when utilizing these techniques as well as algorithms for simultaneously modeling and optimizing.

Guozhi Dong, Humboldt-Universität zu Berlin (joint work with Michael Hintermüller, Kostas Papafitsoros)
A data-driven model-based method for quantitative MRI

Recently, an integrated physics-based model has been introduced for quantitative magnetic resonance imaging. It incorporates the physical model by Bloch equations into the data acquisition, and leads to high accuracy estimation of the tissue parameters. However, in general, the physical model might be not explicitly known. In this talk, we introduce a novel data-driven model-based method which combines the advances of integrated physics-based method with deep neural networks.

VIS

Thu.1 H 3013

Complementarity: Extending Modeling and Solution Techniques (Part II)

Organizer: Michael Ferris
Chair: Michael Ferris

Francesco Caruso, University of Naples "Federico II" (joint work with Maria Carmela Ceparano, Jacqueline Morgan)

Approximation of Nash equilibria via continuous optimization

We propose an algorithm based on a non-standard (non-convex) relaxation of the classical best response approach which guarantees the convergence to a Nash equilibrium in two-player non zero-sum games when the best response functions are not linear, both their compositions are not contractions and the strategy sets are Hilbert spaces. First, we prove a uniqueness result for Nash equilibria. Then, we define an iterative method and a numerical approximation scheme, relying on a continuous optimization technique, which converge to the unique Nash equilibrium. Finally, we provide error bounds.

David Stewart, University of Iowa (joint work with Mario Barela)

Simulating electrical circuits with diodes and transistors

Electrical circuits with dynamical elements (inductors and capacitors) are implicit differential algebraic equations, and when ideal diodes are included they are differential complementarity problems. The matrices that arise in these problems are symmetric positive definite, which means solutions exist and are unique. These systems can be efficiently solved numerically by high order Diagonally Implicit Runge-Kutta methods in a way that exploits the network structure.

CON

Thu.1 H 2032

Methods and Applications in Mixed Integer Semidefinite Programming

Organizer: Christoph Helmberg
Chair: Christoph Helmberg

Angelika Wiegele, Alpen-Adria-Universität Klagenfurt (joint work with Nicolo Gusmeroli, Franz Rendl)

An Exact Penalty Method over Discrete Sets

We are interested in solving linearly constrained binary quadratic problems (BQP) by transforming the problems into unconstrained ones and using a max-cut solver. This is in the spirit of "exact penalty methods", but optimizing the penalized function over the discrete set. We improve on a method investigated by Lasserre (2016) who computed a sufficiently large penalty paramter by solving two semidefinite programs. Our new parameters lead to a better performance when solving the transformed problem. We present preliminary computational results demonstrating the strength of this method.

Julie Sliwak, RTE, Polytechnique Montréal, LIPN (joint work with Miguel Anjos, Lucas Létocart, Jean Maeght, Emiliano Traversi)

A conic-bundle approach to solve semidefinite relaxations of Alternating Current Optimal Power Flow problems

The Alternating Current Optimal Power Flow (ACOPF) problem is a challenging problem due to its significant nonconvexity. To prove global optimality, Semidefinite Relaxations (SDRs) are a powerful tool: the rank-one SDR is often exact and when it is not, the Lasserre hierarchy SDRs achieve global optimality. However, solving large-scale semidefinite problems is still a computational challenge. We propose a conic-bundle algorithm to solve SDRs of ACOPF based on a clique decomposition arising from an ad-hoc chordal extension of the power network.

Felix Lieder, Heinrich-Heine-Universität Düsseldorf

Exploiting Completely Positive Projection Heuristics

In this talk we revisit completely positive cone programs. A simple reformulation as a fixed point problem leads us to a family of (globally convergent) outer algorithms. NP-hardness of the original problem is shifted to the completely positive projection operator. Its sequential (approximate) evaluations are then tackled by exploiting the underlying structure in combination with powerful local optimization tools. Finally some promising numerical results on small dimensional maximum stable set problems are presented, indicating that the resulting heuristics often perform well in practice.

CON

Thu.1 H 2033

Matrix Analysis and Conic Programming

Organizer: Etienne de Klerk
Chair: Fei Wang

Cécile Hautecoeur, UCLouvain (joint work with François Glineur)

Nonnegative matrix factorization over polynomial signals via a sum-of-squares approach

Nonnegative matrix factorization (NMF) is a linear dimensionality reduction technique successfully used for analysis of discrete data, such as images. It is a discrete process by nature while the analyzed signals may be continuous. The aim of this work is to extend NMF to deal with continuous signals, avoiding a priori discretization. In other words, we seek a small basis of nonnegative signals capable of additively reconstructing a large dataset. We propose a new method to compute NMF for polynomials or splines using an alternating minimization scheme relying on sum-of-squares representation.

Fei Wang, Royal Institute of Technology (KTH)

Noisy Euclidean Distance Matrix Completion with A Single Missing Node

We present several solution techniques for the noisy single source localization problem,i.e., the Euclidean distance matrix completion problem with a single missing node to locate under noisy data. For the case that the sensor locations are fixed, we show that this problem is implicitly convex, and we provide a purification algorithm along with the SDP relaxation to solve it efficiently and accurately. For the case that the sensor locations are relaxed, we study a model based on facial reduction. We present several approaches to solve this problem efficiently and compare their performance.

CON

Thu.1 H 2038

Second and Higher Order Cone Programming and Trust Region Methods

Organizer: Etienne de Klerk
Chair: Walter Gomez

Mirai Tanaka, The Institute of Statistical Mathematics (joint work with Takayuki Okuno)

An adaptive LP-Newton method for second-order cone optimization

The LP-Newton method solves the linear optimization problem (LP) by repeatedly projecting a current point onto a certain relevant polytope. In this talk, we extend the LP-Newton method to the second-order cone optimization problem (SOCP) via a linear semi-infinite optimization problem (LSIP) reformulation. In the extension, we produce a sequence by projection onto polyhedral cones constructed from LPs obtained by finitely relaxing the LSIP. We show the global convergence of the proposed algorithm under mild assumptions, and investigate investigate its efficiency through numerical experiments.

Walter Gomez, Universidad de La Frontera (joint work with Nicolas Fuentealba)

Exact relaxations of non convex trust region subproblems with an additional quadratic constraint.

In this work we study nonconvex trust region problems with an additional quadratic constraint. For this class of problems we propose a family of relaxations, and study some key properties regarding convexity, exactness of the relaxation, sufficient condition for exactness, etc. For the case that the additional quadratic constraint is not convex , we generalize sufficient conditions for exactness of the relaxation proposed originally for trust region problems with an additional conic and discuss some examples for which trivial extensions of the sufficient conditions do not apply.

Lijun Ding, Cornell University (joint work with Lek-Heng Lim)

Higher-Order Cone Programming [canceled]

We introduce a conic embedding condition that gives a hierarchy of cones and cone programs. This condition is satisfied by a large number of convex cones including the cone of copositive matrices, the cone of completely positive matrices, and all symmetric cones. We discuss properties of the intermediate cones and conic programs in the hierarchy. In particular, we demonstrate how this embedding condition gives rise to a family of cone programs that interpolates between LP, SOCP, and SDP.

CNV

Thu.1 H 1028

Splitting Methods and Applications (Part I)

Organizers: Pontus Giselsson, Ernest Ryu, Adrien Taylor
Chair: Adrien Taylor

Francisco Javier Aragón Artacho, University of Alicante (joint work with Yair Censor, Aviv Gibali)

The cyclic Douglas–Rachford algorithm with r-sets-Douglas–Rachford operators

The Douglas–Rachford (DR) algorithm is an iterative procedure that uses sequential reflections onto convex sets and which has become popular for convex feasibility problems. In this paper we propose a structural generalization that allows to use r-sets-DR operators in a cyclic fashion. We prove convergence and present numerical illustrations of the potential advantage of such operators with $r > 2$ over the classical 2-sets-DR operators in a cyclic algorithm.

Sorin-Mihai Grad, Vienna University (joint work with Oleg Wilfer)

Combining duality and splitting proximal point methods

We approach via conjugate duality some optimization problems with intricate structure that cannot be directly solved by means of the existing proximal point type methods. A splitting scheme is employed on the dual problem and the optimal solutions of the original one are recovered by means of optimality conditions. We use this approach for minmax location and entropy constrained optimization problems, presenting also some computational results where our method is compared with some recent ones from the literature.

Xiaoqun Zhang, Shanghai Jiao Tong University

A Stochastic Primal Dual Fixed Point Method for Composited Convex Optimization

In this work we proposed a stochastic version of primal dual fixed point method(SPDFP) for solving a sum of two proper lower semi-continuous convex function one of which is composited with a linear operator. Under some assumptions we proved the convergence of the proposed algorithm and also provided a variant for the implementation. Convergence analysis shows that the expected error of iterate is of the order $O(k^{-\alpha})$) where k is the iteration number and $\alpha \in (0, 1)$. Finally, two numerical examples are performed to demonstrate the effectiveness of the proposed algorithms.

DER

Thu.1 H 3025

Emerging Trends in Derivative-Free Optimization (Part III)

Organizers: Ana Luisa Custodio, Sébastien Le Digabel, Margherita Porcelli, Francesco Rinaldi, Stefan Wild
Chair: Ana Luisa Custodio

Susan Hunter, Purdue University (joint work with Kyle Cooper, Kalyani Nagaraj)

Bi-objective simulation optimization on integer lattices using the epsilon-constraint method in a retrospective approximation framework

We propose the Retrospective Partitioned Epsilon-constraint with Relaxed Local Enumeration (R-PERLE) algorithm to solve the bi-objective simulation optimization problem on integer lattices. R-PERLE is designed for simulation efficiency and provably converges to a local efficient set w.p.1 under appropriate regularity conditions. It uses a retrospective approximation (RA) framework and solves each resulting bi-objective sample-path problem only to an error tolerance commensurate with the sampling error. We discuss the design principles that make our algorithm efficient.

Mauro Passacantando, Università di Pisa (joint work with Stefano Lucidi, Francesco Rinaldi)

A global optimization approach for solving non-monotone equilibrium problems

A global optimization approach for solving non-monotone equilibrium problems (EPs) is proposed. The regularized gap functions are used to reformulate any EP as a constrained global optimization program and some bounds on the Lipschitz constant of such functions are provided. The proposed approach combines exact penalty functions with an improved version of the DIRECT algorithm which exploits local bounds of the Lipschitz constant. Unlike most existing methods, no monotonicity condition is assumed. Preliminary numerical results on several classes of EPs show the effectiveness of the approach.

Evgeniya Vorontsova, Université Grenoble Alpes (joint work with Pavel Dvurechensky, Alexander Gasnikov, Eduard Gorbunov)

[moved] Optimal stochastic gradient-free methods with inexact oracle

We propose new accelerated stochastic gradient-free methods for convex and strongly convex optimization problems with small additive noise of unknown nature. We try to make the analysis accurate to obtain the best possible estimates on how this noise accumulates. Note that we don't assume that we "live" in a bounded set. Since that we have to show that generated sequence of points will be bounded. This requires new technique.

GLO

Thu.1 H 1029

Global Optimization - Contributed Session II

Chair: Ozan Evkaya

Majid Darehmiraki, Behbahan Khatam Alanbia University of Technology (joint work with Seyedeh Masoumeh Hosseini Nejad)

The proximal gradient method for the subproblem of trust region method

Trust region algorithms are a class of numerical methods for nonlinear optimization problems, which have been extensively studied for many decades. Finding solution for the subproblem of the trust region method is a fundamental problem in nonlinear optimization. In this paper, using Tikhonov regularization, we first turn the constrained quadratic problem into an unconstrained problem, and then solve it by the proximal gradient (PG) method. The Proposed method is effective both for dense and large-sparse problems, including the so-called hard case.

José Fernández, University of Murcia (joint work with Laura Anton-Sanchez, Boglárka G.-Tóth, Juana L. Redondo, Pilar M. Ortigosa)

Firm expansion: how to invest? A MINLP model and B&B and heuristic procedures to deal with it

A chain wants to expand its presence in a given region, where it already owns some existing facilities. The chain can open a new facility and/or modify the qualities of some of its existing facilities and/or close some of them. In order to decide the location and quality of the new facility (in case it is open) as well as the new qualities for the existing facilities, a MINLP is formulated, whose objective is to maximize the profit obtained by the chain. Both an exact interval Branch-and-Bound method and a heuristic evolutionary algorithm are proposed to cope with this problem.

Ozan Evkaya, Atilim University

Parameter estimations of finite mixture models with particular optimization tools

Copulas can be easily incorporated into finite mixtures but as the structure of mixture models the gradient based optimization tools are not practical for the purpose of parameter estimation. This paper mainly investigates the performance of various optimization tools with different properties in terms of finding parameters of finite mixture models. In that respect, traditional gradient based, recently developed heuristic and global optimization algorithms are studied. For testing performance, considered problem with specific optimization routines are compared in terms of accuracy and run time

MUL

Thu.1 H 0111

Uncertainty in Multi-Objective Optimization

Organizers: Gabriele Eichfelder, Alexandra Schwartz
Chair: Patrick Groetzner

Fabian Chlumsky-Harttmann, TU Kaiserslautern (joint work with Anita Schöbel)

Cutting planes for robust multi-objective optimization

Previously developed concepts for robust multi-objective optimization such as set-based and point-based minmax robust efficiency determine efficient solutions that are good in the worst case. However, finding robust efficient solutions for a given uncertain multi-objective problem remains difficult. We adopt a row generating approach incrementally increasing the set of considered scenarios and investigate what selection rule for the scenario to add is most beneficiary to achieve fast convergence.

Patrick Groetzner, Augsburg University (joint work with Ralf Werner)

Multiobjective Optimization Under Uncertainty: A Robust Regret Approach

Consider a multiobjective decision problem with uncertainty given as a set of scenarios. In the single criteria case, robust optimization methodology helps to identify solutions which remain feasible and of good quality for all possible scenarios. Here one method is to compare the possible decisions under uncertainty against the optimal decision with the benefit of hindsight, i.e. to minimize the regret of not having chosen the optimal decision. In this talk I will extend this regret to the multiobjective setting to introduce a robust strategy for multiobjective optimization under uncertainty.

NON

Thu.1 H 0104

Recent Advances of First-Order Methods for Nonlinear Problems (Part I)
Organizers: Shiqian Ma, Yangyang Xu
Chair: Shiqian Ma

Haihao Lu, MIT
Q-Stochastic Gradient Descent: a New Stochastic First-Order Method for Ordered Empirical Loss Minimization

We propose a new approach to stochastic first-order method for tackling empirical loss minimization problems such as those that arise in machine learning. We develop a theory and computationally simple way to construct a gradient estimate that is purposely biased. On the theory side, we show that the proposed algorithm is guaranteed to converges at a sublinear rate to the global optimum of the modified objective function. On the computational side, we present numerical experiments that confirm the usefulness of the new method compared with standard SGD in different settings.

Tianbao Yang, University of Iowa (joint work with Rong Jin, Qihang Lin, Qi Qi, Yi Xu)
Stochastic Optimization for DC Functions and Non-smooth Non-convex Regularizers with Non-asymptotic Convergence

We propose new stochastic optimization algorithms and study their first-order convergence theories for solving a broad family of DC functions. We improve the existing algorithms and theories of stochastic optimization for DC functions from both practical and theoretical perspectives. Moreover, we extend the proposed stochastic algorithms for DC functions to solve problems with a general non-convex non-differentiable regularizer, which does not necessarily have a DC decomposition but enjoys an efficient proximal mapping.

N. Serhat Aybat, Penn State University (joint work with Afrooz Jalilzadeh, Uday Shanbhag, Erfan Y. Hamedani)
A Doubly-Randomized Block-Coordinate Primal-Dual Method for Large-scale Convex-Concave Saddle Point Problems: Acceleration via Variance-Reduction

We consider computing a saddle point (x^*, y^*) of convex-concave $L(x, y) = \sum_{n=1}^{N} \Phi_n(x, y)$. This problem class includes convex optimization with a large number of constraints. To contend with the challenges in computing full gradients, we employ a primal-dual scheme in which randomly selected primal and dual variable blocks, x_i and y_j, are updated at every iteration. When N is large, we can utilize an increasing batch-size of the gradients of Φ_n, to achieve the optimal rate of $O(1/k)$ in terms of $L(x^k, y^*) - L(x^*, y^k)$. Preliminary results on QCQPs with many constraints look promising.

NON

Thu.1 H 0106

Optimality Conditions in Nonlinear Optimization (Part I)
Organizer: Gabriel Haeser
Chair: Paulo J. S. Silva

Alexey Tret'yakov, University of Podlasie in Siedlce (joint work with Olga Brezhneva, Yuri Evtushenko)
Elementary proofs of a Karush-Kuhn-Tucker Theorem

We present elementary proofs of a Karush-Kuhn-Tucker (KKT) theorem for an optimization problem with inequality constraints. We call the proofs “elementary” because they do not use advanced results of analysis. Our proofs of the KKT theorem use only basic results from Linear Algebra and a definition of differentiability. The simplicity of the proofs makes them particularly suitable for use in a first undergraduate course in optimization.

Bruno Figueira Lourenço, University of Tokyo
Amenable cones, error bounds and algorithms

We will talk about a new family of cones called “amenable cones”. We will show that feasibility problems over amenable cones admit error bounds even when constraint qualifications fail to hold. Therefore, amenable cones provide a natural framework for extending the so-called ”Sturm's Error Bound”. We will present many example of amenable cones and discuss the connection between the amenability condition and other properties such as niceness and facial exposedness. At the end, we will also discuss algorithmic implications of our results.

Paulo J. S. Silva, University of Campinas - UNICAMP (joint work with Roberto Andreani, Gabriel Haeser, Leornardo D. Secchin)
Sequential optimality conditions for mathematical problems with complementarity constraints

Recently, the convergence of methods for nonlinear optimization problems has been analyzed using sequential optimality conditions. However, such conditions are not well suited for Mathematical Problems with Complementarity Constraints (MPCCs). Here we propose new sequential conditions for usual stationarity concepts in MPCC, namely weak, C- and M-stationarity, together with the associated weakest MPCC constraint qualifications. We also show that some algorithms reach AC-stationary points, extending their convergence results. The new results include the linear case, not previously covered.

NON

Thu.1 H 0107

Methods of Optimization in Riemannian Manifolds (Part I)
Organizer: Orizon Pereira Ferreira
Chair: Orizon Pereira Ferreira

João Xavier da Cruz Neto, Federal University of Piauí (joint work with Lucas Meireles, Gladyston de Carvalho Bento)
An Inexact Proximal Point Method for Multiobjective Optimization on Riemannian Manifolds

In this talk, is introduced a definition of approximate Pareto efficient solution as well as a necessary condition for such solutions in the multiobjective setting on Riemannian manifolds. It is also propose an inexact proximal point method for nonsmooth multiobjective optimization by using the notion of approximate solution. The main convergence result ensures that each cluster point (if any) of any sequence generated by the method is a Pareto critical point. Furthermore, when the problem is convex on a Hadamard manifold, full convergence of the method for a weak Pareto optimal is obtained.

João Carlos Souza, Federal University of Piauí (joint work with Yldenilson Almeida, Paulo Oliveira, João Xavier da Cruz Neto)
Accelerated proximal-type method for DC functions in Hadamard manifolds

In this work, we consider a proximal-type method for solving minimization problems involving smooth DC (difference of convex) functions in Hadamard manifolds. The method accelerates the convergence of the classical proximal point method for DC functions and, in particular, convex functions. We prove that the point which solves the proximal subproblem can be used to define a descent direction of the objective function. Our method uses such a direction together with a line search for finding critical points of the objective function. We illustrate our results with some numerical experiments.

Maurício Louzeiro, UFG (joint work with Orizon Pereira Ferreira, Leandro Prudente)
Gradient Method for Optimization on Riemannian Manifolds with Lower Bound Curvature

The gradient method for minimize a differentiable convex function on Riemannian manifolds with lower bounded sectional curvature is analyzed in this talk. The analysis of the method is presented with three different finite procedures for determining the step size, namely, Lipschitz stepsize, adaptive stepsize and Armijo's stepsize. Convergence of the whole sequence to a minimizer, without any level set boundedness assumption, is proved. Iteration-complexity bound is also presented. As well as, some examples of functions that satisfy the assumptions of our results.

NON

Thu.1 H 2053

Mixed-Integer Optimal Control and PDE Constrained Optimization (Part III)
Organizers: Falk Hante, Christian Kirches, Sven Leyffer
Chair: Christian Kirches

Clemens Zeile, Otto-von-Guericke University Magdeburg (joint work with Francesco Braghin, Nicolò Robuschi, Sebastian Sager)
Multiphase Mixed-Integer Nonlinear Optimal Control of Hybrid Electric Vehicles

This talk considers the problem of computing the minimum-fuel energy management strategy of a hybrid electric vehicle on a given driving cycle. A tailored algorithm is devised by extending the combinatorial integral approximation technique that breaks down the original mixed-integer nonlinear program into a sequence of nonlinear programs and mixed-integer linear programs. Specifically, we address the multiphase context and propose combinatorial constraints for the optimal gear choice, torque split and engine on/off controls in order to account for technical requirements.

Bart van Bloemen Waanders, Sandia National Laboratory
Mixed Integer PDE-constrained optimization with scalable software

We present algorithms to solve mixed integer problems constrained by partial differential equations (PDEs). A branch and bound methodology is used to address the discrete nature of the problem and at each bound computation the relaxation requires the solution of a PDE-constrained optimization problem. A hierarchical modeling approach (with multiple starts) efficiently supports the bounding process. Low-fidelity models allow exploration for the most promising branching options. We discuss our C++ software design which features scalable parallelism. A numerical prototype demonstrates our approach.

Sven Leyffer, Argonne National Laboratory (joint work with Todd Munson, Ryan Vogt)
Mixed-Integer PDE Constrained Optimization for Design of Electromagnetic Cloaking

We formulate a mixed-integer partial-differential equation constrained optimization problems (MIPDECO) for designing an electromagnetic cloak governed by the 2D Helmholtz equation with absorbing boundary conditions. We extend the formulation to include uncertainty with respect to the angle of the incidence wave, and develop a mixed-integer trust-region approach for solving both the nominal and the uncertain instance. Our method alternates between a forward/adjoint PDE solve and a knapsack problem. We present numerical results of our new approach that demonstrate its effectiveness.

PDE

Thu.1 H 0112

Geometric Methods in Optimization of Variational Problems (Part I)

Organizers: Roland Herzog, Anton Schiela
Chair: Roland Herzog

Ronny Bergmann, TU Chemnitz (joint work with Roland Herzog, Daniel Tenbrinck, Jose Vidal-Nunez)

A primal-dual algorithm for convex nonsmooth optimization on Riemannian manifolds

Based on a Fenchel dual notion on Riemannian manifolds we investigate the saddle point problem related to a nonsmooth convex optimization problem. We derive a primal-dual hybrid gradient algorithm to compute the saddle point using either an exact or a linearized approach for the involved nonlinear operator. We investigate a sufficient condition for convergence of the linearized algorithm on Hadamard manifolds. Numerical examples illustrate, that on Hadamard manifolds we are on par with state of the art algorithms and on general manifolds we outperform existing approaches.

Robin Richter, Georg-August Universität Göttingen (joint work with Duy Hoang Thai, Stephan Huckemann)

Bilevel optimization in imaging with application to fingerprint analysis

Removing texture from an image while preserving sharp edges, to obtain a so-called cartoon, is a challenging task in image processing, especially since the term texture is mathematically not well defined. We propose a generalized family of algorithms, guided by two optimization problems simultaneously, profiting from the advantages of both variational calculus and harmonic analysis. In particular, we aim at avoiding introduction of artefacts and staircasing, while keeping the contrast of the image.

Dominik Stöger, TU München, Fakultät für Mathematik (joint work with Felix Krahmer)

The convex geometry of matrix completion

Matrix completion refers to the problem of reconstructing a low-rank matrix from only a random subset of its entries. It has been studied intensively in recent years due to various applications in learning and data science. A benchmark algorithm for this problem is nuclear norm minimization, a natural convex proxy for the rank. We will discuss the stability of this approach under the assumption that the observations are perturbed by adversarial noise.

PDE

Thu.1 H 2013

PDE-constrained Optimization Under Uncertainty (Part I)

Organizers: Harbir Antil, Drew Philip Kouri, Thomas Michael Surowiec, Michael Ulbrich, Stefan Ulbrich
Chair: Thomas Michael Surowiec

René Henrion, Weierstrass Institute for Applied Analysis and Stochastics (WIAS) (joint work with Mohamad Hassan Farshbaf Shaker, Martin Gugat, Holger Heitsch)

Optimal Neumann boundary control of the vibrating string with uncertain initial data

The talk addresses a PDE-constrained optimization problem, namely the optimal control of vibrating string under probabilistic constraints. The initial position of the string is supposed to be random (multiplicative noise on Fourier coefficients). The objective is to find a cost optimal control driving the final energy of the string to an amount smaller then epsilon with probability larger than p. The numerical solution of the resulting convex optimization problem relies on the 'spheric-radial decomposition' of Gaussian random vectors.

