2009 ISMP

20TH INTERNATIONAL SYMPOSIUM ON MATHEMATICAL PROGRAMMING

August 23-28, 2009
Chicago, Illinois, USA

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John R. Birge
Jerry W. and Carol Lee Levin
Professor of Operations Management

On behalf of the Organizing Committee and The University of Chicago, I welcome you to ISMP 2009, the 20th International Symposium on Mathematical Programming. This year we celebrate the 60th anniversary of the Zeroth ISMP, the meeting organized in Chicago by Tjalling Koopmans and the Cowles Commission that featured George Dantzig's presentation of the simplex method. Chicago and its renowned architecture once again form the backdrop of this year's symposium with venues in the heart of the city at the Chicago Booth School's Gleacher Center on the Chicago River and the Chicago Marriott Downtown Magnificent Mile on Michigan Avenue.

The Cowles Commission's inaugural event in 1949 included the presentation of 32 papers discussed among fewer than 50 participants. ISMP 2009 includes 1,050 invited and contributed research paper presentations, 14 plenary and semi-plenary talks, and more than 1,100 attendees. The topics span the entire range of theory, computational methods, and applications of mathematical programming.

I want to thank each of the sponsors of ISMP 2009 for making it possible for so many people to participate in and benefit from this assembly of the latest and greatest in optimization. I would also like to express my sincere appreciation to all of the many volunteers who made this meeting possible by organizing talks, sessions and thematic clusters. I wish to acknowledge, in particular, the members of the Program Committee for arranging an exceptional group of plenary and semi-plenary lectures and the Organizing Committee for their efforts in efficiently composing the scientific program, smoothly coordinating local arrangements, tightly connecting with our sponsors, and vividly presenting the image of ISMP 2009 to the outside world. I am also indebted to the INFORMS meetings staff for pulling together all of the many moving parts in this diffuse organizational array to operate as a single, well-oiled machine.

As you listen to discussions of new discoveries and novel applications for mathematical programming, I hope you will take a moment to reflect on all that the field has accomplished in the six decades since that first meeting and to consider how mathematical programming can contribute to society's future in the decades ahead. In addition to expanding your view of mathematical programming, I also hope you have a chance to extend other horizons by experiencing some of Chicago's cultural attractions, entertainment venues, parks, beaches and neighborhoods.

With my best wishes for a pleasing and rewarding time in Chicago and at ISMP 2009.

John R. Birge

John Birge
University of Chicago Booth School of Business

SUNDAY, AUGUST 23

3:00pm-9:00pm	Registration	M –Chicago Foyer, 5th Floor
6:00pm-7:30pm	Opening Session	Orchestra Hall, Chicago Symphony Center
	Buses depart from the Marriott (on Ohio Street, around the corner to the left from the Michigan Avenue exit, see map on page 9) to Chicago Symphony Center ***beginning at 5:30pm.*** *Some people may prefer to take the 15-minute walk; see map on page 9. Buses return to the Marriott for the reception