Harbir Antil, George Mason University

Risk-Averse Control of Fractional Diffusion

In this talk, we introduce and analyze a new class of optimal control problems constrained by elliptic equations with uncertain fractional exponents. We utilize risk measures to formulate the resulting optimization problem. We develop a functional analytic framework, study the existence of solution and rigorously derive the first-order optimality conditions. Additionally, we employ a sample-based approximation for the uncertain exponent and the finite element method to discretize in space.

Philipp Guth, University of Mannheim (joint work with Vesa Kaarnioja, Frances Kuo, Claudia Schillings, Ian Sloan)

PDE-constrained optimization under uncertainty using a quasi-Monte Carlo method

In this work we apply a quasi-Monte Carlo (QMC) method to an optimal control problem constrained by an elliptic PDE equipped with an uncertain diffusion coefficient. In particular the optimization problem is to minimize the expected value of a tracking type cost functional with an additional penalty on the control. It is shown that the discretization error of the solution is bounded by the discretization error of the adjoint state. For the convergence analysis the latter is decomposed into truncation error, finite element error and QMC error, which are then analysed separately.

ROB

Thu.1 H 1058

Robust Optimization: New Advances in Methodology and Applications

Organizer: Nikos Trichakis
Chair: Nikos Trichakis

Lukáš Adam, Southern University of Science and Technology
Distributionally robust multi-objective optimization [canceled]

Recently, there were multiple papers concerning distributionally robust optimization. They usually consider a single objective. In this talk, we generalize the concept into optimization problems with multiple objectives. We present several approaches based on scalarization, Pareto front and set comparison. We show the advantages and disadvantages of all approaches both from a theoretical point and computational complexity. We conclude the talk by a numerical comparison.

Phebe Vayanos, University of Southern California (joint work with John P. Dickerson, Duncan McElfresh, Eric Rice)
Robust Active Preference Learning

We consider the problem faced by a recommender system that seeks to offer a user their favorite item. Before making a recommendation, the system has the opportunity to elicit the user's preferences by making a moderate number of queries. We propose an exact robust optimization formulation of the problem which integrates the learning (preference elicitation) and recommendation phases and an equivalent reformulation as a mixed-binary linear program. We evaluate the performance of our approach on synthetic and real data from the US homeless youth where we learn the preferences of policy-makers.

Nikos Trichakis, MIT (joint work with David Simchi-Levi, Peter Yun Zhang)
Robust Optimization for Response Supply Chain Design Against Bioattacks

We study end-to-end design of a supply chain for antibiotics to defend against bioattacks. We model the defender's inventory prepositioning and dispensing capacity installation decisions, attacker's move, and defender's adjustable shipment decisions, so as to minimize inventory and life loss costs, subject to population survivability targets. We provide theoretical backing to the performance of the Affinely Adjustable Robust Counterpart by proving its optimality under certain conditions. We conduct a high-fidelity case study with millions of nodes to guard against anthrax attacks in the US.

SPA

Thu.1 H 1012

Sparse Optimization and Information Processing - Contributed Session II

Organizer: Shoham Sabach
Chair: Mustafa C. Pinar

Radu-Alexandru Dragomir, Université Toulouse Capitole & D.I. Ecole Normale Supérieure
Fast Gradient Methods for Symmetric Nonnegative Matrix Factorization

We describe fast gradient methods for solving the symmetric nonnegative matrix factorization problem (SymNMF). We use recent results on non-Euclidean gradient methods and show that the SymNMF problem is smooth relatively to a well-chosen Bregman divergence. This approach provides a simple hyper-parameter-free method which comes with theoretical convergence guarantees. We also discuss accelerated variants. Numerical experiments on clustering problems show that our algorithm scales well and reaches both state of the art convergence speed and clustering accuracy for SymNMF methods.

Yue Xie, University of Wisconsin-Madison (joint work with Uday Shanbhag)
A Tractable ADMM Scheme for Computing KKT Points and Local Minimizers for l0 Minimization Problems

We consider an equivalent formulation of l^0-minimization problem over a polyhedral set as MPCC. It is known that ℓ_0-norm penalty implicitly emphasizes sparsity of the solution. We show that under suitable assumptions, an equivalence is derived between KKT points and local minimizers of this formulation. A perturbed variant of proximal ADMM is proposed for which each subproblem is tractable and convergence can be claimed under mild assumptions. Preliminary numerics suggest that this scheme may significantly outperform their standard nonconvex ADMM counterparts.

Mustafa C. Pinar, Bilkent University (joint work with Deniz Akkaya)
Minimizers in Robust Regression Adjusted for Sparsity

Robust regression analysis using Huber's linear-quadratic loss function has been studied in the context of numerical optimization since the 1980s. Its statistical properties under deviations from normality are well-known. We couple the Huber loss function with a L^0-norm term to induce sparsity, and study the local and global minimizers of the resulting non-convex function inspired from results of Nikolova on the least squares regression adjusted for sparsity.

STO

Thu.1 H 3012

Advances in Probabilistic/Chance Constrained Problems

Chair: Pedro Pérez-Aros

Yassine Laguel, Université Grenoble Alpes (joint work with Wellington De Oliveira, Jerome Malick, Guilherme Ramalho, Wim Van Ackooij)

On the interplay between generalized concavity and chance constraints

Probabilistic constraints (or chance constraints) aim at providing safety regions for optimization problems exposed to uncertainty. Understanding when these regions are convex is important for numerical resolution of the optimization problem. In this work we show that "eventual convexity" often occurs : for structured but general models of chance constraints, convexity of levels sets is guaranteed when the probability level is greater than a computable threshold. We illustrate our results on examples uncovered by previous theory.

Pedro Pérez-Aros, Universidad de O'Higgins (joint work with René Henrion, Wim Van Ackooij)

Generalized gradients for probabilistic/robust (probust) constraints

Ideas from robust optimization lead to probust functions, i.e. probability functions acting on generalized semi-infinite inequality systems. In this work, we employ powerful tools from variational analysis to study generalized differentiation of such probust functions. We also provide explicit outer estimates of the generalized subdifferentials in terms of nominal data.

Thu.2 10:45–12:00

APP

Thu.2 H 3004

Applications in Economics
Chair: Po-An Chen

Benteng Zou, University of Luxembourg (joint work with Luisito Bertinelli, Stephane Poncin)
The Dynamics Competition of Key Elements of Sustainable Technology – the Rare Earth Elements

Rare earth elements are widely uses of i-phones, computers, hybrid cars, wind and solar energy and are essentially important for the worldwide sustainable development. Few has been done related to rare earth elements competition in economic research. This current study tries to fill in this gap. A monopoly to duopoly competition is constructed and studied. We provide necessary and sufficient conditions when should enter the competition and what would be the consequences and response of China. We also provide the analysis if cooperation between China and USA is possible.

Asiye Aydilek, Gulf University for Science and Technology (joint work with Harun Aydilek)
Do we really need heterogenous agent models under recursive utility?

We investigate the existence of representative agent under various heterogeneities in a recursive utility framework. We provide the analytical solution of household allocations. We numerically explore whether we can find a representative agent whose income is the aggregate income of the society and whose allocations are the aggregate allocations of the society under heterogeneity in the parameter of risk aversion and/or parameter of intertemporal substitution, or discount rate or survival probability. We find that there is no representat

Po-An Chen, National Chiao Tung University (joint work with Chi-Jen Lu, Yu-Sin Lu)
An Alternating Algorithm for Finding Linear Arrow-Debreu Market Equilibrium

Jain reduced equilibrium computation in Arrow-Debreu (AD) markets to that in bijective markets. Motivated by the convergence of mirror-descent algorithms to market equilibria in linear Fisher markets, we simply design algorithms to solve a rational convex program for linear bijective markets in this paper. Our algorithm for computing linear AD market equilibrium is based on solving the rational convex program formulated by Devanur et al., repeatedly alternating between a step of gradient-descent-like updates and a follow-up step of optimization. Convergence can be achieved by a new analysis.

APP

Thu.2 H 3012

Applications in Engineering
Chair: Manuel Radons

Dimitrios Nerantzis, Imperial College London (joint work with Filippo Pecci, Ivan Stoianov)
Pressure and energy optimization of water distribution systems without storage capacity.

We consider the problem of optimal pressure and energy control of water distribution systems without storage capacity. We formulate the problem as a nonlinear, nonconvex program and employ an interior point algorithm (IPOPT) for its efficient solution. We present our results from a case study using a large scale, real network from UK.

Manuel Radons, TU Berlin (joint work with Timo Burggraf, Michael Joswig, Marc Pfetsch, Stefan Ulbrich)
Semi-automatically optimized calibration of internal combustion engines

Modern combustion engines incorporate a number of actuators and sensors that can be used to control and optimize the performance and emissions. We describe a semi-automatic method to simultaneously measure and calibrate the actuator settings and the resulting behavior of the engine. The method includes an adaptive process for refining the measurements, a data cleaning step, and an optimization procedure. The combination of these techniques significantly reduces the number of measurements required to achieve a given set of calibration goals. We demonstrate our method on practical examples.

BIG

Thu.2 H 0105

Nonconvex Optimization in Machine Learning (Part I)

Organizer: Ethan Fang
Chair: Ethan Fang

Yuxin Chen, Princeton University
Noisy Matrix Completion: Bridging Convex and Nonconvex Optimization

This talk is about noisy matrix completion. Arguably one of the most popular paradigms is convex relaxation, which achieves remarkable efficacy in practice. However, the theoretical support of this approach is still far from optimal. We make progress towards demystifying the practical efficacy of convex relaxation vis-à-vis random noise. When the rank of the matrix is $O(1)$, we demonstrate that convex programming achieves near-optimal estimation errors. All of this is enabled by bridging convex relaxation with nonconvex optimization, a seemingly distinct algorithm that is robust against noise.

Zhuoran Yang, Princeton University
Variational Transport: A Convergent Particle-Based Algorithm for Distributional Optimization

We consider the problem of minimizing a functional defined over a family of probability distributions, where the functional is assumed to have a variational form. For this problem, we propose the variational transport algorithm, which approximately performs functional gradient descent over the manifold of probability distributions via iteratively pushing a set of particles. By characterizing both the statistical error of estimating the functional gradient and the progress of optimization algorithm, we show that the proposed algorithm enjoys global convergence with high probability.

Alfonso Lobos, University of California, Berkeley (joint work with Paul Grigas, Nathan Vermeersch)
Stochastic In-Face Frank-Wolfe Methods for Non-Convex Optimization and Sparse Neural Network Training

The Frank-Wolfe (FW) method and its extensions are well-suited for delivering solutions with desirable structural properties, such as sparsity or low-rank structure. We adapt the methodology of in-face directions within the FW method to the setting of non-convex optimization. We are particularly motivated by the application of stochastic versions of FW and the extensions mentioned above to the training of neural networks with sparse and/or low-rank properties. We develop theoretical computational guarantees, and we complement these results with extensive numerical experiments.

BIG

Thu.2 H 0110

Recent Advances in Optimization Techniques for Large-Scale Structured Problems

Organizer: Akiko Takeda
Chair: Akiko Takeda

Zirui Zhou, Hong Kong Baptist University (joint work with Zhaosong Lu)
Nonmonotone Enhanced Proximal DC Algorithms for a Class of Structured Nonsmooth DC Programming

In this talk we propose two nonmonotone enhanced proximal DC algorithms for solving a class of structured nonsmooth difference-of-convex (DC) minimization, in which the first convex component is the sum of a smooth and a nonsmooth function while the second one is the supremum of finitely many smooth convex functions. We show that any accumulation point of the generated sequence is a D-stationary point. We next propose randomized counterparts for them and show that any accumulation point of the generated sequence is a D-stationary point almost surely. Numerical results shall also be presented.

Michael R. Metel, RIKEN AIP (joint work with Akiko Takeda)
Stochastic proximal gradient methods for non-smooth non-convex optimization

Our work focuses on stochastic proximal gradient methods for optimizing a smooth non-convex loss function with a non-smooth non-convex regularizer and convex constraints. To the best of our knowledge we present the first non-asymptotic convergence results for this class of problem. We present two simple stochastic proximal gradient algorithms, for finite-sum and general stochastic optimization problems, which have the same or superior convergence complexities compared to the current state-of-the-art for the unconstrained problem setting.

Pierre-Louis Poirion, RIKEN Institute (joint work with Bruno Figueira Lourenço, Akiko Takeda)
Random projections for conic LP

In this paper we propose a new random projection method that allows to reduce the number of inequalities of a Linear Program (LP). More precisely, we randomly aggregate the constraints of a LP into a new one with much fewer constraints, while preserving, approximatively, the value of the LP. We will also see how to extend this to conic linear programming.

BIG

Thu.2 H 3007

Big Data and Machine Learning - Contributed Session II
Chair: Rachael Tappenden

Lei Zhao, Shanghai Jiao Tong University (joint work with Daoli Zhu)
Linear Convergence of Variable Bregman Stochastic Coordinate Descent Method for Nonsmooth Nonconvex Optimization by Level-set Variational Analysis

In this paper, we develop a new variational approach on level sets aiming towards linear convergence of a variable Bregman stochastic coordinate descent (VBSCD) method for a broad class of nonsmooth and nonconvex optimization problem. Along this way, we not only derive the convergence of VBSCD, that is any accumulation of the sequence generated by VBSCD is a critical point, but also provide $\{\mathbb{E}_{\xi_{k-1}}F(x^k)\}$ $Q-$linear and almost surely $\{\mathbb{E}_{\xi_{k-1}}x^k\}$ $R-$linear convergence rate.

Sarit Khirirat, Division of Decision and Control (joint work with Mikael Johansson, Sindri Magnússon)
Compressed Gradient Methods with Memory-Based Error Compensation

The veritable scale of modern data necessitates information compression in distributed optimization for machine learning. Gradient compression schemes using memory-based error compensation have displayed superior performance in practice. We illustrate how these approaches can be improved by using Hessian information in the compression. Explicit expressions for the accuracy gains on strongly convex and non-convex optimization problems are derived. The superiority of our approach in terms of convergence speed and solution accuracy is illustrated in numerical examples with 1-bit compression.

Rachael Tappenden, University of Canterbury (joint work with Naga Venkata C. Gudapati, Majid Jahani, Chenxin Ma, Martin Takáč)
Underestimate Sequences and Quadratic Averaging

This talk discusses several first order methods for minimizing strongly convex functions in both the smooth and composite cases. The algorithms, based on efficiently updating lower bounds on the objective functions, have natural stopping conditions that provide the user with a certificate of optimality. Convergence of all algorithms is guaranteed via a new Underestimate Sequence framework, and the algorithms converge linearly, with the accelerated variants converging at the optimal linear rate.

VIS

Thu.2 H 3013

Numerical Methods for Bilevel Optimization and Applications (Part I)
Organizer: Alain Zemkoho
Chair: Alain Zemkoho

Anthony Dunn, University of Southampton
Foam prediction to improve biogas production using anaerobic digestion

Anaerobic digestion is used in renewable energy plants to produce biogas from recycled biological waste. Within the reaction digester, a phenomenon known as foaming can occur at irregular time intervals which results in a reduced yield of biogas and requires an extensive repair period. We show that machine learning based techniques (relying on single and two-level optimization) allow for the development of a predictive maintenance model that recognises periods of high foam risk. This enables the plant operators to apply suitable changes in the operations system to reduce the risk

Andrey Tin, University of Southampton
Gauss-Newton-type method for bilevel optimization

This article examines the application of Newton-type methods for overdetermined systems to find solutions of bilevel programming problems. Since the Jacobian of the system is non-square, we discuss Gauss-Newton method and Newton method with Moore-Penrose pseudo inverse to solve the system. To our knowledge, this is the first time these methods are discussed in literature to solve bilevel programs. We prove that the methods can be well-defined for the introduced optimality conditions. In numerical part we compare the results of the methods with known solutions and performance of 124 examples.

Alain Zemkoho, University of Southampton (joint work with Yekini Shehu, Phan Tu Vuong)
An inertial extrapolation method for convex simple bilevel optimization

We consider a scalar objective minimization problem over the solution set of another optimization problem. This problem is known as simple bilevel optimization problem and has drawn a significant attention in the last few years. We propose and establish the convergence of a fixed-point iterative method with inertial extrapolation to solve the problem. Our numerical experiments show that the proposed method outperforms the currently known best algorithm to solve the class of problem considered.

CON

Thu.2 H 2032

Advances in Algorithms for Conic Optimization

Organizer: Julio C Goez
Chair: Joachim Dahl

Joachim Dahl, Joachim Dahl

A primal-dual algorithm for expontial-cone optimization

We discuss a primal-dual algorithm for expontial-cone optimization. The algorithm is based on primal-dual scaling proposed by Tuncel, with similar properties as Nesterov-Todd scalings for symmetric cones. We also discuss a new corrector for nonsymmetric cones, which considerably reduces the number of iterations required to solve a number of test problems. This algorithm has recently been developed for version 9 of the MOSEK software.

Alex Wang, Carnegie Mellon University (joint work with Fatma Kilinc-Karzan)

A Linear-Time Algorithm for Generalized Trust Region Subproblem based on a Convex Quadratic Reformulation

We consider the generalized trust region subproblem (GTRS) of minimizing a nonconvex quadratic objective over a nonconvex quadratic constraint. An obvious lifting of this problem recasts the GTRS as minimizing a linear objective subject to two nonconvex quadratic constraints. In this talk, we give an explicit characterization of the convex hull of this nonconvex region and show how it leads to a linear time (in the input size) algorithm for approximating the GTRS.

Julio C Goez, NHH Norwegian School of Economics

Disjunctive conic cuts: the good, the bad, and implementation [canceled]

We discuss a generalization of Balas disjunctive cuts which introduces the concept of disjunctive conic cuts (DCCs) and disjunctive cylindrical cuts (DCyCs). The first part of this talk will summarize the main results about DCCs and DCyCs including some results about valid conic inequalities for hyperboloids and non-convex quadratic cones. In the second part, we will discuss some of the limitation of this approach to derive useful valid inequalities in the context of MISOCO. In the last part we explore the potential for implementation of DCCs and DCyC.

CON

Thu.2 H 2033

Polynomial Optimization Algorithms, Software, and Applications

Organizer: Etienne de Klerk
Chair: Anders Eltved

Brais González Rodríguez, Universidade de Santiago de Compostela (joint work with Julio González Díaz, Ángel M. González Rueda, Joaquín Ossorio Castillo, Diego Rodríguez Martínez, David Rodríguez Penas)

RAPOSa, a freely available solver for polynomial optimization problems

We will present a new implementation of the reformulation linearization techniques, RLT, in the context of polynomial programming problems, originally introduced in Sherali and Tuncbilek (1991). The implementation incorporates most of the features of the RLT algorithm discussed in past literature. Moreover, additional enhancements have been introduced, such as parallelization and warm start features at various levels of the branching process. The current version of the algorithm has proven to be very efficient, and comparisons with other global optimization solvers will be presented.

Yi-Shuai Niu, Shanghai Jiao Tong University (joint work with Ya-Juan Wang)

Higher-order moment portfolio optimization via DC programming and sums-of-squares

We are interested in solving higher-order moment portfolio optimization via DC (Difference of Convex) programming approach. The problem can be rewritten as a polynomial optimization which is equivalent to a DC program based on the Difference-of-Convex-Sums-of-Squares (DCSOS) decomposition. The later problem can be solved by DCA. We also propose an improved DC algorithm called Boosted DCA (BDCA). The main idea of BDCA is to introduce a line search based on Armijo typo rule to accelerate the convergence of DCA. Numerical simulation results show good performance of our methods.

Anders Eltved, Technical University of Denmark (joint work with Martin S. Andersen)

Exact Relaxation of Homogeneous Quadratically Constrained Quadratic Programs with Tree Structure

We study the semidefinite relaxation of homogeneous nonconvex quadratically constrained quadratic programs where the matrices have a specific sparsity pattern. In particular, we consider problems where the graph of the aggregate nonzero structure of the matrices is a tree. We present a priori sufficient conditions for the semidefinite relaxation to be exact, which implies that the original problem is solvable in polynomial time. Checking these conditions requires solving a number of second order cone programs based on the data in the matrices, which can be done in polynomial time.

CON

Thu.2 H 2038

Algorithms for Conic Programming

Organizer: Etienne de Klerk
Chair: Konrad Schrempf

Chee Khian Sim, University of Portsmouth

Polynomial complexity and local convergence of an interior point algorithm on semi-definite linear complementarity problems

We consider an infeasible predictor-corrector primal-dual path following interior point algorithm to solve semi-definite linear complementarity problems (SDLCPs). The well-known Nesterov-Todd (NT) search direction is used in the algorithm. We provide the best known polynomial complexity when the algorithm is used to solve SDLCPs, and also give two sufficient conditions for when local superlinear convergence of iterates generated by the algorithm occurs.

Kresimir Mihic, University of Edinburgh (joint work with Jacek Gondzio, Spyridon Pougkakiotis)

Randomized multi-block ADMM based iterative methods for solving large scale coupled convex problems

In this work we propose an ADMM based framework for solving large scale quadratic optimization problems. We focus on non-separable dense and huge-scale sparse problems for which the current interior point methods do not bring satisfactory performance in terms of run time or scalability. We show that by integrating first and second order methods we can achieve a significant boost in performance with a limited loss in solution quality.

Konrad Schrempf, University of Applied Sciences Upper Austria

Primal "non-commutative" interior-point methods for semidefinite programming

Going over from the continuous (analytical) to the discrete (applied) setting one can use an "algebraic barrier" to get a family of (primal) "non-commutative" feasible-interior-point methods which are in particular useful for polynomial optimization (using sum-of-squares). I'm going to summarize the main ideas of my recent preprint arxiv:1812.10278 and show how an algebraic center can be used in different ways to find "good" minimization directions.

CNV

Thu.2 H 1028

Splitting Methods and Applications (Part II)

Organizers: Francisco Javier Aragón Artacho, Matthew K. Tam
Chair: Francisco Javier Aragón Artacho

C.H. Jeffrey Pang, National University of Singapore

Deterministic distributed asynchronous optimization with Dykstra's splitting

Consider the setting where each vertex of a graph has a function, and communications can only occur between vertices connected by an edge. We wish to minimize the sum of these functions. For the case when each function is the sum of a strongly convex quadratic and a convex function, we propose a distributed version of Dykstra's algorithm. This algorithm is distributed, decentralized, asynchronous, has deterministic convergence. We show how to extend to directed graphs with unreliable communications and some results on convergence rates.

Pontus Giselsson, Lund University

Separate and Project: Nonlinear Forward-Backward Splitting with Projection Correction

We propose nonlinear forward-backward splitting with projection correction. The algorithm performs a forward-backward step that creates a separating hyperplane between the current point and the solution set. This is followed (if needed) by a correction step that projects onto the separating hyperplane. The metric in the backward step is an arbitrary strictly monotone single-valued mapping. This gives a very general method with known special cases such as, AFBA, Bregman PDHG, NoLips, FB(H)F, etc. Another special case is a novel four-operator splitting method for monotone inclusions.

Adrien Taylor, Inria/ENS Paris (joint work with Carolina Bergeling, Pontus Giselsson, Ernest Ryu)

Computer-aided proofs for operator splitting

We propose a methodology for automatically studying the performance of common splitting methods. The methodology enjoys comfortable tightness guarantees and relies on appropriate uses of semidefinite programming and/or symbolic computations. We illustrate the use of the framework for generating tight contraction factors for Douglas–Rachford splitting that are likely too complicated for a human to find bare-handed. We show that the methodology can also be used for performing optimal parameter selection.

CNV

Thu.2 H 1029

Convex and Nonsmooth Optimization - Contributed Session II

Chair: Jose Vidal-Nunez

Nima Rabiei, American University of Iraq

AAR-Based Decomposition Method For Limit Analysis

The analysis of the bearing capacity of structures with a rigid-plastic behaviour can be achieved resorting to computational limit analysis. Recent techniques have allowed scientists and engineers to determine upper and lower bounds of the load factor under which the structure will collapse. Despite the attractiveness of these results, their application to practical examples is still hampered by the size of the resulting optimisation process.

Maryam Yashtini, Georgetown University (joint work with Sung Ha Kang)

High Quality Reconstruction with Euler's elastica-based methods

In this talk, I present numerical methods for solving Euler's elastica-regularized model for image processing. The minimizing functional is non-smooth and non-convex, due to the presence of a curvature term, which makes this model more powerful than the total variation-based models. Theoretical analysis as well as various numerical results in image processing and medical image reconstruction will be presented.

Jose Vidal-Nunez, TU Chemnitz (joint work with Ronny Bergmann, Roland Herzog, Daniel Tenbrinck)

Fenchel duality for convex optimization on Riemannian manifolds

This talk introduces a new duality theory that generalizes the classical Fenchel-Legendre conjugation to functions defined on Riemannian manifolds. We present that results from convex analysis also hold for this novel duality theory on manifolds. Especially the Fenchel–Moreau theorem and properties involving the Riemannian subdifferential can be stated in this setting. A main application of this theory is that a specific class of optimization problems can be rewritten into a primal-dual saddle-point formulation. This is a first step towards efficient algorithms.

DER

Thu.2 H 3025

Recent Advances in Derivative-Free Optimization (Part III)

Chair: Francesco Rinaldi

Tyler Chang, Virginia Polytechnic Institute and State University (Virginia Tech) (joint work with Thomas Lux, Layne Watson)

A Surrogate for Local Optimization using Delaunay Triangulations

The Delaunay triangulation is an unstructured simplicial mesh, which is often used to perform piecewise linear interpolation. In this talk, the Delaunay triangulation is presented as a surrogate model for blackbox optimization. If the objective function is smooth, then the estimated gradient in each simplex is guaranteed to converge to the true gradient, and the proposed algorithm will emulate gradient descent. This algorithm is useful when paired with an effective global optimizer, particularly in situations where function evaluations are expensive and gradient information is unavailable.

Alexander Matei, TU Darmstadt (joint work with Tristan Gally, Peter Groche, Florian Hoppe, Anja Kuttich, Marc Pfetsch, Martin Rakowitsch, Stefan Ulbrich)

Detecting model uncertainty via parameter estimation and optimal design of experiments

In this talk we propose an approach to identify model uncertainty using both parameter estimation and optimal design of experiments. The key idea is to optimize sensor locations and input configurations for the experiments such that the identifiable model parameters can be determined with minimal variance. This enables us to determine confidence regions, in which the real parameters or the parameter estimations from different test sets have to lie. We test the proposed method using examples from load-carrying mechanical structures. Numerical results are presented.

Douglas Vieira, Enacom (joint work with Adriano Lisboa, Matheus de Oliveira Mendonça)

Convergence properties of line search strategies for multimodal functions

It is presented line search optimization methods using a mathematical framework based on the simple concept of a v-pattern and its properties, providing theoretical guarantees on preserving, in the localizing interval, a local optimum no worse than the starting point. The framework can be applied to arbitrary unidimensional functions, including multimodal and infinitely valued ones. Enhanced versions of the golden section and Brent's methods are proposed and analyzed within this framework: they inherit the improving local optimality guarantee.

NON

Thu.2 H 0104

Recent Advances of First-Order Methods for Nonlinear Problems (Part II)

Organizers: Shiqian Ma, Ion Necoara, Quoc Tran-Dinh, Yangyang Xu
Chair: Yangyang Xu

Hao Yu, Alibaba Group (U.S.) Inc (joint work with Michael Neely)

A primal-dual parallel method with $MCALO(1/\epsilon)$ convergence for constrained composite convex programs

This work considers large scale constrained (composite) convex programs, which are difficult to solve by interior point methods or other Newton-type methods due to the non-smoothness or the prohibitive computation and storage complexity for Hessians and matrix inversions. The conventional Arrow-Hurwicz-Uzawa subgradient method is a parallel algorithm with $O(1/\epsilon^2)$ convergence for constrained convex programs that are possibly non-smooth or non-separable. This work proposes a new primal-dual parallel algorithm with faster $MCALO(1/\epsilon)$ convergence for such challenging constrained convex programs.

Runchao Ma, University of Iowa (joint work with Qihang Lin)

Iteration Complexity for Constrained Optimization Problem under Local Error Bound and Weak Convexity

This paper considers the constrained optimization problem with functional constraints. We first consider the case when problem is convex and has local error bound condition. Algorithms are proposed when condition number in local error bound is either known or unknown. Iteration complexity is derived to show the benefit coming from local error property. We then consider the case that constrained optimization problem is a weakly convex problem where both objective function and constraint are weakly convex. Algorithm is proposed and corresponding complexity is analyzed.

Yuyuan Ouyang, Clemson University

Lower complexity bounds of first-order methods for some machine learning models

We consider a class of large-scale optimization problems that arise from machine learning applications. In particular, the objective function has rotational invariance with respective decision variables. We show that, given the machine learning model, there exists worst-case datasets that yield lower complexity bounds of first-order methods for the specified model.

NON

Thu.2 H 0106

Optimality Conditions in Nonlinear Optimization (Part II)

Chair: Paulo J. S. Silva

Olga Brezhneva, Miami University (joint work with Ewa Szczepanik, Alexey Tret'yakov)

Necessary and sufficient optimality conditions for p-regular inequality constrained optimization problems

The focus of this talk is on nonregular optimization problems with inequality constraints. We are interested in the case when classical regularity assumptions (constraint qualifications) are not satisfied at a solution. We propose new necessary and sufficient optimality conditions for optimization problems with inequality constraints in the finite dimensional spaces. We present generalized KKT-type optimality conditions for nonregular optimization problems using the construction of a p-factor operator. The results are illustrated by some examples.

Maria Daniela Sanchez, Centro de Matemática de La Plata, Universidad Nacional de La Plata (joint work with Nadia Soledad Fazzio, Maria Laura Schuverdt, Raul Pedro Vignau)

Optimization Problems with Additional Abstract Set Constraints

We consider optimization problems with equality, inequality and additional abstract set constraints. We extend the notion of Quasinormality Constraint Qualification for problems with additional abstract set constraints. Also, we analyse the global convergence of the Augmented Lagrangian method when the algorithm is applied to problems with abstract set constraints. Motivated by the results obtained, we also studied the possibility to extend the definitions of others constraint qualifications well known in the literature for the case in which abstract set constraints is considered.

S. K. Gupta, IIT Roorkee

Optimality conditions for a class of multiobjective interval valued fractional programming problem

The article aims to study the Karush-Kuhn-Tucker optimality condition for a class of a fractional interval multivalued programming problem. For the solution concept, LU and LS-Pareto optimality are discussed, and some nontrivial examples are illustrated. The concepts of LU-V-invex and LS-V-invex for a fractional interval problem are introduced and using these assumptions, the Karush-Kuhn-Tucker optimality conditions for the problem have been established. Non-trivial examples are discussed throughout to make a clear understanding of the results established.

NON

Thu.2 H 2053

Methods of Optimization in Riemannian Manifolds (Part II)

Organizer: Orizon Pereira Ferreira
Chair: Orizon Pereira Ferreira

Josua Sassen, University of Bonn (joint work with Behrend Heeren, Klaus Hildebrandt, Martin Rumpf)

Geometric optimization using nonlinear rotation-invariant coordinates

We consider Nonlinear Rotation-Invariant Coordinates (NRIC) representing triangle meshes with fixed combinatorics as a vector stacking all edge lengths and dihedral angles. Previously, conditions for the existence of vertex positions matching given NRIC have been established. We develop the machinery needed to use NRIC for solving geometric optimization problems and introduce a fast and robust algorithm that reconstructs vertex positions from close-to integrable NRIC. Comparisons to alternatives indicate that NRIC-based optimization is particularly effective for near-isometric problems.

Orizon Pereira Ferreira, Federal University of Goias (UFG) (joint work with Maurício Louzeiro, Leandro Prudente)

Iteration-complexity and asymptotic analysis of steepest descent method for multiobjective optimization on Riemannian manifolds

The steepest descent method for multiobjective optimization on Riemannian manifolds with lower bounded sectional curvature is analyzed in this paper. The aim of the paper is twofold. Firstly, an asymptotic analysis of the method is presented. The second aim is to present iteration-complexity bounds for the method with these three stepsizes. In addition, some examples are presented to emphasize the importance of working in this new context. Numerical experiments are provided to illustrate the effectiveness of the method in this new setting and certify the obtained theoretical results.

PDE

Thu.2 H 0112

Geometric Methods in Optimization of Variational Problems (Part II)

Organizers: Roland Herzog, Anton Schiela
Chair: Anton Schiela

Andreas Weinmann, Hochschule Darmstadt

Reconstructing manifold-valued images using total variation regularization and related methods

In various problems in image processing, the data take values in a nonlinear manifold. Examples are circle-valued data in SAR imaging, special orthogonal group-valued data expressing vehicle headings, aircraft orientations or camera positions, motion group data as well as shape-space data. A further example is the space of positive matrices representing the diffusibility of water molecules in DTI imaging. In this talk we consider various variational approaches for such data including TV and higher order methods.

Thomas Vogt, University of Lübeck

Measure-valued Variational Models for Non-Convex Imaging Problems

Many non-convex variational models from image processing can be solved globally using convex relaxation frameworks. A popular framework comes from the context of calibration methods. We show that this framework can be interpreted as a measure-valued variational problem. This perspective can be applied to scalar, vectorial and manifold-valued problems with first- and second-order regularization.

Gladyston de Carvalho Bento, TU Chemnitz

Generalized optimality conditions for weak Pareto-optimal solutions on Riemannian manifolds

It is known that optimality criteria form the foundations of mathematical programming both theoretically and computationally. In this talk will be approach generalized optimality conditions for weak Pareto-optimal solutions on Riemannian manifolds which allowed to consider the proximal point method for nondifferentiable multiobjective programs without any assumption of convexity over the constraint sets that determine the vectorial improvement steps throughout the iterative process.

PDE

Thu.2 H 2013

PDE-constrained Optimization Under Uncertainty (Part II)

Organizers: Harbir Antil, Drew Philip Kouri, Thomas Michael Surowiec, Michael Ulbrich, Stefan Ulbrich
Chair: Harbir Antil

Thomas Michael Surowiec, Philipps-Universität Marburg (joint work with Drew Philip Kouri)

A primal-dual algorithm for PDE-constrained optimization under uncertainty

We propose a primal-dual algorithm for solving nonsmooth risk-averse optimization problems in Banach spaces motivated by PDE-constrained optimization under uncertainty. The overall algorithm is based on the well-known method of multipliers, whereas the subproblem solves are based on inexact Newton solvers for smooth PDE-constrained problems. The analysis exploits a number of recent results on the epigraphical regularization of risk measures. We prove convergence of the algorithm for solutions and stationary points and we conclude with several illustrative numerical examples

Ekaterina Kostina, Heidelberg University

Robustness aspects in model validation for dynamic processes

Development and quantitative validation of complex nonlinear dynamic models is a difficult task that requires the support by numerical methods for parameter estimation, and the optimal design of experiments. In this talk special emphasis is placed on issues of robustness, i.e. how to take into account uncertainties – such as outliers in the measurements for parameter estimation, and the dependence of optimal experiments on unknown values of model parameters. New numerical methods will be presented, and applications will be discussed that indicate a wide scope of applicability of the methods.

Andreas Van Barel, KU Leuven (joint work with Stefan Vandewalle)

Multilevel Quasi-Monte Carlo for stochastic PDE constrained optimization

This talk explores the use of multilevel quasi-Monte Carlo methods to generate estimations of gradients and Hessian-vector products for the optimization of PDEs with random coefficients. In ideal circumstances, the computational effort may scale linearly with the required accuracy, instead of quadratically, as is the case for Monte Carlo based methods. The performance is tested for a tracking type robust optimization problem constrained by an elliptic diffusion PDE with lognormal diffusion coefficient.

ROB

Thu.2 H 3006

A Mixed Bag of Decision Problems

Organizer: Peyman Mohajerin Esfahani
Chair: Peyman Mohajerin Esfahani

Man-Chung Yue, Imperial College London (joint work with Wolfram Wiesemann)

Optimistic Likelihood Problems Using (Geodesically) Convex Optimization

A fundamental problem arising in many areas of machine learning is the evaluation of the likelihood of a given observation under different nominal distributions. Frequently, these nominal distributions are themselves estimated from data, which makes them susceptible to estimation errors that are preserved or even amplified by the likelihood estimation. To alleviate this issue, we propose to replace the nominal distributions with ambiguity sets containing all distributions that are sufficiently close to the nominal distributions. When this proximity is measured by the Fisher-Rao distance or the Kullback-Leibler divergence, the emerging optimistic likelihoods can be calculated efficiently using either geodesic or standard convex optimization techniques. We showcase the advantages of our optimistic likelihoods on a classification problem using artificially generated as well as standard benchmark instances.

Bart P.G. Van Parys, Massachusetts Institute of Technology (joint work with Dimitris Bertsimas)

Data Analytics with B(R)agging Prediction Models.

We discuss prescribing optimal decisions in a framework where their cost depends on uncertain problem parameters that need to be learned from supervised data. Any naive use of training data may, however, lead to gullible decisions over-calibrated to one particular data set. In this presentation, we describe an intriguing relationship between distributional robust decision making and a bagging learning method by Breiman.

Zhi Chen, City University of Hong Kong (joint work with Zhenyu Hu, Qinshen Tang)

Allocation Inequality in Cost Sharing Problem

We consider the cost sharing problem where a coalition of agents, each endowed with an input, shares the output cost incurred from the total coalitional input. Inventory pooling under ambiguous demand with known mean and covariance is a typical example of this problem. We bridge two important allocations-average cost pricing and the Shapley value-from the angle of allocation inequality. We use the concept of majorization to characterize allocation inequality and we derive simple conditions under which one allocation majorizes the other.

SPA

Thu.2 H 1012

Continuous Systems in Information Processing (Part II)
Organizer: Martin Benning
Chair: Daniel Tenbrinck

Jan Lellmann, University of Lübeck
Measure-Valued Variational Image Processing

Many interesting image processing problems can be solved by finding suitable minimizers of a variational model. In this talk, we consider models where the unknowns reside in a space of measures. We will consider theoretical results and discuss some applications, in particular in diffusion-weighted imaging, manifold-valued optimization and approximation of non-convex problems.

Noémie Debroux, University of Cambridge (joint work with Angelica Aviles-Rivero, Veronica Corona, Martin Graves, Carole Le Guyader, Carola-Bibiane Schönlieb, Guy Williams)
A unified variational joint reconstruction and registration model for motion-compensated MRI

This work addresses a central topic in Magnetic Resonance Imaging (MRI) which is the motion-correction problem in a joint reconstruction and registration framework. From a set of multiple MR acquisitions corrupted by motion, we aim at jointly reconstructing a single high quality motion-free corrected image and retrieving the physiological dynamics through the deformation maps. To this purpose, we propose a novel variational model relying on hyperelasticity and compressed sensing principles.

Daniel Tenbrinck, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU) (joint work with Martin Burger, Fjedor Gaede)
Variational Graph Methods for Efficient Point Cloud Sparsification

In this talk we present an efficient coarse-to-fine optimization strategy for sparsification of large point clouds modeled via finite weighted graphs. Our method is derived from the recently proposed Cut Pursuit strategy and leads to a significant speed up (up to factor 120) in computing optimizers for a family of related variational problems. We demonstrate results on both unperturbed as well as noisy 3D point cloud data.

Thu.3 13:30–14:45

APP

Thu.3 H 3004

Other Applications

Chair: Jean-Paul Arnaout

Sugandima Mihirani Vidanagamachchi, University of Ruhuna (joint work with Shirly Devapriya Dewasurendra)

A Reconfigurable Architecture for Commentz-Walter Algorithm

This work describes the hardware implementation of Commentz-Walter algorithm to match multiple patterns in protein sequences. Multiple pattern matching for different applications with the most widely used Aho-Corasick algorithm has been carried out over the years by PCs as well as GPUs and FPGAs. However, due to the complexity of Commentz-Walter algorithm, it has not been implemented in any hardware platform except in PCs. In this work, a specific architecture for this task using Commentz-Walter algorithm has been developed, tested and implemented on an FPGA to efficiently match proteins.

Yidiat Omolade Aderinto, University of Ilorin (joint work with Issa Temitope Issa)

On Mathematical Model of Biological Pest Control of Sorghum Production

In this paper, mathematical model of Sorghum production from seed/planting to harvesting stage was presented with respect to its pests(prey) and the corresponding natural prey enemy (predators) at every stage. The model was characterized, the existence and uniqueness of the model solution was established. And finally numerical applications was carried out using Differential Transform method, and it was found that pests at different stages of sorghum production can be minimized below injury level using biological control which in turn leads to maximization of the sorghum production.

Jean-Paul Arnaout, Gulf University for Science & Technology

Worm Optimization Algorithm for the Euclidean Location-Allocation Problem

Facility location is a critical aspect of strategic planning for a broad spectrum of public and private firms. This study addresses the Euclidean location-allocation problem with an unknown number of facilities, and an objective of minimizing the fixed and transportation costs. This is a NP-hard problem and in this paper, a worm optimization (WO) algorithm is introduced and its performance is evaluated by comparing it to Genetic Algorithms (GA) and Ant Colony Optimization (ACO). The results show that WO outperformed ACO and GA and reached better solutions in a faster computational time.

BIG

Thu.3 H 0105

Canceled! Nonconvex Optimization in Machine Learning (Part II)

Organizer: Ethan Fang
Chair: Ethan Fang

Stephane Chretien, National Physical Laboratory (joint work with Assoweh Mohamed Ibrahim, Brahim Tamadazte)

Low tubal rank tensor recovery using the Burer-Monteiro factorisation approach [canceled]

In this paper, we study the low-tubal-rank tensor completion problem, i.e., to recover a third-order tensor by observing a subset of elements selected uniformly at random. We propose a fast iterative algorithm, called Tubal-Alt-Min. The unknown low-tubal-rank tensor is parameterised as the product of two much smaller tensors which naturally encode the low-tubal-rank property. Tubal-Alt-Min alternates between estimating those two tensors using least squares minimisation. We establish a "local is global" property for the minimisers, which implies convergence of Tubal-Alt-Min to global solutions.

Ke Wei, Fudan University (joint work with Jian-Feng Cai, Tianming Wang)

Nonconvex Optimization for Spectral Compressed Sensing [canceled]

Spectral compressed sensing is about reconstructing spectrally sparse data from incomplete information. Two difference classes of nonconvex optimization algorithms are introduced to tackle this problem. Theoretical recovery guarantees will be presented for the proposed algorithms under certain random models, showing that the sampling complexity is essentially proportional to the intrinsic dimension of the problems rather the ambient dimension. Empirical observations demonstrate the efficacy of the algorithms.

BIG

Thu.3 H 3007

Big Data and Machine Learning - Contributed Session III

Chair: Dimosthenis Pasadakis

Qing Qu, New York University

Short-and-Sparse Deconvolution – A Geometric Approach

The problem of locating repetitive unknown motifs in signals appears ubiquitously in neuroscience, computational imaging, microscopy data analytics, and more. We cast this problem as a short-and-sparse blind deconvolution problem, and formulate it as a nonconvex optimization problem over the sphere. By studying the geometric structure of the nonconvex landscape, we show how to develop practical optimization methods, that solves the problem to the target solution up to a shift ambiguity. The new geometric insights lead to new optimization strategies that even works in very challenging regimes

Cheolmin Kim, Northwestern University (joint work with Youngseok Kim, Diego Klabjan)

Scale Invariant Power Iteration

Several machine learning models can be formulated as maximization of a scale invariant function under a Euclidian ball constraint, for example, PCA, GMM, NMF. We generalize power iteration to this setting and analyze convergence properties of the algorithm. Our main result states that if initialized close to a local maximum, then the algorithm converge to this local maximum. Also, the convergence rate is linear and thus equal to the rate of power iteration. Numerically, we benchmark the algorithm against state-of-the-art methods to find out that the algorithm outperforms benchmark algorithms.

Dimosthenis Pasadakis, Università della Svizzera italiana (USI) (joint work with Drosos Kourounis, Olaf Schenk)

Spectral Graph Partition Refinement using the Graph p-Laplacian

A continuous reformulation of the traditional spectral method for the bi-partitioning of graphs is presented, that exploits the tendency of the p-norm to promote sparsity, thus leading to partitions with smaller edgecuts. The resulting non-linear and non convex graph p-Laplacian quotient minimization is handled with an accelerated gradient descent, while a continuation approach reduces the p-norm from a 2-norm towards a 1-norm. The benefits of our scheme are demonstrated in a plethora of complex graphs emerging from power networks and social interactions.

VIS

Thu.3 H 3013

Numerical Methods for Bilevel Optimization and Applications (Part II)

Organizer: Alain Zemkoho

Chair: Alain Zemkoho

Thomas Kleinert, Friedrich-Alexander-Universität (FAU) Erlangen-Nürnberg (joint work with Martin Schmidt)

Computing Stationary Points of Bilevel Reformulations with a Penalty Alternating Direction Method

Bilevel problems are highly challenging optimization problems that appear in many applications. Due to the hierarchical structure, they are inherently non-convex. In this talk we present a primal heuristic for (MI)QP-QP bilevel problems based on a penalty alternating direction method. We derive a convergence theory stating that the method converges to a stationary point of an equivalent single-level reformulation of the bilevel problem. Further, we provide an extensive numerical study and illustrate the good performance of our method both in terms of running times and solution quality.

Tangi Migot, University of Guelph

On a regularization-active set algorithm to solve the MPCC and its implementation

We consider here the mathematical program with complementarity constraints (MPCC). In a recent work by Dussault et al. [How to compute an M-stationary point of the MPCC], the authors present an algorithmic scheme based on a general family of regularization for the MPCC with guaranteed convergence to an M-stationary point. This algorithmic scheme is a regularization-penalization-active set approach, and thus, regroups several techniques from nonlinear optimization. Our aim in this talk is to discuss this algorithmic scheme and several aspects of its implementation in Julia.

Jie Jiang, Xi'an Jiaotong University

Quantitative analysis for a class of two-stage stochastic linear variational inequality problems

This talk considers a class of two-stage stochastic linear variational inequality problems. We first give conditions for the existence of solutions to both the original problem and its perturbed problems. Next we derive quantitative stability assertions of this two-stage stochastic problem under total variation metrics via the corresponding residual function. After that, we study the discrete approximation problem. The convergence and the exponential rate of convergence of optimal solution sets are obtained under moderate assumptions respectively.

CON

Thu.3 H 2033

Miscellaneous Topics in Conic Programming

Organizer: Etienne de Klerk
Chair: Sandra S. Y. Tan

Antonios Varvitsiotis, National University of Singapore (NUS)

Robust self-testing of quantum systems via noncontextuality inequalities

Self-testing unknown quantum systems is a fundamental problem in quantum information processing. We study self-testing using non-contextuality inequalities and show that the celebrated Klyachko-Can-Binicioğlu-Shumovsky noncontextuality tests admit robust self-testing. Our results rely crucially on the graph-theoretic framework for contextuality introduced by Cabello, Severini, and Winter, combined with well-known uniqueness and robustness properties for solutions to semidefinite programs.

Lucas Slot, CWI (joint work with Monique Laurent)

Convergence analysis of measure-based bounds for polynomial optimization on compact sets

We investigate a hierarchy of upper bounds introduced by Lasserre (2011) for the minimization of a polynomial f over a set K, obtained by searching for a degree $2r$ sos density function minimizing the expected value of f over K with respect to a given measure. For the hypercube, de Klerk and Laurent (2018) show that the convergence rate of these bounds to the global minimum is in $O(1/r^2)$. We extend this result to a large subclass of convex bodies. For general compact K, we show a convergence rate in $O(\log r/r)$ under a minor condition and a rate in $O((\log r/r)^2)$ when K is a convex body.

Sandra S. Y. Tan, NUS (joint work with Vincent Y. F. Tan, Antonios Varvitsiotis)

A Unified Framework for the Convergence Analysis of Optimization Algorithms via Sum-of-Squares

Given the popularity of machine learning, understanding the convergence properties of the optimization algorithms is of theoretical importance. However, existing convergence proofs consist mostly of ad-hoc arguments. We introduce a novel framework for bounding the convergence rates of various algorithms by means of sum-of-squares certificates, thereby unifying their convergence analyses. Using our approach, we recover known convergence bounds for three widely-used first-order algorithms, putting forth a promising framework for unifying the convergence analyses of other optimization algorithms.

CON

Thu.3 H 2038

Conic Optimization Approaches to Discrete Optimization Problems

Organizer: Etienne de Klerk
Chair: Enrico Bettiol

Fatima Ezzahra Khalloufi, Faculty of science of Agadir, Ibn Zohr University (joint work with Rachida Abounacer, Mohamed Hachimi)

The novel Improvement of Clarke and Wright algorithm for solving Capacitated Vehicle Routing problem

We propose an algorithm that has been improved from the classical Clarke and Wright algorithm to solve the Capacitated vehicle routing problem.The main concept of our proposed algorithm is to combine the Clarke and Wright heuristic with Sweep heuristic inspired of transition of probabilities used in Ant Colony algorithm to construct a solution.The objective is to seek a set minimum total cost routes for a fleet of k identical vehicle with capacity D to serve n customers form a depot .Our results shows that our approach provides shorter distances in the majority of well-know instances.

Timotej Hrga, University of Ljubljana (joint work with Borut Lužar, Janez Povh)

Parallel Branch and Bound algorithm for Stable Set problem

We present a method for solving stable set problem to optimality that combines techniques from semidefinite optimization and efficient implementation using high-performance computing. We use parallel branch & bound algorithm that applies Lovász theta function and its strengthenings as upper bound to approximate original problem using semidefinite relaxation. Depending on the sparsity of the graph combination of two SDP solvers is used to compute solutions of the obtained relaxations. We will present numerical experience with the proposed algorithm and show scalability and efficiency of it.

Enrico Bettiol, Université Paris 13 (joint work with Immanuel Bomze, Lucas Létocart, Francesco Rinaldi, Emiliano Traversi)

A CP relaxation for block-decomposable Binary QCQPs via Column Generation

We propose an algorithm for binary non-convex quadratically constrained quadratic problems. In the extended formulation with the matrix X, product of the original variables, we propose a Dantzig-Wolfe-reformulation-based method with a linear master and a pricing of Max-Cut-type. The domain of this relaxation lies in the cone of Completely Positive matrices. For block-decomposable problems, we present an adaptation of our algorithm which exploits the block structure. We give conditions under which we obtain the same bound as the previous relaxation. We also provide computational results.

CNV

Thu.3 H 1028

Splitting Methods and Applications (Part III)
Organizers: Pontus Giselsson, Ernest Ryu, Adrien Taylor
Chair: Ernest Ryu

Puya Latafat, KU Leuven (joint work with Panagiotis Patrinos, Andreas Themelis)
Block-coordinate and incremental aggregated proximal gradient methods: A unified view

We establish a link between the block-coordinate proximal gradient for minimizing the sum of two nonconvex functions (none of which is necessarily separable) and incremental aggregated proximal gradient methods for finite sum problems. The main tool for establishing this connection is the forward-backward envelope (FBE), which serves as a Lyapunov function. This result greatly simplifies the rate-of-convergence analysis and opens up the possibility to develop accelerated variants of incremental aggregated proximal gradient methods.

Matthew K. Tam, University of Göttingen (joint work with Yura Malitsky)
Splitting Algorithms with Forward Steps

The forward-backward splitting algorithm is a method for finding a zero in the sum of two monotone operators when one assumed single-valued and cocoercive. Unfortunately, the latter property, which is equivalent to strong monotonicity of the inverse, is too strong to hold in many monotone inclusions of interest. In this talk, I will report on recently discovered modifications of the forward-backward splitting algorithm which converge without requiring the cocoercivity assumption. Based on joint work with Yura Malitsky (University of Göttingen)

Ernest Ryu, UCLA (joint work with Robert Hannah, Wotao Yin)
Scaled Relative Graph: Nonexpansive operators via 2D Euclidean Geometry

Many iterative methods in applied mathematics can be thought of as fixed-point iterations, and such algorithms are usually analyzed analytically, with inequalities. In this paper, we present a geometric approach to analyzing contractive and nonexpansive fixed point iterations with a new tool called the scaled relative graph (SRG). The SRG provides a rigorous correspondence between nonlinear operators and subsets of the 2D plane. Under this framework, a geometric argument in the 2D plane becomes a rigorous proof of contractiveness of the corresponding operator.

CNV

Thu.3 H 1029

Convex and Nonsmooth Optimization - Contributed Session III
Chair: Andrew Eberhard

Ching-pei Lee, National University of Singapore / University of Wisconsin-Madison (joint work with Stephen Wright)
(Non-accelerated) First-Order Algorithms Converge Faster than $O(1/k)$ on Convex Problems

It has been known for many years that both gradient descent and stochastic coordinate descent achieve a global convergence rate of $O(1/k)$ in the objective value, when applied to a scheme for minimizing a Lipschitz-continuously differentiable, unconstrained convex function. In this work, we improve this rate to $o(1/k)$. We extend the result to proximal gradient and proximal stochastic coordinate descent with arbitrary samplings for the coordinates on regularized problems to show similar $o(1/k)$ convergence rates.

Yan Gu, Kyoto University (joint work with Nobuo Yamashita)
An Alternating Direction Method of Multipliers with the BFGS Update for Structured Convex Quadratic Optimization

We consider a special proximal alternating direction method of multipliers (ADMM) for the structured convex quadratic optimization problem. In this work, we propose a proximal ADMM whose regularized matrix in the proximal term is generated by the BFGS update (or limited memory BFGS) at every iteration. These types of matrices use second-order information of the objective function. The convergence of the proposed method is proved under certain assumptions. Numerical results are presented to show the effectiveness.

Andrew Eberhard, RMIT University (joint work with Shuai Liu, Yousong Luo)
Partial Smoothness, Tilt Stability and the VU–Decomposition

Under the assumption of prox-regularity and the presence of a tilt stable local minimum we are able to show that a VU like decomposition gives rise to the existence of a smooth manifold on which the function in question coincides locally with a smooth function. We will also consider the inverse problem. If a fast track exists around a strict local minimum does this imply the existence of a tilt stable local minimum? We investigate conditions under which this is so by studying the closely related notions of fast track and of partial smoothness and their equivalence.

NON

Thu.3 H 0104

Advances in Nonlinear Optimization With Applications (Part II)

Organizers: Yu-Hong Dai, Deren Han
Chair: Yu-Hong Dai

Xingju Cai, Nanjing Normal University

An indefinite proximal point algorithm for maximal monotone operator

We investigate the possibility of relaxing the positive definiteness requirement of the proximal matrix in PPA. A new indefinite PPA for finding a root of maximal monotone operator is proposed via choosing an indefinite proximal regularization term. The proposed method is more exible, especially in dealing with cases where the operator has some special structures. We prove the global convergence. We also allow the subproblem to be solved in an approximate manner and propose two exible inexact criteria.

Caihua Chen, Nanjing University

On the Linear Convergence of the ADMM for Regularized Non-Convex Low-Rank Matrix Recovery

In this paper, we investigate the convergence behavior of ADMM for solving regularized non-convex low-rank matrix recovery problems. We show that the ADMM will converge globally to a critical point of the problem without making any assumption on the sequence generated by the method. If the objective function of the problem satisfies the Łojasiewicz inequality with exponent at every (globally) optimal solution, then with suitable initialization, the ADMM will converge linearly. We exhibit concrete instances for which the ADMM converges linearly.

Deren Han,

On the convergence rate of a splitting augmented Lagrangian method [canceled]

In this talk, we present a new ADMM based prediction-correction method (APCM) for solving a three-block convex minimization problem with linear constrains. We solve the subproblem partially parallel in the prediction step and only the third variable and Lagrange multiplier are corrected in the correction step, which results in less time cost in the prediction step and employs different step size in the correction step. We show its global convergence and the $O(1/t)$ convergence rate under mild conditions. We also give the globally linear convergence rate with some additional assumptions.

NON

Thu.3 H 0106

Nonlinear Optimization - Contributed Session III

Chair: Refail Kasimbeyli

Gulcin Dinc Yalcin, Eskisehir Technical University (joint work with Refail Kasimbeyli)

Weak Subgradient Based Cutting Plane Method

In this study, we present a version of the Cutting-Plane Method, developed for minimizing a nonconvex function. We use weak subgradients which is based on the idea of supporting conic surfaces. This supporting approach does not require convexity condition on the function. The suggested method, minimizes the pointwise maximum of superlinear functions, by the weak subgradient. Since the graphs of supporting functions are conical surfaces, the new method is called the "Cutting Conic Surfaces Method". The subproblem is "linearized" and some illustrative examples are provided.

Acknowledgment : This study is supported by The Scientific and Technological Research Council of Turkey (TUBITAK) under the Grant No. 217M487.

Rafael Durbano Lobato, Università di Pisa (joint work with Antonio Frangioni)

SMS++: a Structured Modelling System for (Among Others) Multi-Level Stochastic Problems

The aim of the open-source Structured Modeling System++ (SMS++) is to facilitate the implementation of general and flexible algorithms for optimization problems with several nested layers of structure. We will present the current state of SMS++, focussing on recent developments concerning the representation of uncertainty, which are meant to facilitate the transformation of complex deterministic models into stochastic ones. Specific SMS++ facilities for "general-purpose decomposition techniques" will then allow to efficiently produce multi-level decomposition approaches to these problems.

Refail Kasimbeyli, Eskisehir Technical University (joint work with Gulcin Dinc Yalcin)

Weak subgradient based solution method using radial epiderivatives

This work presents a weak subgradient based solution method in nonconvex unconstrained optimization. The weak subgradient notion does not require convexity condition on the function under consideration, and hence allows to investigate a wide class of nonconvex optimization problems. By using relationships between the weak subgradients and the radial epiderivatives, we present a method for approximate estimation of weak subgradients, and use it to update a current solution. The convergence theorems for the presented method, are established and the illustrative examples are provided.

Acknowledgment : This study is supported by The Scientific and Technological Research Council of Turkey (TUBITAK) under the Grant No. 217M487.

NON

Thu.3 H 0107

Variational Inequalities, Minimax Problems and GANs (Part II)

Organizer: Konstantin Mishchenko
Chair: Konstantin Mishchenko

Daoli Zhu, Shanghai Jiao Tong University (joint work with Sien Deng)

A Variational Approach on Level sets and Linear Convergence of Variable Bregman Proximal Gradient Method for Nonconvex Optimization Problems

We provide various level-set based error bounds to study necessary and sufficient conditions on the linear convergence of variable Bregman proximal gradient (VBPG) method for a broad class of nonsmooth and nonconvex optimization problems. We also provide a fresh perspective that allows us to explore the connections among many known sufficient conditions for linear convergence of various first-order methods.

Sarath Pattathil, MIT (joint work with Aryan Mokhtari, Asuman Ozdaglar)

A Unified Analysis of Extra-gradient and Optimistic Gradient Methods for Saddle Point Problems: Proximal Point Approach

In this talk, we consider solving convex-concave saddle point problems. We focus on two variants of gradient decent-ascent algorithms, extra-gradient (EG) and optimistic gradient descent-ascent (OGDA) methods, and show that they admit a unified analysis as approximations of the classical proximal point method for solving saddle-point problems. This viewpoint enables us to generalize OGDA (in terms of parameters) and obtain new convergence rate results for these algorithms for the bilinear case as well as the strongly convex-concave setting.

Georgios Piliouras, SUTD

Online Optimization in Zero-Sum Games and Beyond: A Dynamical Systems Approach

We study systems where such online algorithms, such as online gradient descent and multiplicative weights, compete against each other in zero-sum games. We prove that these systems exhibit Poincaré recurrence and can be interpreted as Hamiltonian dynamics. We discuss implications of these results for discrete-time dynamics, designing new algorithms with provable guarantees beyond convex-concave games and we present some open questions.

NON

Thu.3 H 2032

Nonlinear Optimization - Contributed Session II

Chair: Jourdain Lamperski

Simone Rebegoldi, Università degli Studi di Modena e Reggio Emilia (joint work with Silvia Bonettini, Marco Prato)

Convergence analysis of an inexact forward-backward scheme using the forward-backward envelope

We present an inexact variable metric linesearch based forward-backward method for minimizing the sum of an analytic function and a subanalytic convex term. Upon the concept of forward-backward envelope, we build a continuously differentiable surrogate function, coinciding with the objective function at every stationary point and satisfying a relative error condition which might fail for the objective function. By exploiting the Kurdyka-Lojasiewicz property on the surrogate, we prove convergence of the iterates to a stationary point, as well as the convergence rates for the function values.

Andrea Cristofari, Università di Padova

An almost cyclic 2-coordinate descent method for minimization problems with one linear equality constraint

A block decomposition method is proposed for minimizing a non-convex continuously differentiable function subject to one linear equality constraint and simple bounds on the variables. The working set is computed according to an almost cyclic strategy that does not use first-order information, so that the whole gradient of the objective function does not need to be computed during the algorithm. Under an appropriate assumption on the level set, global convergence to stationary points is established by using different line search strategies. Numerical results are finally provided.

Jourdain Lamperski, MIT

Solving Linear Inequalities via Non-convex Optimization

We mainly consider solving homogeneous linear inequalities. We formulate a non-convex optimization problem in a slightly lifted space, whose critical points map to feasible solutions of the linear inequalities. We show various properties of the non-convex objective function and develop an algorithm that computes critical points thereof, thus yielding an algorithm for linear inequalities. We establish convergence guarantees for the algorithm and further investigate its performance via computational experiments.

NON

Thu.3 H 2053

Nonlinear Optimization - Contributed Session I

Chair: Raul Tempone

Truc-Dao Nguyen, Wayne State University (joint work with Tan Cao, Giovanni Colombo, Boris Mordukhovich)

Discrete Approximations of a Controlled sweeping process over polyhedral sets with perturbations

The talk is devoted to a class of optimal control problems governed by a perturbed sweeping (Moreau) process with the moving convex polyhedral set, where the controls are used to determine the best shape of the moving set in order to optimize the given Bolza-type problem. Using the method of discrete approximations together with the advanced tools of variational analysis and generalized differentiation allows us to efficiently derive the necessary optimality conditions for the discretized control problems and the original controlled problem. Some numerical examples are presented.

Adrian Hauswirth, ETH Zürich (joint work with Saverio Bolognani, Florian Dörfler, Gabriela Hug)

Timescale Separation in Autonomous Optimization

Autonomous optimization is an emerging concept in control theory that refers to the design of feedback controllers that steer a physical system to a steady state that solves a predefined nonlinear optimization problem. These controllers are modelled after optimization algorithms, but are implemented in closed loop with the physical system. For this interconnection to be stable, both systems need act on sufficiently different timescales. We quantify the required timescale separation and give prescriptions that can be directly used in the design of such feedback-based optimization schemes.

Raul Tempone, RWTH Aachen (joint work with Christian Bayer, Juho Häppölä)

Pricing American options by Markovian projections

We consider the pricing American basket options in a multivariate setting, including the Black-Scholes, Heston and the rough Bergomi model. In high dimensions, nonlinear PDEs methods for solving the problem become prohibitively costly due to the curse of dimensionality. We propose a stopping rule depending on a low-dimensional Markovian projection of the given basket of assets. We approximate the optimal early-exercise boundary of the option by solving a Hamilton-Jacobi-Bellman PDE in the projected, low-dimensional space. This is used to produce an exercise strategy for the original option.

PDE

Thu.3 H 0112

Geometric Methods in Optimization of Variational Problems (Part III)

Organizers: Roland Herzog, Anton Schiela
Chair: Roland Herzog

Anton Schiela, Universität Bayreuth (joint work with Julian Ortiz)

An SQP method for equality constrained optimization on manifolds

We present a composite step method, designed for equality constrained optimization on differentiable manifolds. The use of retractions allows us to pullback the involved mappings to linear spaces and use tools such as cubic regularization of the objective function and affine covariant damped Newton method for feasibility. We show fast local convergence when different chart retractions are considered. We test our method on equilibrium problems in finite elasticity where the stable equilibrium position of an inextensible transversely isotropic elastic rod under dead load is searched.

Silvio Fanzon, University of Graz (joint work with Kristian Bredies)

Optimal transport regularization for dynamic inverse problems

We propose and study a novel optimal transport based regularization of linear dynamic inverse problems. The considered inverse problems aim at recovering a measure valued curve and are dynamic in the sense that (i) the measured data takes values in a time dependent family of Hilbert spaces, and (ii) the forward operators are time dependent and map, for each time, Radon measures into the corresponding data space. The variational regularization we propose bases on dynamic optimal transport. We apply this abstract framework to variational reconstruction in dynamic undersampled MRI

Hanne Hardering, TU Dresden

Geometric Finite Elements

We introduce a class of finite elements for the discretization of energy minimization problems for manifold-valued maps. The discretizations are conforming in the sense that their images are contained in the manifold and invariant under isometries. Based on this desireable invariance, we developed an a priori error theory.

PDE

Thu.3 H 2013

PDE-constrained Optimization Under Uncertainty (Part III)

Organizers: Harbir Antil, Drew Philip Kouri, Thomas Michael Surowiec, Michael Ulbrich, Stefan Ulbrich
Chair: Michael Ulbrich

Sergio Rodrigues, RICAM

Semiglobal exponential stabilization of nonautonomous semilinear parabolic-like systems

It is shown that an explicit oblique projection nonlinear feedback controller is able to stabilize semilinear parabolic equations, with time-dependent dynamics and with a polynomial nonlinearity. The actuators are typically modeled by a finite number of indicator functions of small subdomains. No constraint is imposed on the norm of the initial condition. Simulations are presented, which show the semiglobal stabilizing performance of the nonlinear feedback.

Johannes Milz, Technical University of Munich (joint work with Michael Ulbrich)

An approximation scheme for distributionally robust optimization with PDEs

We consider distributionally robust optimization (DRO) for uncertain discretized PDE-constrained problems. To obtain a tractable and an accurate lower-level problem, we define ambiguity sets by moment constraints and approximate nonlinear functions using quadratic expansions w.r.t. parameters resulting in an approximate DRO problem. Its cost function is given as the sum of the value functions of a trust-region problem and an SDP. We construct smoothing functions and show global convergence of a homotopy method. Numerical results are presented using the adjoint approach to compute derivatives.

ROB

Thu.3 H 1058

Distributionally Robust Optimization: Advances in Methodology and Applications

Organizer: Aurelie Thiele
Chair: Aurelie Thiele

Sanjay Mehrotra, Northwestern University (joint work with Jinlin Li, Shanshan Wang)

Distributionally Robust Chance-Constrained Assignment with an Application to Operation Room Assignments

We will present a distributionally robust chance constraint optimization model, where the probability distribution specifying the chance constraint is robustified using a Wasserstein ambiguity set. For this problem, we will present novel techniques for strengthening big-M type formulations, and techniques for generating inequalities for use within a branch-and-cut framework. Results based on experiments using real data from an operating room will be presented, where the problem under consideration is to assign surgeries to the operating room.

Tito Homem-de-Mello, Universidad Adolfo Ibanez (joint work with Guzin Bayraksan, Hamed Rahimian)

Effective scenarios for multi-stage distributionally robust models

Recent research has studied the notion of effective scenarios for static distributionally robust stochastic programs. Roughly speaking, a scenario is deemed effective if its removal changes the optimal value of the problem. In this presentation we discuss the extension of these ideas to the case of multistage stochastic programs. Such extension requires proper ways of defining the meaning of removing a scenario in a dynamic context. Computational and analytical results show that identifying such effective scenarios may provide useful insight on the underlying uncertainties of the problem.

Aurelie Thiele, Southern Methodist University (joint work with Hedieh Ashrafi)

Robust continuous optimization for project portfolio management under uncertainty

We consider the management of projects under uncertainty in a firm's market entry, competitors' entry and product adoption dynamics. The company can adjust manpower staffing on a portfolio of projects (new products), which diversifies its portfolio but delays market entry for each product line, making it more likely a rival will launch a competing product first. We present a robust optimization approach to balance those concerns and extend our framework to dynamic policies based on information revealed over time about competitors' products entering the market.

ROB

Thu.3 H 3006

Dynamic Optimization Under Data Uncertainty

Organizer: Omid Nohadani
Chair: Omid Nohadani

Sebastian Pokutta, Georgia Tech (joint work with Andreas Bärmann, Alexander Martin, O. Schneider)

From Robust Optimization to Online Inverse Optimization

Robust optimization can be solved via online learning requiring only access to the nominal problem for a given uncertainty realization. We show that a similar perspective can be assumed for an online learning approach to online inverse optimization, even for discrete and non-convex decisions. The decision maker observes an expert's decisions over time and learns an objective function that is equivalent to the expert's private objective. We present a new framework for inverse optimization through online learning that goes beyond duality approaches and demonstrate its real-world applicability.

Eojin Han, Northwestern University (joint work with Chaithanya Bandi, Omid Nohadani)

Robust Periodic-Affine Policies for Multiperiod Dynamic Problems

We introduce a new class of adaptive policies called periodic-affine policies, that allows a decision maker to optimally manage and control large-scale newsvendor networks in the presence of uncertain demand without distributional assumptions. These policies model many features of the demand such as correlation, and can be generalized to multi-product settings and multi-period problems. This is accomplished by modeling the uncertain demand via sets. We provide efficient algorithms and demonstrate their advantages on the sales data from one of India's largest pharmacy retailers.

Dan Iancu, Stanford University (joint work with Nikos Trichakis, Do-Young Yoon)

Monitoring With Limited Information

We consider a system with an evolving state that can be stopped at any time by a decision maker (DM), yielding a state-dependent reward. The DM observes the state only at limited number of monitoring times, which he must choose, in conjunction with a stopping policy. We propose a robust optimization approach, whereby adaptive uncertainty sets capture the information acquired through monitoring. We consider two versions of the problem, static and dynamic and show that, under certain conditions, the same reward is achievable under either static or dynamic monitoring.

SPA

Thu.3 H 1012

Sparse Optimization and Information Processing - Contributed Session III

Organizer: Shoham Sabach
Chair: Bogdan Toader

Ryan Cory-Wright, Massachusetts Institute of Technology (joint work with Dimitris Bertsimas, Jean Pauphilet)

A Dual Perspective on Discrete Optimization: Nonlinear Reformulations and Scalable Algorithms

This talk provides a framework for deriving tractable nonlinear reformulations of semi-continuous optimization problems. By imposing ridge or big-M penalty terms, we invoke strong duality to reformulate semi-continuous problems as tractable mixed-integer convex optimization problems. We also study the reformulation's continuous relaxation, provide a sufficient condition for tightness, and propose a randomized rounding scheme which provides high-quality warm-starts. Finally, we present promising computational results for facility location, network design and unit commitment problems.

Bolin Pan, UCL (joint work with Simon Arridge, Paul Beard, Marta Betcke, Ben Cox, Nam Huynh, Felix Lucka, Edward Zhang)

Dynamic Photoacoustic Reconstruction using Curvelet Sparsity with Optical Flow Constraint

In photoacoustic tomography, the acoustic propagation time across the specimen is the ultimate limit on sequential sampling frequency. In this talk, we first consider the photoacoustic reconstruction problem from compressed/subsampled measurements by utilizing sparsity in the Curvelet frame. Then we introduce the dynamic photoacoustic reconstruction from subsampled/compressed dynamic data using Curvelet sparsity in the photoacoustic image domain. Additionally, spatio-temporal regularization via optical flow constraint is applied.

Bogdan Toader, Oxford University (joint work with Stephane Chretien, Andrew Thompson)

The dual approach to non-negative super-resolution: impact on primal reconstruction accuracy

We study the problem of super-resolution using TV norm minimisation, where we recover the locations and weights of non-negative point sources from a few samples of their convolution with a Gaussian kernel. A practical approach is to solve the dual problem. In this talk, we study the stability of solutions with respect to the solutions to the dual problem. In particular, we establish a relationship between perturbations in the dual variable and the primal variables around the optimiser. This is achieved by applying a quantitative version of the implicit function theorem in a non-trivial way.

STO

Thu.3 H 3012

Solution and Analysis of Stochastic Programming and Stochastic Equilibria

Chair: Shu Lu

Pedro Borges, IMPA (joint work with Claudia Sagastizábal, Mikhail Solodov)

New Techniques for Sensitivity Analysis of Solution Mappings with Applications to Possibly Non-Convex Stochastic Programming

We introduce a well-behaved regularization of solution mappings of parametric convex problems that is single-valued and smooth. We do not assume strict complementarity or second order sufficiency. Such regularization gives a cheap upper smoothing for possibly non-convex optimal value functions. Classical first and second order derivatives of the regularized solution mappings can be obtained cheaply solving certain linear systems. For convex two-stage stochastic problems the interest of our techniques is assessed, comparing its numerical performance against a bundle method.

Shu Lu, University of North Carolina at Chapel Hill

Statistical inference for piecewise normal distributions and application to stochastic variational inequalities

Confidence intervals for the mean of a normal distribution with a known covariance matrix can be computed using closed-form formulas. In this talk, we consider a distribution that is the image of a normal distribution under a piecewise linear function, and provide a formula for computing confidence intervals for the mean of that distribution given a sample under certain conditions. We then apply this method to compute confidence intervals for the true solution of a stochastic variational inequality. This method is based on a closed-form formula which makes computation very efficient.

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Bassily, Raef, The Ohio State University
Wed.3, H 0110 **132** [16:50]
Bauschke, Heinz, University of British Columbia
Wed, 17:30, Semi-Plenary Talk, H 0105 **17**
Bayer, Christian, WIAS
Wed.3, H 3012 **142** [16:00]
Thu.3, H 2053 *170*
Becerril, Jorge, Universidade do Porto
Tue.4, H 0107 **103** [16:55]
Beck, Amir, Tel Aviv University
Mon, 9:30, Plenary Talk, H 0105 **12**
Becker, Jan, TU Darmstadt
Mon.1, H 3007 **41** [11:00]
Becker, Stephen, University of Colorado Boulder
Tue.2, H 1029 **76** [13:15]
Bednarczuk, Ewa, Warsaw University of Technology
Wed.3, H 2038 *141*
Wed.3, H 3025 **135** [16:50]
Belkin, Mikhail, Ohio State University
Tue.1, H 2013 **62** [11:20]
Wed.3, H 0110 *132*
Benko, Matúš, Johannes Kepler University Linz
Tue.2, H 1028 76[c], 76[o], **76** [13:40], *76*
Benning, Martin, Queen Mary University of London
Tue.3, H 3007 94[c], 94[o], *94*, **94** [15:35]
Thu.2, H 1012 163[o]
Berahas, Albert, Lehigh University
Mon.1, H 0105 45[c], 45[o]
Mon.2, H 0105 55[c], 55[o]
Tue.1, H 0105 67[c], 67[o]
Tue.2, H 0105 79[c], 79[o], **79** [14:05]
Tue.3, H 0105 85[c]
Tue.4, H 2013 97[c], 97[o], *97*
Wed.2, H 0104 120[o]
Wed.2, H 2033 *123*
Wed.3, H 0104 131[c], 131[o]
Berggren, Martin, Umeå Universitet
Tue.4, H 0106 **102** [16:30]
Berglund, Erik, KTH Royal University of Technology
Wed.3, H 1029 **137** [16:00]
Bergmann, Ronny, TU Chemnitz
Tue.3, H 0106 *92*
Thu.1, H 0112 **151** [9:00]
Thu.2, H 1029 *159*
Bergou, El houcine, INRA-KAUST
Wed.1, H 2013 114[o], *114*, **114** [11:55]
Wed.2, H 2013 126[c], 126[o]
Wed.3, H 2013 138[c]

Besançon, Mathieu, INRIA Lille Nord-Europe
Wed.2, H 3007 **129** [14:40]
Bettiol, Enrico, Université Paris 13
Thu.3, H 2038 166[c], **166** [14:20]
Bettiol, Piernicola, Université de Bretagne Occidentale
Wed.1, H 0111 **116** [12:20]
Betz, Livia, Universität Duisburg-Essen
Wed.2, H 0106 **127** [15:05]
Biehl, Johanna Katharina, TU Darmstadt
Tue.3, H 0112 **93** [15:10]
Bigi, Giancarlo, Università di Pisa
Mon.1, H 3007 **41** [11:25]
Birgin, Ernesto G., Universidade de São Paulo
Wed.1, H 1012 **113** [12:20]
Blanchet, Jose, Stanford University
Tue.3, H 3012 *94*
Tue.4, H 1058 **104** [16:30]
Blekherman, Grigoriy, Georgia Institute of Technology
Wed.1, H 2032 110[c], 110[o], **110** [12:20]
Wed.2, H 2032 122[c], 122[o]
Bluhm, Andreas, Technical University of Munich
Mon.1, H 2053 **42** [11:25]
Bonart, Henning, Technische Universität Berlin
Mon.2, H 2033 **59** [14:35]
Borges, Pedro, IMPA
Thu.3, H 3012 **173** [13:30]
Boț, Radu, University of Vienna
Wed, 10:15, Semi-Plenary Talk, H 0104 **16**
Wed.3, H 1028 *134*
Boukouvala, Fani, Georgia Institute of Technology
Wed.3, H 2033 **135** [16:00]
Boumal, Nicolas, Princeton University
Wed.1, H 0105 113[o], **113** [12:20]
Wed.2, H 0105 124[o]
Boumaza, Kenza, INRA
Mon.2, H 3012 **57** [13:45]
Brezhneva, Olga, Miami University
Thu.1, H 0106 *149*
Thu.2, H 0106 **160** [10:45]
Briceño-Arias, Luis, Universidad Tecnica Federico Santa Maria
Tue.2, H 0112 **82** [13:40]
Wed.3, H 2038 *141*
Brokate, Martin, TU München
Wed.1, H 3013 **109** [11:30]
Brosch, Daniel, Tilburg University
Wed.1, H 0107 **110** [12:20]
Brüggemann, Jo Andrea, Weierstrass Institute for Applied Analysis and Stochastics (WIAS)
Wed.2, H 3013 **121** [14:40]
Poster Session **22**
Brune, Alexander, University of Birmingham
Wed.1, H 3004 **107** [11:55]
Brust, Johannes, Argonne National Laboratory
Wed.2, H 1029 **125** [14:15]
Burke, James, University of Washington
Mon.1, H 1028 **43** [11:25]
Tue, 16:30, Memorial Session, H 0105 **15**
Caballero, Renzo, King Abdullah University of science and technology (KAUST)
Poster Session **22**
Cai, Xingju, Nanjing Normal University
Thu.3, H 0104 **168** [13:30]
Cannarsa, Piermarco, University of Rome Tor Vergata
Thu, 15:15, Semi-Plenary Talk, H 0104 **18**
Cao, Liyuan, Lehigh University
Wed.2, H 2033 **123** [15:05]
Cao, Tan [canceled], State University of New York–Korea
Tue.3, H 0107 **92** [15:10]
Thu.3, H 2053 *170*
Cartis, Coralia, Oxford University
Mon.1, H 2038 **44** [11:00]
Tue.1, H 3002 *68*, *68*
Tue.2, H 3025 80[o]
Wed.1, H 1012 *113*
Wed.1, H 1029 114[o]
Wed.2, H 2033 *123*
Wed.2, H 2053 *126*
Wed.3, H 0105 136[c], 136[o]
Caruso, Francesco, University of Naples "Federico II"
Thu.1, H 3013 **145** [9:00]
Celledoni, Elena, Norwegian University of Science and Technology
Tue.3, H 3007 **94** [14:45]
Červinka, Michal, Czech Academy of Sciences
Tue.2, H 1028 **76** [14:05]
Chandrasekaran, Venkat, California Institute of Technology (Caltech)
Tue.1, H 2032 64[o], **64** [10:55]
Tue.2, H 2032 75[c], 75[o], *75*
Chang, Tsung-Hui, The Chinese University of Hong Kong, Shenzhen
Wed.1, H 0104 **108** [11:55]
Chang, Tyler, Virginia Polytechnic Institute and State University (Virginia Tech)
Thu.2, H 3025 **159** [10:45]
Chelmus, Teodor, Alexandru Ioan Cuza University of Iasi
Tue.4, H 3013 **101** [16:55]
Chen, Caihua, Nanjing University
Thu.3, H 0104 **168** [13:55]
Chen, De-Han, Central China Normal University
Mon.2, H 2013 **58** [14:10]
Chen, Jongchen, National Yunlin University of Science and Technology
Poster Session **22**
Chen, Po-An, National Chiao Tung University
Thu.2, H 3004 154[c], **154** [11:35]
Poster Session *23*
Chen, Xiaojun, Hong Kong Polytechnic University
Wed.1, H 3012 **118** [11:30]
Chen, Yadan, Academy of Mathematics and System Science, Chinese Academy of Sciences
Tue.4, H 3007 **106** [16:55]
Chen, Yuxin, Princeton University
Mon, 16:20, Best Paper Session, H 0105 **13**
Thu.2, H 0105 **155** [10:45]
Chen, Zhi, City University of Hong Kong
Wed.3, H 3006 *141*
Thu.2, H 3006 **162** [11:35]
Chen, Zhiping, Xi'an Jiaotong University
Tue.4, H 3012 **105** [17:20]
Chenche, Sarah, Guelma University Algeria
Poster Session **22**
Cheng, Jianqiang [canceled], University of Arizona
Tue.3, H 1058 **93** [14:45]
Chi, Yuejie, Carnegie Mellon University
Wed.3, H 0110 **132** [16:00]
Chlumsky-Harttmann, Fabian, TU Kaiserslautern
Thu.1, H 0111 **148** [9:00]
Chouzenoux, Emilie, LIGM, Université Paris-Est Marne-la-Vallée (UMR CNRS 8049)
Wed.3, H 2038 141[o], *141*
Chretien, Stephane [canceled], National Physical Laboratory
Thu.3, H 0105 **164** [13:30]
Thu.3, H 1012 *172*
Christof, Constantin, Technical University of Munich
Tue.2, H 0107 **81** [13:40]

Wed.1, H 0106 115[o]
Wed.2, H 0106 127[c], 127[o]
Wed.3, H 0106 139[o], *139*, *139*
Clason, Christian, Universität Duisburg-Essen
Mon.1, H 3006 **46** [11:00]
Tue.1, H 1029 *65*
Wed.1, H 0106 115[c], 115[o]
Wed.2, H 0106 127[o], *127*
Wed.3, H 0106 139[c], 139[o]
Coey, Chris, MIT OR Center
Mon.1, H 0111 **41** [11:50]
Mon.2, H 0111 *52*
Combettes, Patrick L., North Carolina State University
Tue.3, H 1028 87[c], 87[o]
Wed.1, H 1028 111[c], 111[o], **111** [12:20]
Wed.2, H 1028 122[c], 122[o], *122*
Wed.3, H 1028 134[c], 134[o]
Cortez, Karla, Faculdade de Engenharia da Universidade do Porto
Tue.1, H 0107 **69** [10:55]
Cory-Wright, Ryan, Massachusetts Institute of Technology
Thu.3, H 1012 **172** [13:30]
Cristofari, Andrea, Università di Padova
Tue.2, H 2038 *77*
Thu.3, H 2032 **169** [13:55]
Csetnek, Robert Ernö, University of Vienna
Wed.2, H 2038 **129** [14:15]
Wed.3, H 1028 *134*
Csizmadia, Zsolt, FICO
Tue.3, H 2053 **91** [15:10]
Cui, Ying, University of Southern California
Mon.1, H 0104 39[o], *39*
Tue.2, H 2013 73[o]
Curtis, Frank E., Lehigh University
Mon.1, H 0105 **45** [11:50]
Tue.2, H 0105 *79*
Wed.1, H 1029 *114*
Thu, 15:15, Semi-Plenary Talk, H 0105 **18**
Custodio, Ana Luisa, Universidade Nova de Lisboa
Mon.1, H 2038 44[o]
Mon.2, H 2038 54[o]
Tue.1, H 2038 66[o]
Tue.2, H 2038 77[o]
Tue.3, H 2038 88[o]
Tue.4, H 2038 100[o]
Wed.1, H 2033 112[o], **112** [12:20]
Wed.2, H 2033 123[o]
Wed.3, H 2033 135[o]
Thu.1, H 3025 147[c], 147[o]
Thu.3, H 3025 **??**[c]
D'Ambrosio, Claudia, CNRS / École Polytechnique
Tue.4, H 1012 **101** [16:55], *101*
d'Aspremont, Alexandre, CNRS / École Normale Supérieure
Tue.3, H 0104 *90*
Tue.3, H 0105 **85** [14:45]
da Cruz Neto, João Xavier, Federal University of Piauí
Thu.1, H 0107 **150** [9:00], *150*
Dahito, Marie-Ange, PSA Group / École Polytechnique
Mon.2, H 2032 **56** [14:10]
Dahl, Joachim, Joachim Dahl
Thu.2, H 2032 157[c], **157** [10:45]
Dai, Yu-Hong, Chinese Academy of Sciences
Tue.1, H 3025 68[c], 68[o], *68*, **68** [11:20]
Thu.3, H 0104 168[c], 168[o]
Dan, Hiroshige, Kansai University
Wed.1, H 1029 **114** [11:30]
Darehmiraki, Majid, Behbahan Khatam Alanbia University of Technology
Thu.1, H 1029 **148** [9:00]
Poster Session *22*
Darvay, Zsolt, Babes-Bolyai University
Mon.2, H 3002 **51** [13:45]
Davis, Damek, Cornell University
Mon, 16:20, Best Paper Session, H 0105 **14**
Davoli, Elisa, University of Vienna
Mon.2, H 0106 **58** [13:45]
de Carvalho Bento, Gladyston, TU Chemnitz
Thu.1, H 0107 *150*
Thu.2, H 0112 **161** [11:35]
de Klerk, Etienne, Tilburg University
Tue.3, H 3006 87[c], 87[o], *87*
Wed.1, H 0107 *110*
Wed.2, H 2032 **122** [14:15]
Thu.1, H 2033 146[o]
Thu.1, H 2038 146[o]
Thu.2, H 2033 157[o]
Thu.2, H 2038 158[o]
Thu.3, H 2033 166[o]
Thu.3, H 2038 166[o]
De los Reyes, Juan Carlos, Escuela Politécnica Nacional
Mon.1, H 0106 **47** [11:00]
Mon.2, H 1028 *53*
De Marchi, Alberto, Bundeswehr University Munich
Mon.2, H 3013 55[c], **55** [14:35]
de Ruiter, Frans, Tilburg University, The Netherlands
Wed.3, H 3004 140[c], 140[o], **140** [16:50]
De Santis, Marianna, Sapienza University of Rome
Tue.3, H 2032 **86** [14:45]
de Wolff, Timo, TU Braunschweig
Tue.1, H 2032 *64*
Tue.4, H 2032 **98** [17:20]
Wed.1, H 2032 *110*
Debroux, Noémie, University of Cambridge
Thu.2, H 1012 **163** [11:10]
Defazio, Aaron [canceled], Facebook
Wed.2, H 0104 **120** [14:40]
Demenkov, Maxim, Institute of Control Sciences
Tue.2, H 0111 **80** [13:15]
Poster Session **22**
den Hertog, Dick, Tilburg University, The Netherlands
Mon.1, H 1058 **48** [11:25]
Mon.2, H 3025 *60*, *60*
Wed.3, H 3004 *140*
Dentcheva, Darinka, Stevens Institute of Technology
Mon, 15:30, Semi-Plenary Talk, H 0105 **12**
Desilles, Anna, ENSTA ParisTech
Mon.1, H 3012 **46** [11:00]
Diago, Miguel, Polytechnique Montréal
Mon.2, H 2038 **54** [14:10]
Diamond, Steven, Stanford University
Tue.2, H 2032 *75*
Tue.4, H 0111 **102** [16:30]
Dikariev, Ilya, University BTU Cottbus-Senftenberg
Mon.2, H 3012 **57** [14:10]
Dinc Yalcin, Gulcin, Eskisehir Technical University
Thu.3, H 0106 **168** [13:30], *168*
Ding, Chao, AMSS, Chinese Academy of Sciences
Tue.3, H 1029 88[c], 88[o], *88*, **88** [15:35]
Ding, Lijun [canceled], Cornell University
Thu.1, H 2038 **146** [9:50]
Dixit, Avinash, Indian Institute of Technology (BHU) Varanasi
Wed.3, H 3025 **135** [16:25]
Doikov, Nikita, UCLouvain
Mon.2, H 0105 **55** [14:35]
Dong, Guozhi, Humboldt-Universität zu Berlin
Thu.1, H 3007 144[c], **144** [9:50]

Dong, Hongbo [canceled], Washington State University
Tue.3, H 3002 **89** [15:10]
Dong, Zhi-Long, Xi'an Jiaotong University
Tue.1, H 3025 **68** [10:30]
Dorostkar, Ali, Isfahan Mathematics House (IMH)
Wed.1, H 1058 **111** [11:55]
Dragomir, Radu-Alexandru, Université Toulouse Capitole & D.I. Ecole Normale Supérieure
Thu.1, H 1012 **152** [9:00]
Driggs, Derek, University of Cambridge
Wed.2, H 2053 **126** [14:15]
Drori, Yoel, Google
Tue.4, H 3002 **100** [16:30]
Du, Yu, University of Colorado Denver
Tue.3, H 1028 **87** [14:45]
Duchi, John, Stanford University
Tue.3, H 0104 *90*
Tue.4, H 1058 **104** [16:55]
Wed.1, H 1012 *113*
Dunn, Anthony, University of Southampton
Thu.2, H 3013 **156** [10:45]
Durea, Marius, Alexandru Ioan Cuza University of Iasi
Tue.2, H 3013 **78** [14:05]
Tue.4, H 3013 *101*, *101*
Dutta, Aritra, King Abdullah University of Science and Technology (KAUST)
Wed.1, H 2013 114[c], 114[o]
Wed.2, H 2013 126[o], **126** [14:15]
Dvinskikh, Darina, Weierstrass Institute for Applied Analysis and Stochastics (WIAS)
Wed.2, H 2038 **129** [14:40]
Wed.3, H 3002 *132*
Dvurechensky, Pavel, Weierstrass Institute for Applied Analysis and Stochastics (WIAS)
Mon.2, H 1028 *53*
Tue.2, H 2033 **84** [13:40]
Wed.3, H 3002 132[o], *132*
Thu.1, H 3025 *147*
E.-Nagy, Marianna, Budapest University of Technology and Economics
Mon.1, H 3002 **40** [11:00]
Ebeling-Rump, Moritz, Weierstrass Institute for Applied Analysis and Stochastics (WIAS)
Tue.1, H 0112 **70** [10:55]
Eberhard, Andrew, RMIT University
Thu.3, H 1029 167[c], **167** [14:20]
Eckstein, Jonathan, Rutgers University
Tue.3, H 1028 87[o], *87*, **87** [15:35]
Wed, 17:30, Semi-Plenary Talk, H 0105 17[c]
Eftekhari, Armin, EPFL
Tue.1, H 3007 **71** [10:30]
Eichfelder, Gabriele, TU Ilmenau
Mon.1, H 3013 44[o]
Mon.2, H 3013 55[o]
Wed.1, H 3002 112[o]
Thu.1, H 0111 148[o]
Ek, David, KTH Royal Institute of Technology
Mon.1, H 2032 **45** [11:25]
Ekici, Ali, Ozyegin University
Thu.1, H 3004 143[c], **143** [9:50]
El Housni, Omar, Columbia University
Tue.1, H 3012 **71** [10:55]
Tue.4, H 2053 *104*
El-Bakry, Amr S., ExxonMobil Upstream Research Comp
Mon, 15:30, Semi-Plenary Talk, H 0104 **13**
Eltved, Anders, Technical University of Denmark
Thu.2, H 2033 157[c], **157** [11:35]
Engel, Sebastian, Technische Universität München
Wed.1, H 0106 **115** [12:20]
Engelmann, Alexander, Karlsruhe Institute of Technology
Wed.3, H 0112 **140** [16:25]
Erdogdu, Murat, University of Toronto
Tue.1, H 2053 **67** [10:55], *67*
Espath, Luis, King Abdullah University of science and technology (KAUST)
Wed.2, H 3012 **130** [15:05]
Evkaya, Ozan, Atilim University
Thu.1, H 1029 148[c], **148** [9:50]
Fält, Mattias, Lund University
Tue.2, H 0111 **80** [13:40]
Fang, Ethan, The Pennsylvania State University
Thu.2, H 0105 155[c], 155[o]
Thu.3, H 0105 164[c], 164[o]
Fang, Kun, University of Cambridge
Mon.1, H 2053 **42** [11:50]
Fanzon, Silvio, University of Graz
Thu.3, H 0112 **170** [13:55]
Fawzi, Hamza, University of Cambrige
Mon.1, H 2053 42[c], 42[o], *42*
Mon.2, H 0112 **53** [13:45]
Faybusovich, Leonid, University of Notre Dame
Tue.4, H 3006 **99** [16:55]
Feiling, Jan, Porsche AG
Tue.2, H 2038 **77** [14:05]
Feldmeier, Michael, The University of Edinburgh
Wed.1, H 1029 **114** [11:55]
Fernández, José, University of Murcia
Thu.1, H 1029 **148** [9:25]
Ferris, Michael, University of Wisconsin-Madison
Wed.3, H 1058 133[c], 133[o], **133** [16:50]
Thu.1, H 3013 145[c], 145[o]
Filipecki, Bartosz, TU Chemnitz
Tue.1, H 1012 62[c], **62** [11:20]
Forets, Marcelo, Universidad de la República
Mon.1, H 0111 **41** [11:00]
Forouzandeh, Zahra, Faculdade de Engenharia da Universidade do Porto
Mon.2, H 3013 **55** [14:10]
Fountoulakis, Kimon, University of Waterloo
Tue.1, H 3004 63[c], 63[o], **63** [11:20]
Franca, Guilherme, Johns Hopkins University
Wed.2, H 1058 **123** [14:15]
Freund, Robert, Massachusetts Institute of Technology
Tue.2, H 3006 75[c], 75[o]
Wed.2, H 0107 **121** [14:15]
Friedlander, Michael, University of British Columbia
Mon.2, H 2032 *56*
Wed.2, H 0107 **121** [14:40]
Wed.3, H 3008 *136*
Fukuda, Mituhiro, Tokyo Institute of Technology
Mon.1, H 0112 42[o]
Tue.1, H 1029 *65*
Tue.1, H 3006 64[o], *64*
Funke, Simon, Simula Research Laboratory
Tue.2, H 0107 **81** [13:15]
Poster Session **22**
Gajardo, Pedro, Universidad Tecnica Federico Santa Maria
Mon.1, H 3012 46[c], 46[o], **46** [11:50]
Mon.2, H 3012 57[c], 57[o]
Galabova, Ivet, University of Edinburgh
Tue.3, H 0111 **91** [15:10]
Gangl, Peter, Graz University of Technology
Tue.1, H 0106 *69*
Tue.2, H 0106 **81** [14:05]
Gao, Rui, University of Texas at Austin
Tue.1, H 3012 **71** [11:20]

Tue.4, H 3012 105[c], 105[o]
Gao, Yini, Singapore Management University
Wed.1, H 3007 **117** [12:20]
Garmatter, Dominik, TU Chemnitz
Tue.2, H 2053 **79** [13:40]
Garrigos, Guillaume, Université Paris Diderot
Wed.1, H 2038 **118** [11:30]
Garstka, Michael, Oxford University
Tue.2, H 0111 80[c], **80** [14:05]
Gasnikov, Alexander, Moscow Institute of Physics and Technology
Mon.2, H 1028 *53*
Tue.2, H 2033 *84*
Wed.2, H 1058 *123*
Wed.3, H 3002 **132** [16:25]
Thu.1, H 3025 *147*
Gauger, Nicolas, TU Kaiserslautern
Wed.3, H 0112 **140** [16:00]
Gautam, Pankaj, Indian Institute of Technology (BHU) Varanasi
Wed.1, H 3008 **109** [11:55]
Gazagnadou, Nidham, Télécom ParisTech
Tue.3, H 2033 **95** [14:45]
Gebken, Bennet, Paderborn University
Mon.1, H 3013 **44** [11:25]
Geetha Jayadev, Gopika, University of Texas at Austin
Tue.2, H 1012 **73** [13:40]
Georghiou, Angelos, McGill University, Montréal
Mon.2, H 1058 59[c], 59[o], *59*, **59** [14:35]
Gfrerer, Helmut, Johannes Kepler University Linz
Tue.4, H 0110 98[c], 98[o], *98*, **98** [17:20]
Wed.1, H 3013 109[c], 109[o]
Ghadimi, Saeed, Princeton University
Tue.1, H 0104 *72*
Wed.3, H 2013 **138** [16:00]
Ghilli, Daria, University of Padua
Tue.2, H 0112 **82** [14:05]
Ghosal, Shubhechyya, Imperial College Business School
Tue.2, H 3012 **83** [13:40]
Gidel, Gauthier, Université de Montréal
Mon.2, H 2053 **56** [14:35]
Giselsson, Pontus, Lund University
Tue.2, H 0111 *80*
Tue.3, H 2033 *95*
Thu.1, H 1028 147[o]
Thu.2, H 1028 **158** [11:10], *158*
Thu.3, H 1028 167[o]
Poster Session *23*
Glineur, François, Université catholique de Louvain
Tue.4, H 3002 100[o], **100** [17:20]
Thu.1, H 2033 *146*
Goez, Julio C [canceled], NHH Norwegian School of Economics
Thu.2, H 2032 157[o], **157** [11:35]
Gomez, Walter, Universidad de La Frontera
Thu.1, H 2038 146[c], **146** [9:25]
Gonçalves, Douglas, UFSC Federal University of Santa Catarina
Mon.2, H 2032 **56** [14:35]
Gondzio, Jacek, The University of Edinburgh
Tue.2, H 3025 *80*
Tue.4, H 0111 *102*
Wed.1, H 3004 **107** [11:30]
Wed.2, H 3004 *119*
Wed, 17:30, Semi-Plenary Talk, H 0104 17[c]
Thu.2, H 2038 *158*
Gonzaga, Clovis, LACTEC
Tue.3, H 1012 **85** [15:10]
González Rodríguez, Brais, Universidade de Santiago de Compostela
Thu.2, H 2033 **157** [10:45]
Gotoh, Jun-ya, Chuo University
Tue.3, H 3002 *89*
Wed.2, H 1012 125[o], **125** [14:15]
Wed.3, H 1012 137[c], 137[o]
Götschel, Sebastian, Zuse Institute Berlin
Wed.2, H 0112 **128** [14:15]
Gounaris, Chrysanthos, Carnegie Mellon University
Wed.2, H 3007 129[c], 129[o], *129*
Gouveia, João, University of Coimbra
Wed.1, H 2032 **110** [11:55]
Gower, Robert, Telecom Paris Tech
Tue.2, H 2033 *84*
Tue.3, H 2033 *95*
Wed.3, H 0104 **131** [16:25]
Goyal, Vineet, Columbia University
Tue.1, H 3012 *71*
Tue.4, H 2053 104[c], 104[o], **104** [17:20]
Goyens, Florentin, University of Oxford
Wed.3, H 0105 **136** [16:00]
Grad, Sorin-Mihai, Vienna University
Thu.1, H 1028 **147** [9:25]
Grapiglia, Geovani, Universidade Federal do Paraná
Mon.1, H 0105 45[o]
Mon.2, H 0105 55[o]
Tue.1, H 0105 67[o]
Tue.2, H 0105 79[o]
Tue.4, H 3007 **106** [16:30]
Wed.1, H 1012 113[c], 113[o]
Gräßle, Carmen, Universität Hamburg
Mon.2, H 2033 59[c], 59[o]
Poster Session **22**
Gratton, Serge, INP-IRIT
Tue.1, H 2038 *66*
Tue.2, H 2038 *77*
Wed.1, H 2053 115[o], **115** [11:30], *115*, *115*
Gribling, Sander, CWI, Amsterdam
Mon.1, H 2053 **42** [11:00]
Grigas, Paul, University of California, Berkeley
Mon.1, H 3025 **48** [11:00]
Tue.3, H 0105 85[o], *85*
Thu.1, H 3006 144[c], 144[o]
Thu.2, H 0105 *155*
Grishchenko, Dmitry, Université Grenoble Alpes
Tue.2, H 0104 **78** [14:05]
Groetzner, Patrick, Augsburg University
Thu.1, H 0111 148[c], **148** [9:25]
Gu, Yan, Kyoto University
Thu.3, H 1029 **167** [13:55]
Guminov, Sergey, IITP, Russian Academy of Sciences
Wed.2, H 1058 **123** [15:05]
Gunasekar, Suriya [canceled], Toyota Technological Institute at Chicago
Mon.2, H 0104 **50** [14:10]
Günther, Christian, Martin Luther University Halle-Wittenberg
Wed.1, H 3002 112[c], **112** [11:55]
Gupta, S. K., IIT Roorkee
Thu.1, H 3007 *144*
Thu.2, H 0106 **160** [11:35]
Gupta, Vishal, USC Marshall School of Business
Tue.2, H 1058 **82** [13:15]
Gurbuzbalaban, Mert, Rutgers University
Tue.3, H 0104 **90** [14:45]
Gurol, Selime, IRT Saint Exupéry / CERFACS
Wed.1, H 2053 **115** [11:55]

Guth, Philipp, University of Mannheim
Thu.1, H 2013 **151** [9:50]
Haeser, Gabriel, University of São Paulo
Thu.1, H 0106 149[o], *149*
Hager, William, University of Florida
Tue.2, H 0104 **78** [13:40]
Hahn, Mirko, Otto-von-Guericke University Magdeburg
Mon.2, H 3006 **57** [14:10]
Hall, Georgina, INSEAD
Tue.3, H 2032 **86** [15:35]
Hall, Julian, University of Edinburgh
Tue.3, H 0111 **91** [14:45]
Hallak, Nadav, Tel Aviv University
Tue.1, H 3007 71[c], 71[o], **71** [11:20]
Han, Deren [canceled],
Tue.1, H 3025 68[o]
Thu.3, H 0104 168[o], **168** [14:20]
Han, Eojin, Northwestern University
Thu.3, H 3006 **172** [13:55]
Hanasusanto, Grani A., The University of Texas at Austin
Mon.1, H 3025 *48*
Wed.2, H 3006 **128** [15:05]
Hansen, Nikolaus, Inria / Ecole Polytechnique
Tue.3, H 2038 **88** [15:10]
Wed.1, H 2033 112[c], *112*
Hante, Falk, FAU Erlangen-Nürnberg
Mon.1, H 3006 46[o], **46** [11:50]
Mon.2, H 3006 57[c], 57[o]
Thu.1, H 2053 150[o]
Hanzely, Filip, King Abdullah University of science and technology (KAUST)
Tue.2, H 2033 84[o]
Tue.3, H 2033 95[o]
Wed.2, H 0104 *120*
Hardering, Hanne, TU Dresden
Thu.3, H 0112 **170** [14:20]
Haskell, William, Purdue University
Wed.3, H 3006 141[c], 141[o], **141** [16:50]
Haubner, Johannes,
Tue.1, H 0106 **69** [10:55]
Hauswirth, Adrian, ETH Zürich
Thu.3, H 2053 **170** [13:55]
Hautecoeur, Cécile, UCLouvain
Thu.1, H 2033 **146** [9:00]
Hazimeh, Hussein [canceled], MIT
Thu.1, H 3006 **144** [9:25]
He, Niao, University of Illinois at Urbana-Champaign
Wed.2, H 0110 **120** [14:40]
Hebestreit, Niklas, Martin-Luther-University Halle-Wittenberg
Tue.1, H 3013 **66** [10:30]
Heinkenschloss, Matthias, Rice University
Tue.1, H 0112 **70** [10:30]
Wed.2, H 0112 128[o]
Wed.3, H 0112 140[c], 140[o]
Thu, 16:15, Plenary Talk, H 0105 19[c]
Held, Harald, Siemens, Corporate Technology
Tue.4, H 1028 **96** [16:55]
Helmberg, Christoph, TU Chemnitz
Tue.1, H 1012 *62*
Tue.3, H 2032 **86** [15:10]
Thu.1, H 2032 145[c], 145[o]
Henrion, René, Weierstrass Institute for Applied Analysis and Stochastics (WIAS)
Mon, 15:30, Semi-Plenary Talk, H 0105 12[c]
Thu.1, H 2013 **151** [9:00]
Thu.1, H 3012 *153*
Hermosilla, Cristopher, Universidad Tecnica Federico Santa Maria
Tue.1, H 0107 69[c], 69[o]
Tue.2, H 0112 82[c], 82[o]
Tue.3, H 0107 92[c], 92[o]
Tue.4, H 0107 103[c], 103[o]
Wed.1, H 0111 116[o]
Wed.2, H 0111 127[o]
Wed.3, H 0107 139[o], **139** [16:25]
Hertlein, Lukas, Technische Universität München
Wed.1, H 0106 **115** [11:55]
Herzog, Roland, TU Chemnitz
Tue.3, H 0106 *92*
Thu.1, H 0112 151[c], 151[o], *151*
Thu.2, H 0112 161[o]
Thu.2, H 1029 *159*
Thu.3, H 0112 170[c], 170[o]
Hildebrand, Roland, Laboratoire Jean Kuntzmann / CNRS
Wed.3, H 0111 133[c], 133[o], **133** [16:50]
Hinder, Oliver, Stanford Univ.
Wed.1, H 1012 **113** [11:30]
Hintermüller, Michael, Weierstrass Institute for Applied Analysis and Stochastics
Mon.1, H 0106 47[o], **47** [11:25]
Mon.2, H 0106 58[c], 58[o]
Mon, 16:20, Best Paper Session, H 0105 *13*
Tue.3, H 0110 *86*
Wed.2, H 3004 *119*
Wed.2, H 3013 *121*
Thu.1, H 3007 *144*
Ho-Nguyen, Nam,
Mon.2, H 1029 **54** [13:45]
Hoheisel, Tim, McGill University, Montréal
Mon.1, H 1028 43[c], 43[o], **43** [11:50]
Mon.2, H 1028 53[c], 53[o]
Tue.2, H 1028 *76*
Holler, Gernot, University of Graz
Mon.2, H 0106 **58** [14:10]
Holley, Jonas, Robert Bosch GmbH
Wed.2, H 3004 **119** [15:05]
Hömberg, Dietmar, Weierstrass Institute
Tue.1, H 0112 **70** [11:20]
Homem-de-Mello, Tito, Universidad Adolfo Ibanez
Thu.3, H 1058 **171** [13:55]
Hong, Mingyi, University of Minnesota
Mon.1, H 3004 40[c], 40[o], *40*
Thu.1, H 0105 **143** [9:25]
Horn, Benjamin Manfred, Technische Universität Darmstadt
Wed.1, H 0112 **116** [11:55]
Horvath, Samuel, King Abdullah University of Science and Technology
Tue.2, H 2033 84[c], 84[o]
Tue.3, H 2033 95[c], 95[o], **95** [15:35]
Hosseini Nejad, Seyedeh Masoumeh,
Thu.1, H 1029 *148*
Poster Session **22**
Hrga, Timotej, University of Ljubljana
Thu.3, H 2038 **166** [13:55]
Hu, Hao, Tilburg University
Wed.1, H 0107 **110** [11:30]
Huber, Olivier, Humboldt-Universität zu Berlin
Wed.3, H 1058 **133** [16:00]
Hunter, Susan, Purdue University
Thu.1, H 3025 **147** [9:00]
Iancu, Dan, Stanford University
Thu.3, H 3006 **172** [14:20]
Illés, Tibor, Budapest University of Technology and Economics, Budapest, Hungary

Mon.1, H 3002 40[o], **40** [11:25], *40*
Mon.2, H 3002 51[c], 51[o], *51*
Iori, Tomoyuki, Kyoto University
Poster Session **23**
Ito, Masaru, Nihon University
Tue.1, H 1029 **65** [10:30]
Jacobse, Marcel, Universität Bremen
Wed.3, H 1028 **134** [16:50]
Jadamba, Baasansuren, Rochester Institute of Technology
Tue.1, H 3013 **66** [10:55]
Jaggi, Martin, EPFL
Wed.3, H 0104 **131** [16:00]
Jang, Sunho, Seoul National University
Wed.2, H 3012 **130** [14:15]
Janzen, Kristina, TU Darmstadt
Tue.2, H 1012 73[c], **73** [14:05]
Jarre, Florian, Heinrich-Heine Universität Düsseldorf
Mon.1, H 2038 **44** [11:50]
Jauhiainen, Jyrki, University of Eastern Finland
Mon.2, H 0106 **58** [14:35]
Javanmard, Adel, University of Southern California
Tue.1, H 2053 **67** [10:30]
Jiang, Bo, Shanghai University of Finance and Economics
Mon.2, H 3004 *51*, **51** [14:35]
Jiang, Bo, Nanjing Normal University
Wed.1, H 3025 **107** [12:20]
Jiang, Jie, Xi'an Jiaotong University
Thu.3, H 3013 **165** [14:20]
Jiang, Rujun, Fudan University
Mon.2, H 0112 *53*
Tue.2, H 3002 **77** [13:40]
Jiang, Tao, University of Waterloo
Wed.1, H 0104 **108** [12:20]
Jost, Felix, Otto-von-Guericke University Magdeburg
Mon.1, H 0107 39[c], 39[o]
Mon.2, H 0107 50[o], **50** [14:35]
Kahle, Christian, Technische Universität München
Mon.2, H 2033 *59*
Tue.3, H 0106 **92** [15:35]
Kalise, Dante, University of Nottingham
Tue.1, H 0107 **69** [11:20]
Tue.2, H 0112 *82*
Kamoutsi, Angeliki, ETH Zürich
Tue.1, H 0104 **72** [11:20]
Kamzolov, Dmitry, Moscow Institute of Physics and Technology, MIPT
Mon.2, H 1028 **53** [13:45]
Kanoh, Shinichi, University of Tsukuba
Mon.1, H 0112 **42** [11:25]
Kanzow, Christian, University of Würzburg
Tue.2, H 1028 *76*
Tue.3, H 0110 **86** [14:45]
Kaouri, Maha H., University of Reading
Tue.1, H 3002 68[c], **68** [10:55]
Kapelevich, Lea, MIT Operations Research Center
Mon.1, H 0111 *41*
Mon.2, H 0111 **52** [13:45]
Kara, Güray, Norwegian University of Science and Technology
Tue.3, H 1012 **85** [14:45]
Karaca, Orcun, ETH Zürich
Tue.4, H 1028 96[c], **96** [17:20]
Karimi, Mehdi, University of Waterloo
Tue.3, H 3006 **87** [14:45]
Kasimbeyli, Refail, Eskisehir Technical University
Thu.3, H 0106 168[c], *168*, **168** [14:20]
Keil, Tobias, WIAS Berlin
Mon.2, H 2033 59[o], **59** [13:45]
Kelis, Oleg, Technion -Israel Instutute of Tecnology
Wed.3, H 3004 **140** [16:00]
Khalloufi, Fatima Ezzahra, Faculty of science of Agadir, Ibn Zohr University
Thu.3, H 2038 **166** [13:30]
Khan, Akhtar A., Rochester Institute of Technology
Tue.1, H 3013 66[c], 66[o], *66*
Tue.2, H 3013 78[o]
Tue.3, H 3013 89[o], **89** [15:35]
Tue.4, H 3013 101[o]
Khirirat, Sarit, Division of Decision and Control
Thu.2, H 3007 **156** [11:10]
Kilinc-Karzan, Fatma, Carnegie Mellon University
Mon.1, H 3025 48[c], 48[o]
Mon.2, H 1029 *54*
Tue.4, H 3006 99[c], 99[o], **99** [17:20]
Thu.2, H 2032 *157*
Kim, Cheolmin, Northwestern University
Thu.3, H 3007 **165** [13:55]
Kim, Chesoong, Sangji University
Poster Session **23**
Kim, Donghwan, KAIST
Tue.4, H 3002 **100** [16:55]
Kim, Sunyoung, Ewha Womans University
Tue.1, H 3006 **64** [10:30], *64*
Kim, Youngdae, Argonne National Laboratory
Wed.3, H 1058 **133** [16:25]
Kimiaei, Morteza, University of Vienna
Tue.1, H 2038 **66** [11:20]
Wed.3, H 2033 **135** [16:50]
Kirches, Christian, TU Braunschweig
Mon.1, H 3006 46[o]
Mon.2, H 3006 57[o], *57*
Thu.1, H 2053 150[c], 150[o]
Kleinert, Thomas, Friedrich-Alexander-Universität (FAU) Erlangen-Nürnberg
Thu.3, H 3013 **165** [13:30]
Knauer, Matthias, Universität Bremen
Tue.3, H 0107 **92** [14:45]
Knees, Dorothee, University of Kassel
Wed.2, H 0106 **127** [14:15]
Köbis, Elisabeth, Martin Luther University Halle-Wittenberg
Tue.1, H 3013 66[o], *66*
Tue.2, H 3013 78[c], 78[o]
Tue.3, H 3013 89[o], **89** [15:10]
Tue.4, H 3013 101[c], 101[o]
Poster Session **23**, *23*
Köbis, Markus Arthur, Free University Berlin
Tue.3, H 3013 **89** [14:45]
Poster Session *23*, **23**
Kočvara, Michal, University of Birmingham
Wed.1, H 3004 *107*
Wed.2, H 2053 126[c], 126[o]
Wed.3, H 3007 138[o], **138** [16:25]
Kocyigit, Cagil, École polytechnique fédérale de Lausanne
Tue.1, H 1058 **70** [10:55]
Wed.3, H 3006 *141*
Kolda, Tamara G., Sandia National Laboratories
Wed, 9:00, Plenary Talk, H 0105 **15**
Konnov, Igor, Kazan Federal University
Wed.1, H 1058 **111** [11:30]
Koppel, Alec, U.S. Army Research Laboratory
Mon.1, H 0110 49[c], 49[o], **49** [11:50]
Mon.2, H 0110 61[c], 61[o]
Tue.1, H 0104 72[c], 72[o]
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Kostina, Ekaterina, Heidelberg University
Mon.1, H 0107 *39*, *39*
Thu.2, H 2013 **162** [11:10]

Kothari, Pravesh, Carnegie Mellon University
Wed.3, H 2032 **134** [16:25]
Kouri, Drew Philip, Sandia National Laboratories
Thu.1, H 2013 151[o]
Thu.2, H 2013 162[o], *162*
Thu.3, H 2013 171[o]
Kovalev, Dmitry, King Abdullah University of Science and Technology (KAUST)
Mon.2, H 2053 **56** [14:10]
Kröner, Axel, Humboldt-Universität zu Berlin
Tue.2, H 0107 81[c], 81[o], **81** [14:05]
Tue.3, H 0112 93[c], 93[o]
Krug, Richard, Friedrich-Alexander-Universität Erlangen-Nürnberg
Mon.1, H 3006 **46** [11:25]
Kuhlmann, Renke, University of Wisconsin-Madison
Tue.2, H 3025 **80** [13:15]
Kuhn, Daniel, EPFL
Mon.2, H 1058 *59*
Tue.1, H 1058 *70*, *70*, **70** [11:20]
Tue.3, H 3012 *94*, *94*
Tue.4, H 1058 *104*
Wed.3, H 3004 *140*
Wed.3, H 3006 *141*, *141*
Kummer, Mario, TU Berlin
Tue.1, H 0110 *63*, **63** [11:20]
Kungurtsev, Vyacheslav, Czech Technical University in Prague
Wed.1, H 2013 **114** [11:30]
Kuryatnikova, Olga, Tilburg University
Tue.4, H 2032 **98** [16:30]
Kyng, Rasmus, ETH Zürich
Tue.1, H 3004 **63** [10:55]
Lacoste-Julien, Simon, University of Montreal & Mila & SAIL Montreal
Mon.2, H 2053 **56** [13:45]
Laguel, Yassine, Université Grenoble Alpes
Thu.1, H 3012 **153** [9:00]
Laird, Carl, Sandia National Laboratories
Wed.2, H 0112 128[c], 128[o]
Wed.3, H 0112 140[o], **140** [16:50]
Lam, Henry, Columbia University
Wed.1, H 3006 117[c], 117[o], *117*, *117*
Lam, Xin-Yee, National University of Singapore
Tue.2, H 3004 **74** [13:40]
Lamadrid L., Alberto J., Lehigh University
Tue.3, H 1012 85[c], **85** [15:35]
Lämmel, Sebastian, Technische Universität Chemnitz
Poster Session **23**
Lamperski, Jourdain, MIT
Wed.2, H 0107 *121*
Thu.3, H 2032 169[c], **169** [14:20]
Lan, Guanghui, Georgia Institute of Technology
Mon.2, H 1029 **54** [14:10]
Tue.2, H 0104 78[o]
Tue.3, H 0104 90[o]
Lara, Felipe, Getulio Vargas Foundation
Wed.1, H 3008 109[c], **109** [12:20]
Larson, Jeffrey, Argonne National Laboratory
Mon.1, H 2038 **44** [11:25]
Latafat, Puya, KU Leuven
Thu.3, H 1028 **167** [13:30]
Laurain, Antoine, Instituto de Matemática e Estatística
Mon.2, H 2013 **58** [13:45]
Laxmi, Scindhiya, Indian institute of Technology Roorkee
Thu.1, H 3007 **144** [9:00]
Le, Hien, University of Mons
Wed.3, H 2013 **138** [16:25]
Le Digabel, Sébastien, Polytechnique Montréal
Mon.1, H 2038 44[o]
Mon.2, H 2038 54[o], **54** [14:35]
Tue.1, H 2038 66[o]
Tue.2, H 2038 77[c], 77[o]
Tue.3, H 2038 88[o]
Tue.4, H 2038 100[c], 100[o]
Wed.1, H 2033 112[o], *112*
Wed.2, H 2033 123[o]
Wed.3, H 2033 135[o]
Thu.1, H 3025 147[o]
Lee, Ching-pei, National University of Singapore / University of Wisconsin-Madison
Thu.3, H 1029 **167** [13:30]
Lee, Chul-Hee, INHA University
Poster Session **23**
Lee, Jon, University of Michigan, Ann Arbor
Tue.4, H 1012 101[c], 101[o], *101*, *101*
Legat, Benoît, UCLouvain
Mon.1, H 0111 **41** [11:25]
Lellmann, Jan, University of Lübeck
Thu.2, H 1012 **163** [10:45]
Leyffer, Sven, Argonne National Laboratory
Mon.1, H 3006 46[c], 46[o]
Mon.2, H 3006 57[o], *57*
Tue.3, H 0112 *93*
Thu.1, H 2053 150[o], **150** [9:50]
Lezcano Casado, Mario, University of Oxford
Wed.3, H 0105 **136** [16:50]
Li, Andrew, Carnegie Mellon University
Tue.2, H 1058 **82** [13:40]
Li, Chiao-Wei, National Tsing Hua University
Poster Session **23**
Li, Fengpei,
Wed.1, H 3006 **117** [11:30]
Li, Guoyin, University of New South Wales, Australia
Tue.1, H 1028 65[c], 65[o], **65** [11:20]
Tue.2, H 3002 *77*
Li, Mingyu, Department of Industrial Economics and Technology Management, NTNU
Thu.1, H 3004 **143** [9:25]
Li, Qingna, Beijing Institute of Technology
Wed.1, H 0110 108[c], 108[o], **108** [12:20]
Li, Xiaobo, National University of Singapore
Wed.3, H 3012 **142** [16:25]
Li, Xin, University of Central Florida
Wed.1, H 2013 **114** [12:20]
Wed.2, H 2013 *126*
Li, Xinxin, Jilin University
Tue.1, H 3025 **68** [10:55]
Li, Xudong, Fudan University
Mon, 16:20, Best Paper Session, H 0105 **14**
Tue.2, H 2013 *73*
Tue.2, H 3004 74[c], 74[o]
Tue.3, H 1029 **88** [15:10]
Tue.4, H 3004 97[c], 97[o]
Liang, Jingwei, University of Cambridge
Tue.1, H 1028 **65** [10:55]
Liang, Ling, National University of Singapore
Tue.4, H 3004 **97** [16:30]
Liang, Tengyuan, University of Chicago
Mon.2, H 0104 **50** [14:35]
Liberti, Leo, CNRS / École Polytechnique
Tue.4, H 1012 **101** [17:20]
Lieder, Felix, Heinrich-Heine-Universität Düsseldorf
Mon.1, H 2038 *44*
Thu.1, H 2032 **145** [9:50]

Liers, Frauke, Friedrich-Alexander-Universität Erlangen-Nürnberg
Wed, 10:15, Semi-Plenary Talk, H 0105 **16**
Lilienthal, Patrick-Marcel, Otto-von-Guericke-Universität Magdeburg
Mon.2, H 0107 **50** [14:10]
Lin, Meixia, National University of Singapore
Tue.4, H 3004 **97** [16:55]
Lin, Qihang, University of Iowa
Tue.2, H 1029 **76** [13:40]
Wed.2, H 0107 *121*
Wed.2, H 0110 120[c], 120[o]
Wed.3, H 0110 132[o]
Thu.1, H 0104 *149*
Thu.2, H 0104 *160*
Lin, Tianyi, University of California, Berkeley
Mon.2, H 3004 *51*
Tue.3, H 2013 **90** [14:45]
Lindgren, Jussi, Aalto University School of Science
Wed.2, H 3012 **130** [14:40]
Lindstrom, Scott B., The Hong Kong Polytechnic University
Wed.3, H 3008 **136** [16:00]
Ling, Qing, Sun Yat-Sen University
Thu.1, H 0105 **143** [9:00]
Liu, Heyuan, University of California, Berkeley
Tue.3, H 0105 **85** [15:10]
Liu, Huikang, The Chinese University of Hong Kong
Mon.2, H 0112 **53** [14:10]
Liu, Sijia, MIT-IBM Watson AI Lab, IBM Research
Mon.1, H 3004 **40** [11:25]
Liu, Tianxiang, RIKEN Center for Advanced Intelligence Project (AIP)
Wed.3, H 1012 **137** [16:50]
Liu, Xin, Academy of Mathematics and Systems Science, Chinese Academy of Sciences
Mon.2, H 1012 60[c], 60[o], *60*
Tue.2, H 3007 83[o], **83** [13:15]
Tue.4, H 3007 106[o], *106*
Liu, Ya-Feng, Chinese Academy of Sciences
Wed.1, H 3025 107[o]
Wed.2, H 3025 119[c], 119[o], **119** [14:40]
Loayza-Romero, Estefania, Chemnitz University of Technology
Tue.3, H 0106 **92** [14:45]
Lobato, Rafael Durbano, Università di Pisa
Thu.3, H 0106 **168** [13:55]
Löbhard, Caroline, Weierstrass Institute for Applied Analysis and Stochastics (WIAS)
Wed.2, H 0111 **127** [15:05]
Lobo Pereira, Fernando, Universidade do Porto Faculdade de Engenharia
Wed.3, H 0107 **139** [16:50]
Lobos, Alfonso, University of California, Berkeley
Thu.2, H 0105 **155** [11:35]
Loizou, Nicolas, The University of Edinburgh
Tue.2, H 2033 *84*
Tue.4, H 2013 **97** [17:20]
Long, Daniel Zhuoyu, CUHK
Tue.4, H 2053 **104** [16:55]
Lorenz, Dirk, TU Braunschweig
Mon.1, H 1029 **43** [11:00]
Lourenço, Bruno Figueira, University of Tokyo
Tue.1, H 3006 *64*
Wed.3, H 0111 *133*
Thu.1, H 0106 **149** [9:25]
Thu.2, H 0110 *155*
Louzeiro, Maurício, UFG
Thu.1, H 0107 **150** [9:50]
Thu.2, H 2053 *161*
Lu, Haihao, MIT
Thu.1, H 0104 **149** [9:00]
Lu, Kuan, Tokyo Institute of Technology
Wed.2, H 3008 **124** [14:15]
Lu, Shu, University of North Carolina at Chapel Hill
Thu.3, H 3012 173[c], **173** [13:55]
Lucchi, Aurelien, ETH Zürich
Wed.2, H 0104 **120** [15:05]
Luce, Robert, Gurobi
Tue.2, H 2053 79[o], **79** [14:05]
Tue.3, H 2053 91[c], 91[o]
Lucet, Yves, University of British Columbia
Mon.2, H 2038 **54** [13:45]
Luke, Russell, Georg-August-University of Göttingen
Mon.1, H 1012 **49** [11:00]
Wed, 10:15, Semi-Plenary Talk, H 0104 16[c]
Luo, Zhi-Quan, The Chinese University of Hong Kong, Shenzhen
Wed.1, H 3025 107[c], 107[o]
Wed.2, H 3025 119[o], **119** [14:15]
Ma, Runchao, University of Iowa
Thu.2, H 0104 **160** [11:10]
Ma, Shiqian, University of California, Davis
Mon.2, H 1029 54[o]
Wed.1, H 3025 *107*
Thu.1, H 0104 149[c], 149[o]
Thu.2, H 0104 160[o]
Magron, Victor, LAAS-CNRS
Wed.2, H 2032 **122** [15:05]
Maier, Corinna, University of Potsdam
Mon.2, H 0107 **50** [13:45]
Mairal, Julien, Inria
Wed.1, H 2038 118[c], 118[o], **118** [12:20]
Mannel, Florian, University of Graz
Tue.4, H 1029 **99** [17:20]
Manns, Paul, TU Braunschweig
Mon.2, H 3006 **57** [14:35]
Marandi, Ahmadreza, Eindhoven University of Technology
Mon.2, H 3025 **60** [13:45]
Mareček, Jakub, IBM Research
Wed.2, H 2013 **126** [15:05]
Marques Alves, Maicon, Federal University of Santa Catarina - UFSC
Tue.3, H 1028 **87** [15:10]
Matei, Alexander, TU Darmstadt
Thu.2, H 3025 **159** [11:10]
Maxim, Diana, Alexandru Ioan Cuza University of Iasi
Tue.4, H 3013 **101** [17:20]
Mazumder, Rahul [canceled], Massachusetts Institute of Technology
Thu.1, H 3006 **144** [9:00], *144*
Mefo Kue, Floriane, University of Siegen
Mon.2, H 3013 **55** [13:45]
Mehlitz, Patrick, Brandenburgische Technische Universität Cottbus-Senftenberg
Tue.2, H 1028 **76** [13:15]
Mehrotra, Sanjay, Northwestern University
Thu.3, H 1058 **171** [13:30]
Menhorn, Friedrich, Technical University of Munich
Wed.3, H 2033 **135** [16:25]
Menickelly, Matt, Argonne National Laboratory
Mon.1, H 2038 *44*
Mon.2, H 0105 *55*
Tue.1, H 2038 **66** [10:30]
Merino, Pedro, Escuela Politécnica Nacional
Mon.2, H 1028 **53** [14:10]
Mertikopoulos, Panayotis, CNRS

Mon.2, H 3007 *52*
Tue.2, H 3006 **75** [13:40]
Wed.2, H 2038 *129*
Metel, Michael R., RIKEN AIP
Thu.2, H 0110 **155** [11:10]
Meyn, Sean, University of Florida
Mon.1, H 0110 **49** [11:00]
Migot, Tangi, University of Guelph
Thu.3, H 3013 **165** [13:55]
Mihic, Kresimir, University of Edinburgh
Tue.4, H 0111 *102*
Thu.2, H 2038 **158** [11:10]
Milz, Johannes, Technical University of Munich
Thu.3, H 2013 **171** [13:55]
Milzarek, Andre, The Chinese University of Hong Kong, Shenzhen
Mon.1, H 1028 **43** [11:00]
Tue.4, H 1029 99[c], 99[o], *99*
Mishchenko, Konstantin, KAUST
Mon.2, H 2053 56[c], 56[o]
Tue.3, H 2013 90[c], 90[o], **90** [15:35]
Wed.2, H 0104 *120*
Thu.3, H 0107 169[c], 169[o]
Misic, Velibor, UCLA
Tue.2, H 1058 82[c], 82[o], **82** [14:05]
Mitchell, Tim, Max Planck Institute for Dynamics of Complex Technical Systems
Wed.1, H 1029 114[c], **114** [12:20]
Mohajerin Esfahani, Peyman, TU Delft
Mon.2, H 1058 *59*
Tue.1, H 1058 *70*
Tue.3, H 3012 *94*, *94*
Tue.4, H 1058 104[c], 104[o], **104** [17:20]
Thu.2, H 3006 162[c], 162[o]
Mohammadi, Masoumeh, TU Darmstadt
Mon.2, H 2033 **59** [14:10]
Monteiro, Renato, Georgia Institute of Technology
Tue.2, H 0104 **78** [13:15]
Mordukhovich, Boris, Department of Mathematics, Wayne State University
Tue.1, H 1028 **65** [10:30]
Tue.3, H 0107 *92*
Tue.4, H 0110 *98*
Thu.3, H 2053 *170*
Morin, Martin, Lund University
Poster Session **23**
Müller, Christian L., Flatiron Institute
Wed.2, H 1028 **122** [15:05]
Müller, Georg, Universität Konstanz
Wed.3, H 0106 **139** [16:50]
Munoz Zuniga, Miguel, IFPEN
Tue.4, H 2038 **100** [16:55]
Muramatsu, Masakazu, The University of Electro-Communications
Mon.1, H 0112 42[o]
Tue.1, H 3006 64[o], *64*
Wed.3, H 0111 *133*
Murray, Riley, Caltech
Tue.1, H 2032 64[c], 64[o]
Tue.2, H 2032 75[o], **75** [13:40]
Murthy, Karthyek, Singapore University of Technology and Design
Tue.1, H 3012 71[c], 71[o]
Tue.3, H 3012 *94*
Wed.2, H 3006 **128** [14:15]
Nakatsukasa, Yuji, University of Oxford
Tue.2, H 2053 79[c], 79[o]
Tue.3, H 2053 91[o], **91** [14:45]
Wed.2, H 1012 125[c], 125[o]
Wed.3, H 1012 137[o], *137*
Nakayama, Shummin, Chuo University
Wed.2, H 1012 **125** [14:40]
Naldi, Simone, Université de Limoges
Tue.1, H 0110 **63** [10:55]
Nannicini, Giacomo, IBM T.J. Watson
Tue.3, H 2038 **88** [15:35]
Natarajan, Karthik, Singapore University of Technology and Design
Tue.3, H 1058 93[c], 93[o], *93*, **93** [15:35]
Tue.4, H 3012 *105*
Wed.2, H 3006 *128*
Necoara, Ion, University Politehnica Bucharest (UPB)
Mon.1, H 1029 43[o], **43** [11:50]
Mon.2, H 1029 54[c]
Tue.1, H 1029 65[o]
Tue.2, H 1029 76[c], 76[o]
Wed.3, H 0104 *131*
Nedich, Angelia, Arizona State University
Mon.1, H 1029 **43** [11:25]
Nerantzis, Dimitrios, Imperial College London
Thu.2, H 3012 **154** [10:45]
Netrapalli, Praneeth, Microsoft Corporation
Wed.3, H 0110 **132** [16:25]
Nghia, Tran, Oakland University
Tue.2, H 3002 **77** [14:05]
Nguyen, Dang-Khoa, University of Vienna
Wed.3, H 1028 **134** [16:25]
Nguyen, Truc-Dao, Wayne State University
Thu.3, H 2053 **170** [13:30]
Nguyen, Viet Anh, EPFL
Mon.2, H 1058 **59** [14:10]
Tue.1, H 1058 *70*
Tue.3, H 3012 *94*
Tue.4, H 1058 *104*
Nhu, Vu Huu, University of Duisburg-Essen
Wed.2, H 0106 **127** [14:40]
Nimana, Nimit, Khon Kaen University
Wed.3, H 1028 **134** [16:00]
Ninin, Jordan, ENSTA-Bretagne
Tue.4, H 2033 105[c], **105** [16:55]
Niu, Yi-Shuai, Shanghai Jiao Tong University
Thu.2, H 2033 **157** [11:10]
Nocedal, Jorge, Northwestern University
Mon.1, H 0105 **45** [11:00]
Thu, 15:15, Semi-Plenary Talk, H 0105 18[c]
Nohadani, Omid, Northwestern University
Wed.2, H 3007 **129** [15:05]
Thu.3, H 3006 172[c], 172[o], *172*
Ochs, Peter, Saarland University
Tue.1, H 3007 **71** [10:55]
Okamura, Natsuki, The University of Electro-Communications
Tue.1, H 3006 **64** [10:55]
Okuno, Takayuki, RIKEN AIP
Wed.2, H 1012 **125** [15:05]
Thu.1, H 2038 *146*
Oliver, Sophy, University of Oxford
Tue.1, H 3002 **68** [10:30]
Olshevsky, Alex, Boston University
Wed.3, H 3002 **132** [16:00]
Orban, Dominique, GERAD & Polytechnique
Mon.1, H 2032 45[c], 45[o], *45*
Mon.2, H 2032 56[o], **56** [13:45], *56*
Outrata, Jiri, The Institute of Information Theory and Automation
Tue.4, H 0110 **98** [16:55], *98*
Ouyang, Yuyuan, Clemson University

Tue.2, H 0104 78[c], 78[o]
Tue.2, H 3006 *75*
Tue.3, H 0104 90[c], 90[o]
Thu.2, H 0104 **160** [11:35]
Overton, Michael, New York University
Tue.2, H 0105 **79** [13:15]
Tue, 16:30, Memorial Session, H 0105 15[c], 15[o]
Wed.1, H 1029 *114*
Ozdaglar, Asuman,
Tue.1, H 2053 67[o], *67*
Thu.3, H 0107 *169*
Ozener, Okan, Ozyegin University
Thu.1, H 3004 **143** [9:00], *143*
Ozturk, Berk, Massachusetts Institute of Technology
Tue.2, H 2032 **75** [13:15]
Padmanabhan, Divya, Singapore University of Technology and Design
Tue.3, H 1058 **93** [15:10]
Wed.2, H 3006 *128*
Palladino, Michele, Gran Sasso Science Institute
Tue.1, H 0107 69[o]
Tue.2, H 0112 82[o]
Tue.3, H 0107 92[o]
Tue.4, H 0107 103[o], **103** [17:20]
Wed.1, H 0111 116[c], 116[o]
Wed.2, H 0111 127[c], 127[o]
Wed.3, H 0107 139[c], 139[o]
Pan, Bolin [canceled], UCL
Thu.3, H 1012 **172** [13:55]
Pang, C.H. Jeffrey, National University of Singapore
Thu.2, H 1028 **158** [10:45]
Pang, Jong-Shi, University of Southern California
Mon.1, H 0104 39[c], 39[o], **39** [11:00]
Tue, 9:00, Plenary Talk, H 0105 14[c]
Tue.2, H 2013 73[c], 73[o], *73*
Pankajakshan, Arun, University College London
Mon.1, H 3013 **44** [11:00]
Pany, Gayatri, Singapore University of Technology and Design
Wed.1, H 3008 **109** [11:30]
Papafitsoros, Kostas, Weierstrass Institute for Applied Analysis and Stochastics
Mon.1, H 0106 47[c], 47[o], **47** [11:50]
Mon.2, H 0106 58[o]
Thu.1, H 3007 *144*
Papp, David, North Carolina State University
Tue.3, H 3006 **87** [15:35]
Parpas, Panos, Imperial College London
Wed.2, H 2053 126[o], **126** [15:05]
Wed.3, H 3007 138[c], 138[o], *138*, *138*
Parrilo, Pablo [canceled], MIT
Tue.1, H 2053 *67*
Wed.3, H 2032 **134** [16:00]
Pasadakis, Dimosthenis, Università della Svizzera italiana (USI)
Thu.3, H 3007 165[c], **165** [14:20]
Poster Session *24*
Passacantando, Mauro, Università di Pisa
Thu.1, H 3025 **147** [9:25]
Pasupathy, Raghu, Purdue University
Wed.2, H 2033 **123** [14:15]
Patel, Vivak, University of Wisconsin-Madison
Tue.1, H 0104 **72** [10:55]
Pattathil, Sarath, MIT
Thu.3, H 0107 **169** [13:55]
Pearson, John, University of Edinburgh
Tue.3, H 2053 **91** [15:35]
Tue.4, H 0111 *102*
Pecci, Filippo, Imperial College London
Wed.3, H 3007 **138** [16:00]
Thu.2, H 3012 *154*
Peitz, Sebastian, Paderborn University
Mon.1, H 3013 *44*
Mon.2, H 3006 **57** [13:45]
Pena, Javier, Carnegie Mellon University
Wed.2, H 0110 **120** [15:05]
Peña-Ordieres, Alejandra, Northwestern University, Evanston
Mon.2, H 0105 **55** [13:45]
Pereira Ferreira, Orizon, Federal University of Goias (UFG)
Thu.1, H 0107 150[c], 150[o], *150*
Thu.2, H 2053 161[c], 161[o], **161** [11:10]
Pérez-Aros, Pedro, Universidad de O'Higgins
Thu.1, H 3012 153[c], **153** [9:25]
Pesquet, Jean-Christophe, University Paris Saclay
Wed.3, H 2038 141[c], **141** [16:50]
Peters, Benjamin, Otto von Guericke University Magdeburg
Tue.4, H 2032 **98** [16:55]
Petrik, Marek, University of New Hampshire
Tue.2, H 3012 **83** [14:05]
Pfeffer, Max, Max Planck Institute for Mathematics in the Sciences
Wed.2, H 0105 **124** [14:40]
Wed.3, H 1012 *137*
Pfeiffer, Laurent, University of Graz
Wed.2, H 0111 **127** [14:40]
Piliouras, Georgios, SUTD
Thu.3, H 0107 **169** [14:20]
Pillutla, Krishna, University of Washington
Tue.4, H 3004 **97** [17:20]
Pinar, Mustafa C., Bilkent University
Thu.1, H 1012 152[c], **152** [9:50]
Pisciella, Paolo, NTNU-The Norwegian University of Science and Technology
Tue.1, H 1012 **62** [10:55]
Plaumann, Daniel, TU Dortmund University
Tue.1, H 0110 **63** [10:30], *63*
Tue.2, H 0110 *74*
Ploskas, Nikolaos, University of Western Macedonia
Tue.4, H 2033 **105** [16:30]
Pohl, Mathias, University of Vienna
Tue.4, H 3012 **105** [16:55]
Poirion, Pierre-Louis, RIKEN Institute
Tue.4, H 1012 *101*
Thu.2, H 0110 **155** [11:35]
Pokutta, Sebastian, Georgia Tech
Tue.3, H 0105 *85*
Thu.3, H 3006 **172** [13:30]
Pong, Ting Kei, The Hong Kong Polytechnic University
Tue.1, H 3025 *68*
Tue.2, H 3002 77[c], 77[o], *77*
Wed.3, H 1012 *137*
Wed.3, H 3008 136[c], 136[o], **136** [16:50]
Porcelli, Margherita, University of Bologna
Mon.1, H 2038 44[o]
Mon.2, H 2038 54[c], 54[o]
Tue.1, H 2038 66[o]
Tue.2, H 2038 77[o]
Tue.2, H 2053 *79*
Tue.2, H 3025 80[c], **80** [14:05]
Tue.3, H 2038 88[o]
Tue.4, H 2038 100[o]
Wed.1, H 2033 112[o]
Wed.2, H 2033 123[c], 123[o]
Wed.3, H 2033 135[o]
Thu.1, H 3025 147[o]
Postek, Krzysztof, Erasmus University Rotterdam
Mon.1, H 1058 **48** [11:00]

Mon.2, H 3025 60[c], 60[o]
Pougkakiotis, Spyridon, University of Edinburgh
Tue.4, H 0111 102[c], **102** [16:55]
Thu.2, H 2038 *158*
Povh, Janez, University of Ljubljana
Mon.1, H 3002 40[c], 40[o], *40*
Mon.2, H 3002 51[o], *51*, **51** [14:10]
Thu.3, H 2038 *166*
Prato, Marco, Università degli Studi di Modena e Reggio Emilia
Wed.3, H 2038 **141** [16:25]
Thu.3, H 2032 *169*
Qi, Zhengling, The George Washington University
Tue.2, H 2013 **73** [13:40]
Qian, Huajie, Columbia University
Wed.1, H 3006 **117** [11:55]
Qian, Xun, KAUST
Tue.2, H 2033 **84** [14:05]
Qu, Qing, New York University
Thu.3, H 3007 **165** [13:30]
Qu, Zheng, The University of Hong Kong
Tue.2, H 2033 **84** [13:15]
Quintana, Ernest, Martin Luther University Halle-Wittenberg
Tue.1, H 3013 **66** [11:20]
Rabiei, Nima, American University of Iraq
Thu.2, H 1029 **159** [10:45]
Radons, Manuel, TU Berlin
Thu.2, H 3012 154[c], **154** [11:10]
Rajawat, Ketan, Indian Institute of Technology Kanpur
Poster Session **23**
Ralph, Daniel, University of Cambridge
Wed.3, H 2053 **131** [16:00]
Rampazzo, Franco, University of Padova
Tue.4, H 0107 *103*
Wed.1, H 0111 **116** [11:30]
Rauls, Anne-Therese, TU Darmstadt
Wed.3, H 0106 **139** [16:25]
Rautenberg, Carlos, Humboldt-Universität zu Berlin / WIAS
Mon, 16:20, Best Paper Session, H 0105 *13*
Tue.3, H 0110 86[o], *86*
Tue.4, H 0112 103[o], **103** [17:20]
Wed.1, H 0112 116[o]
Wed.2, H 3013 121[o], *121*
Ravier, Robert, Duke University
Thu.1, H 3007 **144** [9:25]
Razaviyayn, Meisam, University of Southern California
Tue.2, H 2013 **73** [14:05]
Rebegoldi, Simone, Università degli Studi di Modena e Reggio Emilia
Wed.3, H 2038 *141*
Thu.3, H 2032 **169** [13:30]
Recht, Benjamin, University of California, Berkeley
Mon.2, H 0104 50[o], **50** [13:45]
Mon.2, H 0110 *61*
Tue.1, H 2013 62[c], 62[o]
Redder, Adrian, Automatic Control Group / Paderborn University
Poster Session **24**
Rehfeldt, Daniel, Technische Universität Berlin
Tue.3, H 0111 91[c], **91** [15:35]
Riccietti, Elisa, University of Toulouse
Wed.1, H 2053 115[c], 115[o], **115** [12:20]
Richtárik, Peter, King Abdullah University of science and technology (KAUST)
Tue.2, H 2033 *84*
Tue.3, H 2013 *90*
Wed.1, H 2013 *114*
Wed.2, H 0104 **120** [14:15]
Richter, Robin, Georg-August Universität Göttingen
Thu.1, H 0112 **151** [9:25]
Ridzal, Denis, Sandia National Laboratories
Wed.2, H 0112 **128** [15:05]
Riener, Cordian, Uit
Wed.2, H 2032 **122** [14:40]
Riis, Erlend Skaldehaug, University of Cambridge
Wed.3, H 0105 **136** [16:25]
Rinaldi, Francesco, Università di Padova
Mon.1, H 2038 44[c], 44[o]
Mon.2, H 2038 54[o]
Tue.1, H 2038 66[o]
Tue.2, H 2038 77[o], **77** [13:40]
Tue.2, H 2053 *79*
Tue.3, H 2038 88[o]
Tue.4, H 2038 100[o]
Wed.1, H 2033 112[o]
Wed.2, H 2033 123[o]
Wed.3, H 2033 135[o]
Thu.1, H 3025 147[o], *147*
Thu.2, H 3025 159[c]
Thu.3, H 2038 *166*
Riquelme, Victor, Universidad Tecnica Federico Santa Maria
Mon.1, H 3012 **46** [11:25]
Roberts, Lindon, University of Oxford
Wed.2, H 2033 **123** [14:40]
Robinson, Daniel, Lehigh University
Tue.1, H 0105 **67** [11:20]
Wed.2, H 1058 123[c], 123[o], *123*, *123*
Wed.3, H 3025 135[c]
Rodomanov, Anton, UCLouvain
Tue.2, H 0105 **79** [13:40]
Rodrigues, Sergio, RICAM
Thu.3, H 2013 **171** [13:30]
Rodrigues Sampaio, Phillipe, Veolia Research and Innovation
Tue.4, H 2038 **100** [17:20]
Romito, Francesco, Sapienza University of Rome
Wed.2, H 3008 **124** [14:40]
Rontsis, Nikitas, University of Oxford
Tue.3, H 2053 *91*
Wed.3, H 1012 **137** [16:00]
Roos, Ernst, Tilburg University
Mon.2, H 3025 **60** [14:10]
Wed.3, H 3004 *140*
Roosta, Fred, University of Queensland
Mon.1, H 0105 **45** [11:25]
Rosasco, Lorenzo, Universita' di Genova and MIT
Tue.1, H 2013 **62** [10:30]
Royer, Clément, University of Wisconsin-Madison
Tue.1, H 0105 **67** [10:30]
Tue.2, H 2038 **77** [13:15]
Wed.1, H 2013 *114*
Rujeerapaiboon, Napat, National University of Singapore
Tue.1, H 1058 *70*, *70*
Wed.3, H 3006 **141** [16:00]
Ruszczynski, Andrzej, Rutgers University
Mon, 16:20, Best Paper Session, H 0105 13[c]
Tue.1, H 0104 **72** [10:30]
Rutkowski, Krzysztof, Warsaw University of Technology
Wed.3, H 2038 **141** [16:00]
Wed.3, H 3025 *135*
Ryu, Ernest, UCLA
Thu.1, H 1028 147[o]
Thu.2, H 1028 *158*
Thu.3, H 1028 167[c], 167[o], **167** [14:20]
Sabach, Shoham, Technion-Israel Institute of Technology
Mon.1, H 1012 49[c], 49[o], **49** [11:50]
Tue.4, H 2033 105[o]

Thu.1, H 1012 152[o]
Thu.3, H 1012 172[o]
Sachs, Ekkehard, Universität Trier
Tue.4, H 0112 **103** [16:30]
Sadeghi, Hamed [canceled], Lund University
Tue.3, H 2033 **95** [15:10]
Safarina, Sena, Tokyo Institute of Technology
Mon.1, H 0112 **42** [11:50]
Salim, Adil, King Abdullah University of Science and Technology (KAUST)
Tue.3, H 2013 **90** [15:10]
Salomon, Ludovic, Polytechnique Montréal
Wed.1, H 2033 **112** [11:55]
Salzo, Saverio, Istituto Italiano di Tecnologia
Wed.1, H 1028 **111** [11:55]
Sanchez, Maria Daniela, Centro de Matemática de La Plata, Universidad Nacional de La Plata
Thu.2, H 0106 **160** [11:10]
Sanchez Licea, Gerardo, Facultad de Ciencias UNAM
Tue.3, H 0107 **92** [15:35]
Sandilya, Ruchi, Weierstrass Institute for Applied Analysis and Stochastics (WIAS)
Wed.2, H 3013 **121** [15:05]
Sarabi, Ebrahim, Miami University, Ohio
Tue.1, H 1028 *65*
Tue.4, H 0110 **98** [16:30]
Sartenaer, Annick, University of Namur
Tue, 16:30, Memorial Session, H 0105 **15**
Sassen, Josua, University of Bonn
Thu.2, H 2053 **161** [10:45]
Saunders, Michael, Stanford University
Mon.1, H 2032 45[o], **45** [11:50]
Mon.2, H 2032 56[c], 56[o], *56*
Saunderson, James, Monash University
Mon.1, H 2053 42[o]
Sauter, Marta, University of Heidelberg
Mon.1, H 0107 **39** [11:00]
Scarinci, Teresa, University of Vienna
Tue.1, H 0107 **69** [10:30]
Schäfer Aguilar, Paloma, TU Darmstadt
Wed.2, H 0111 **127** [14:15]
Scheinberg, Katya, Cornell University
Tue.1, H 0105 **67** [10:55]
Tue, 16:30, Memorial Session, H 0105 **15**
Wed.2, H 2033 *123*
Schenk, Christina, Carnegie Mellon University
Mon.1, H 0107 39[o], **39** [11:50]
Mon.2, H 0107 50[c], 50[o]
Schenk, Olaf, Università della Svizzera italiana
Thu.3, H 3007 *165*
Poster Session **24**
Schiela, Anton, Universität Bayreuth
Thu.1, H 0112 151[o]
Thu.2, H 0112 161[c], 161[o]
Thu.3, H 0112 170[o], **170** [13:30]
Schindler, Kilian, EPFL
Tue.1, H 1058 **70** [10:30]
Schmitt, Johann Michael, TU Darmstadt
Tue.3, H 0112 **93** [15:35]
Schrempf, Konrad, University of Applied Sciences Upper Austria
Thu.2, H 2038 158[c], **158** [11:35]
Schultes, Johanna, University of Wuppertal
Poster Session **24**
Schulz, Volker, Trier University
Tue.2, H 0106 **81** [13:15]
Tue.4, H 0106 *102*
Schulze, Veronika, Paderborn University
Tue.3, H 0106 **92** [15:10]
Schütz, Peter, Norwegian University of Science and Technology NTNU
Mon, 15:30, Semi-Plenary Talk, H 0104 13[c]
Wed.3, H 2053 **131** [16:25]
Thu.1, H 3004 *143*
Schwartz, Alexandra, TU Darmstadt
Mon.1, H 3007 *41*
Mon.1, H 3013 44[c], 44[o], **44** [11:50]
Mon.2, H 3013 55[o]
Wed.1, H 3002 112[o]
Thu.1, H 0111 148[o]
Schweighofer, Markus, Universität Konstanz
Tue.1, H 0110 63[c], 63[o]
Tue.2, H 0110 74[c], 74[o], **74** [13:40]
Schwing, Alex, University of Illinois at Urbana-Champaign
Mon.1, H 3004 **40** [11:50]
Scieur, Damien, SAIT Montreal
Tue.3, H 0104 **90** [15:35]
Scutari, Gesualdo, Purdue University
Mon.1, H 0104 **39** [11:50]
Seidler, Henning, TU Berlin
Tue.1, H 2032 **64** [10:30]
Shafieezadeh Abadeh, Soroosh, EPFL
Tue.1, H 1058 *70*
Tue.3, H 3012 94[c], 94[o], **94** [15:35]
Tue.4, H 1058 *104*
Shaked-Monderer, Naomi, The Max Stern Yezreel Valley College
Wed.3, H 0111 **133** [16:00]
Shanbhag, Uday, Penn State University
Tue, 9:00, Plenary Talk, H 0105 **14**
Thu.1, H 0104 *149*
Thu.1, H 1012 *152*
Poster Session *24*
Shao, Zhen, University of Oxford
Wed.2, H 2053 **126** [14:40]
Sharma, Meenarli, Indian Institute of Technology Bombay
Tue.3, H 0112 **93** [14:45]
Shi, Jianming, Tokyo University of Science
Wed.1, H 3012 **118** [11:55]
Wed.2, H 3008 *124*
Shikhman, Vladimir, Chemnitz University of Technology
Wed.1, H 1058 111[c], **111** [12:20]
Poster Session *23*
Shoemaker, Christine, National University of Singapore
Tue.3, H 2038 **88** [14:45]
Shtern, Shimrit, Technion-Israel Institute of Tecnology
Mon.1, H 1058 48[c], 48[o], *48*, **48** [11:50]
Tue.1, H 3012 *71*
Si, Nian, Stanford University
Tue.3, H 3012 **94** [15:10]
Siddiqui, Sauleh, Johns Hopkins University
Tue.1, H 1012 **62** [10:30]
Siebenborn, Martin, Universität Hamburg
Tue.1, H 0106 69[o]
Tue.2, H 0106 81[c], 81[o]
Tue.3, H 0106 92[c], 92[o]
Tue.4, H 0106 102[o], **102** [16:55]
Silva, Paulo J. S., University of Campinas - UNICAMP
Thu.1, H 0106 149[c], **149** [9:50]
Thu.2, H 0106 160[c]
Sim, Chee Khian, University of Portsmouth
Thu.2, H 2038 **158** [10:45]
Singh, Abhishek, Indian Institute of Technology (BHU) Varanasi
Wed.2, H 3013 **121** [14:15]
Sinn, Rainer, Freie Universität Berlin

Tue.1, H 0110 *63*
Tue.2, H 0110 **74** [13:15]
Skipper, Daphne, United States Naval Academy
Tue.4, H 1012 **101** [16:30], *101*
Sliwak, Julie, RTE, Polytechnique Montréal, LIPN
Thu.1, H 2032 **145** [9:25]
Slot, Lucas, CWI
Thu.3, H 2033 **166** [13:55]
So, Anthony Man-Cho, The Chinese University of Hong Kong
Mon.2, H 0112 53[c], 53[o], *53*, **53** [14:35]
Wed.1, H 3025 *107*
Soares Siqueira, Abel, Federal University of Paraná
Tue.2, H 0111 80[o]
Soheili, Negar, University of Illinois at Chicago
Wed.2, H 0107 121[c], 121[o], **121** [15:05]
Soltani, Roya [canceled], Khatam University
Poster Session **24**
Soltanolkotabi, Mahdi, University of Southern California
Mon.2, H 0104 50[c], 50[o]
Tue.1, H 2013 62[o], **62** [10:55]
Sotirov, Renata, Tilburg University
Tue.4, H 2032 *98*
Wed.1, H 0107 110[c], 110[o], *110*, *110*
Souza, João Carlos, Federal University of Piauí
Thu.1, H 0107 **150** [9:25]
Speakman, Emily,
Tue.4, H 1012 101[o], *101*
Spivak, Alexander, HIT - Holon Institute of Technology
Poster Session **24**
Sra, Suvrit, MIT
Wed.1, H 0105 **113** [11:30]
Wed.3, H 3002 *132*
Srivastava, Prateek R, University of Texas at Austin
Mon.1, H 3025 **48** [11:50]
Staudigl, Mathias, Maastricht University
Mon.2, H 3007 **52** [13:45]
Wed.2, H 2038 129[c], 129[o]
Stengl, Steven-Marian, WIAS/HU Berlin
Tue.3, H 0110 **86** [15:10]
Poster Session **24**
Stewart, David, University of Iowa
Thu.1, H 3013 **145** [9:25]
Stich, Sebastian U., EPFL
Tue.4, H 2013 **97** [16:30]
Stingl, Michael, Friedrich-Alexander-Universität (FAU) Erlangen-Nürnberg
Wed.2, H 3004 **119** [14:15]
Stöger, Dominik, TU München, Fakultät für Mathematik
Thu.1, H 0112 **151** [9:50]
Strasdat, Nico, TU Dresden
Wed.1, H 3013 **109** [11:55]
Strugariu, Radu, Gheorghe Asachi Technical University of Iasi
Tue.2, H 3013 *78*
Tue.4, H 3013 **101** [16:30]
Sturm, Kevin, TU Wien, Institut für Analysis and Scientific Computing
Tue.1, H 0106 **69** [11:20]
Tue.2, H 0106 *81*
Sturt, Bradley, Massachusetts Institute of Technology
Mon.1, H 1058 *48*
Tue.1, H 3012 **71** [10:30]
Subramanyam, Anirudh, Argonne National Laboratory
Mon.1, H 3025 **48** [11:25]
Wed.2, H 3007 129[o], **129** [14:15]
Sun, Andy, Georgia Institute of Technology
Wed.1, H 0104 108[o], *108*
Thu.1, H 0105 143[o]
Sun, Cong, Beijing University of Posts and Telecommunications
Mon.2, H 1012 60[o], **60** [14:35]
Tue.2, H 3007 83[c], 83[o]
Tue.4, H 3007 106[c], 106[o]
Sun, Defeng, The Hong Kong Polytechnic University
Mon.1, H 0104 **39** [11:25]
Tue.2, H 2013 *73*
Tue.2, H 3004 *74*, *74*, *74*
Tue.3, H 1029 *88*
Tue.4, H 3004 *97*
Wed.1, H 0110 *108*
Sun, Kaizhao, Georgia Institute of Technology
Wed.1, H 0104 **108** [11:30]
Thu.1, H 0105 143[c]
Sun, Ruoyu, UIUC
Mon.1, H 3004 40[o], **40** [11:00]
Sun, Yifan, UBC Vancouver
Wed.1, H 2038 **118** [11:55]
Surowiec, Thomas Michael, Philipps-Universität Marburg
Thu.1, H 2013 151[c], 151[o]
Thu.2, H 2013 162[o], **162** [10:45]
Thu.3, H 2013 171[o]
Sutter, Tobias, École Polytechnique Fédérale de Lausanne (EPFL)
Tue.1, H 0104 *72*
Tue.3, H 3012 **94** [14:45]
Sutti, Marco, University of Geneva
Wed.2, H 0105 **124** [14:15]
T. Khalil, Nathalie, Universidade do Porto Faculdade de Engenharia
Tue.2, H 0112 **82** [13:15]
Takáč, Martin, Lehigh University
Tue.4, H 2013 97[o], **97** [16:55]
Wed.2, H 0104 120[c], 120[o]
Wed.3, H 0104 131[o]
Thu.2, H 3007 *156*
Takeda, Akiko, The University of Tokyo/RIKEN
Tue.3, H 3002 **89** [14:45]
Wed.2, H 1012 125[o], *125*
Wed.3, H 1012 137[o], *137*
Thu.2, H 0110 155[c], 155[o], *155*, *155*
Tam, Matthew K., University of Göttingen
Thu.2, H 1028 158[o]
Thu.3, H 1028 **167** [13:55]
Tammer, Christiane, Martin-Luther-University of Halle-Wittenberg
Tue.1, H 3013 66[o], *66*, *66*
Tue.2, H 3013 78[o], **78** [13:15]
Tue.3, H 3013 89[c], 89[o], *89*
Tue.4, H 3013 101[o]
Wed.1, H 3002 *112*
Tan, Sandra S. Y., NUS
Thu.3, H 2033 166[c], **166** [14:20]
Tanaka, Mirai, The Institute of Statistical Mathematics
Thu.1, H 2038 **146** [9:00]
Tanaka, Tamaki, Niigata University
Tue.2, H 3013 **78** [13:40]
Tang, Peipei, Zhejiang University City College
Wed.1, H 0110 *108*, **108** [11:55]
Tankaria, Hardik, Kyoto University
Wed.2, H 1029 **125** [14:40]
Tappenden, Rachael, University of Canterbury
Thu.2, H 3007 156[c], **156** [11:35]
Taylor, Adrien, Inria/ENS Paris
Tue.4, H 3002 100[c], 100[o]
Thu.1, H 1028 147[c], 147[o]
Thu.2, H 1028 **158** [11:35]

Thu.3, H 1028 167[o]
Teboulle, Marc, Tel-Aviv University
Mon, 9:30, Plenary Talk, H 0105 12[c]
Mon.1, H 1012 *49*
Tue.1, H 3007 *71*
Tempone, Raul, RWTH Aachen
Wed.2, H 3012 *130*
Wed.3, H 3012 *142*
Thu.3, H 2053 170[c], **170** [14:20]
Poster Session *22*
ten Eikelder, Stefan, Tilburg University, The Netherlands
Mon.2, H 3025 **60** [14:35]
Tenbrinck, Daniel, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU)
Thu.1, H 0112 *151*
Thu.2, H 1012 163[c], **163** [11:35]
Thu.2, H 1029 *159*
Terlaky, Tamás, Lehigh University, Bethlehem, PA
Wed.1, H 3004 107[c], 107[o], **107** [12:20]
Wed.2, H 3004 119[c], 119[o]
Themelis, Andreas, KU Leuven
Wed.3, H 3008 **136** [16:25]
Wed.3, H 3025 *135*
Thu.3, H 1028 *167*
Thiele, Aurelie, Southern Methodist University
Thu.3, H 1058 171[c], 171[o], **171** [14:20]
Thünen, Anna, Institut für Geometrie und Praktische Mathematik (IGPM), RWTH Aachen University
Mon.1, H 3007 41[c], 41[o]
Mon.2, H 3007 52[c], 52[o], **52** [14:35]
Timme, Sascha, Technische Universität Berlin
Mon.2, H 0111 **52** [14:10]
Tin, Andrey, University of Southampton
Thu.2, H 3013 **156** [11:10]
Tits, Andre, University of Maryland College Park
Tue.2, H 3025 **80** [13:40]
Toader, Bogdan, Oxford University
Thu.3, H 1012 172[c], **172** [14:20]
Toh, Kim-Chuan, National University of Singapore
Tue.1, H 3006 *64*
Tue.2, H 2013 **73** [13:15]
Tue.2, H 3004 *74*, *74*, *74*
Tue.3, H 1029 *88*
Tue.4, H 3004 *97*, *97*
Wed, 9:00, Plenary Talk, H 0105 15[c]
Wed.1, H 0110 *108*
Toint, Philippe L., University of Namur
Tue, 16:30, Memorial Session, H 0105 **15**
Wed.1, H 1012 **113** [11:55]
Wed.1, H 2053 *115*
Tovey, Robert, University of Cambridge
Tue.3, H 3007 **94** [15:10]
Tran-Dinh, Quoc, University of North Carolina at Chapel Hill
Mon.1, H 1029 43[c], 43[o]
Mon.2, H 1029 **54** [14:35]
Tue.1, H 1029 65[c], 65[o]
Tue.2, H 1029 76[o]
Tue.4, H 3004 *97*
Tret'yakov, Alexey, University of Podlasie in Siedlce
Thu.1, H 0106 **149** [9:00]
Thu.2, H 0106 *160*
Trichakis, Nikos, MIT
Thu.1, H 1058 152[c], 152[o], **152** [9:50]
Thu.3, H 3006 *172*
Tröltzsch, Fredi, Technische Universität Berlin
Mon.1, H 2013 47[o], **47** [11:00]
Mon.2, H 2013 58[c], 58[o]
Tue.1, H 0112 70[o]
Truden, Christian, Alpen-Adria-Universität Klagenfurt
Wed.1, H 0107 **110** [11:55]
Tsuchiya, Takashi, National Graduate Institute for Policy Studies
Wed.3, H 0111 **133** [16:25]
Tu, Stephen, UC Berkeley
Mon.2, H 0110 **61** [13:45]
Tuncel, Levent, University of Waterloo
Tue.3, H 3006 *87*
Tue.4, H 3006 **99** [16:30]
Ulbrich, Michael, Technical University of Munich
Mon.1, H 1028 *43*
Tue.1, H 0106 *69*
Wed.1, H 0106 *115*
Thu.1, H 2013 151[o]
Thu.2, H 2013 162[o]
Thu.3, H 2013 171[c], 171[o], *171*
Thu, 16:15, Plenary Talk, H 0105 **19**
Ulbrich, Stefan, TU Darmstadt
Tue.2, H 1012 *73*
Tue.3, H 0112 *93*, *93*
Wed.1, H 0112 *116*
Wed.1, H 3013 *109*
Wed.2, H 0111 *127*
Wed.2, H 0112 **128** [14:40]
Wed.3, H 0106 *139*
Thu.1, H 2013 151[o]
Thu.2, H 2013 162[o]
Thu.2, H 3012 *154*
Thu.2, H 3025 *159*
Thu.3, H 2013 171[o]
Thu, 15:15, Semi-Plenary Talk, H 0104 18[c]
Uribe, Cesar A, MIT
Wed.3, H 3002 132[c], 132[o], *132*, *132*
Uschmajew, André, Max Planck Institute for Mathematics in the Sciences
Wed.1, H 0105 113[c], 113[o]
Wed.2, H 0105 124[o]
Wed.3, H 1012 **137** [16:25]
Vaes, Julien, University of Oxford
Tue.4, H 1028 **96** [16:30]
Vaisbourd, Yakov, Tel Aviv University
Mon.1, H 1012 **49** [11:25]
Valkonen, Tuomo, Escuela Politécnica Nacional
Mon.2, H 0106 *58*
Tue.1, H 1029 **65** [11:20]
Van Barel, Andreas, KU Leuven
Thu.2, H 2013 **162** [11:35]
van Bloemen Waanders, Bart, Sandia National Laboratory
Tue.3, H 0112 *93*
Thu.1, H 2053 **150** [9:25]
van den Berg, Ewout, IBM T.J. Watson
Tue.4, H 1029 **99** [16:30]
Van Mai, Vien, KTH Royal Institue of Technology
Tue.1, H 1029 **65** [10:55]
Van Parys, Bart P.G., Massachusetts Institute of Technology
Thu.2, H 3006 **162** [11:10]
Vandenberghe, Lieven, UCLA
Tue.4, H 3006 *99*
Wed, 17:30, Semi-Plenary Talk, H 0104 **17**
Vandereycken, Bart, University of Geneva
Wed.1, H 0105 113[o]
Wed.2, H 0105 124[c], 124[o]
Vanli, Nuri, Massachusetts Institute of Technology
Tue.1, H 2053 67[c], 67[o], **67** [11:20]
Vannieuwenhoven, Nick, KU Leuven
Wed.1, H 0105 **113** [11:55]

Varvitsiotis, Antonios, National University of Singapore (NUS)
Thu.3, H 2033 **166** [13:30], *166*
Vayanos, Phebe, University of Southern California
Mon.2, H 1058 *59*
Thu.1, H 1058 **152** [9:25]
Veldt, Nate, Cornell University
Tue.1, H 3004 **63** [10:30]
Verma, Deepanshu, George Mason University
Wed.1, H 0112 **116** [11:30]
Vidal-Nunez, Jose, TU Chemnitz
Thu.1, H 0112 *151*
Thu.2, H 1029 159[c], **159** [11:35]
Vidanagamachchi, Sugandima Mihirani, University of Ruhuna
Thu.3, H 3004 **164** [13:30]
Vieira, Douglas, Enacom
Thu.2, H 3025 **159** [11:35]
Vielma, Juan Pablo, Massachusetts Institute of Technology
Mon.1, H 0111 41[c], 41[o], *41*
Mon.2, H 0111 52[c], 52[o], *52*
Vilches, Emilio, Universidad de O'Higgins
Wed.3, H 0107 **139** [16:00]
Viorel, Adrian, Tehnical University of Cluj-Napoca
Poster Session **24**
Vogt, Thomas, University of Lübeck
Thu.2, H 0112 **161** [11:10]
Vollmann, Christian, Trier University
Tue.4, H 0106 **102** [17:20]
Vorobyov, Sergiy A., Aalto University
Wed.1, H 3025 **107** [11:30]
Vorontsova, Evgeniya, Université Grenoble Alpes
Thu.1, H 3025 **147** [9:50]
Vu, Bang Cong, École Polytechnique Fédérale de Lausanne (EPFL)
Wed.1, H 1028 **111** [11:30]
Vuong, Phan Tu, University of Vienna
Tue.2, H 1029 **76** [14:05]
Thu.2, H 3013 *156*
Wachsmuth, Gerd, BTU Cottbus-Senftenberg
Wed.3, H 0106 **139** [16:00]
Wadbro, Eddie, Umeå University
Tue.1, H 0106 **69** [10:30]
Tue.4, H 0106 *102*
Wai, Hoi-To, CUHK
Mon.2, H 0110 **61** [14:10]
Walter, Anna, TU Darmstadt
Wed.1, H 3013 **109** [12:20]
Walter, Daniel, RICAM
Wed.1, H 0106 **115** [11:30]
Wang, Alex, Carnegie Mellon University
Thu.2, H 2032 **157** [11:10]
Wang, Chengjing, Southwest Jiaotong University
Wed.1, H 0110 **108** [11:30], *108*
Wang, Di, Georgia Institute of Technology
Tue.1, H 3004 63[o]
Wang, Fei, Royal Institute of Technology (KTH)
Thu.1, H 2033 146[c], **146** [9:25]
Wang, Hao, ShanghaiTech University
Wed.3, H 1029 **137** [16:50]
Wang, Jie, Peking University
Tue.1, H 2032 **64** [11:20]
Wang, Liping, Nanjing University of Aeronautics and Astronautics
Mon.2, H 1012 **60** [14:10]
Wang, Meihua, Xidian University
Poster Session **24**
Wang, Xiaoyu, Academy of Mathematics and Systems Science, Chinese Academy of Sciences
Tue.2, H 3007 **83** [13:40]
Wang, Yanfei, Chinese Academy of Sciences
Tue.2, H 3007 **83** [14:05]
Wang, Yuzhu, University of Tsukuba
Mon.1, H 0112 **42** [11:00]
Warma, Mahamadii, University of Puerto Rico, Rio Piedras Campus
Tue.4, H 0112 103[o], **103** [16:55]
Wed.1, H 0112 116[c], 116[o], *116*
Wei, Ke [canceled], Fudan University
Thu.3, H 0105 **164** [13:55]
Weinmann, Andreas, Hochschule Darmstadt
Thu.2, H 0112 **161** [10:45]
Weisser, Tillmann, Los Alamos National Laboratory
Mon.2, H 0111 **52** [14:35]
Weldeyesus, Alemseged Gebrehiwot, The University of Edinburgh
Wed.1, H 3004 *107*
Wed.2, H 3004 **119** [14:40]
Welker, Kathrin, Helmut-Schmidt-Universität Hamburg
Tue.1, H 0106 69[c], 69[o]
Tue.2, H 0106 81[o], **81** [13:40]
Tue.3, H 0106 92[o]
Tue.4, H 0106 102[c], 102[o]
Wen, Zaiwen, Peking University
Mon.2, H 1012 *60*
Tue.4, H 1029 99[o], *99*
Wiegele, Angelika, Alpen-Adria-Universität Klagenfurt
Tue.3, H 2032 86[c], 86[o], *86*
Thu.1, H 2032 **145** [9:00]
Wiesemann, Wolfram, Imperial College Business School
Mon.2, H 1058 *59*
Tue.1, H 1058 *70*
Tue.2, H 3012 *83*, *83*
Wed, 10:15, Semi-Plenary Talk, H 0105 16[c]
Wed.3, H 3004 *140*
Wed.3, H 3006 **141** [16:25]
Thu.2, H 3006 *162*
Wild, Stefan, Argonne National Laboratory
Mon.1, H 2038 44[o], *44*
Mon.2, H 0105 **55** [14:10]
Mon.2, H 2038 54[o]
Tue.1, H 2038 66[c], 66[o], *66*
Tue.2, H 2038 77[o]
Tue.3, H 2038 88[o]
Tue.4, H 2038 100[o]
Wed.1, H 2033 112[o]
Wed.2, H 2033 123[o]
Wed.3, H 2033 135[c], 135[o]
Thu.1, H 3025 147[o]
Winckler, Malte, University of Duisburg-Essen
Mon.2, H 2013 **58** [14:35]
Wirsching, Leonard, Heidelberg University
Mon.1, H 0107 **39** [11:25]
Wolenski, Peter, Louisiana State University
Wed.1, H 0111 **116** [11:55]
Wolkowicz, Henry, University of Waterloo
Tue.1, H 3025 *68*
Tue.2, H 2053 **79** [13:15]
Tue, 16:30, Memorial Session, H 0105 **15**
Wed.1, H 0107 *110*
Wong, Elizabeth, UC San Diego
Mon.1, H 2032 **45** [11:00]
Wylie, Calvin, Cornell University
Wed.2, H 1028 **122** [14:15]
Xiao, Lin, Microsoft Research

Tue.3, H 0105 **85** [15:35]
Xie, Jingui, University of Science and Technology of China
Wed.2, H 3006 **128** [14:40]
Xie, Yue, University of Wisconsin-Madison
Thu.1, H 1012 **152** [9:25]
Poster Session **24**
Xu, Fengmin, Xi'an Jiaotong University
Tue.1, H 3025 *68*
Wed.1, H 3012 118[c], 118[o], **118** [12:20]
Wed.2, H 3012 130[c], 130[o]
Wed.3, H 3012 142[c], 142[o]
Poster Session *24*
Xu, Guanglin [canceled],
Wed.1, H 3007 **117** [11:55]
Wed.2, H 3006 *128*
Xu, Yangyang, Rensselaer Poly. Institute
Mon.2, H 1029 54[o]
Tue.2, H 3006 **75** [14:05]
Thu.1, H 0104 149[o]
Thu.2, H 0104 160[c], 160[o]
Xu, Yifeng, Shanghai Normal University
Mon.1, H 2013 **47** [11:25]
Yamada, Isao, Tokyo Institute of Technology
Wed.2, H 1028 **122** [14:40]
Yamada, Syuuji, Niigata University
Wed.2, H 3008 124[c], **124** [15:05]
Yamashita, Makoto, Tokyo Institute of Technology
Mon.1, H 0112 42[c], 42[o], *42*
Tue.1, H 3006 64[o], **64** [11:20]
Yan, Zhenzhen, Nanyang Technological University
Tue.4, H 3012 **105** [16:30]
Wed.1, H 3007 **117** [11:30]
Yang, Lei, National University of Singapore
Tue.2, H 3004 **74** [14:05]
Yang, Minghan, Peking University
Tue.4, H 1029 **99** [16:55]
Yang, Tianbao, University of Iowa
Tue.2, H 1029 *76*
Wed.2, H 0107 *121*
Wed.2, H 0110 120[o]
Wed.3, H 0110 132[c], 132[o]
Thu.1, H 0104 **149** [9:25]
Yang, Yang, Fraunhofer ITWM
Wed.1, H 3025 **107** [11:55]
Yang, Zhuoran, Princeton University
Thu.2, H 0105 **155** [11:10]
Yanikoglu, Ihsan, Ozyegin University
Tue.2, H 3012 **83** [13:15]
Yashtini, Maryam, Georgetown University
Thu.2, H 1029 **159** [11:10]
Yin, Peng-Yeng, National Chi Nan University
Poster Session **25**
Yin, Wotao, University of California, Los Angeles
Wed.1, H 0104 108[c], 108[o]
Thu.1, H 0105 143[o], **143** [9:50]
Thu.3, H 1028 *167*
Ying, Yiming, SUNY Albany
Wed.2, H 0110 **120** [14:15]
Yoshise, Akiko, University of Tsukuba
Mon.1, H 0112 42[o], *42*, *42*
Tue.1, H 3006 64[c], 64[o]
Yousept, Irwin, University of Duisburg-Essen
Mon.1, H 2013 47[c], 47[o], *47*, **47** [11:50]
Mon.2, H 2013 58[o]
Tue.1, H 0112 70[c], 70[o]
Yu, Han, University of Southern California
Mon.2, H 1058 **59** [13:45]
Yu, Hao, Alibaba Group (U.S.) Inc
Thu.2, H 0104 **160** [10:45]
Yu, Huizhen, University of Alberta
Mon.1, H 0110 **49** [11:25]
Yu, Peiran, The Hong Kong Polytechnic University
Tue.2, H 3002 **77** [13:15]
Yuan, Yaxiang, State Key Laboratory of Scientific/Engineering Computing, Institute of Computational Mathematics and Scientific/Engineering Computing, Academy of Mathematics and Systems Science, Chinese Academy of Sciences
Mon.2, H 1012 **60** [13:45], *60*
Tue.2, H 3007 *83*
Tue.4, H 3007 *106*
Yue, Man-Chung, Imperial College London
Tue.1, H 1058 70[c], 70[o]
Tue.2, H 3012 83[c], 83[o]
Thu.2, H 3006 **162** [10:45]
Yuruk, Oguzhan, TU Braunschweig
Wed.1, H 2032 **110** [11:30]
Zeile, Clemens, Otto-von-Guericke University Magdeburg
Thu.1, H 2053 **150** [9:00]
Zemkoho, Alain, University of Southampton
Thu.2, H 3013 156[c], 156[o], **156** [11:35]
Thu.3, H 3013 165[c], 165[o]
Žerovnik, Janez, University of Ljubljana
Mon.1, H 3002 **40** [11:50]
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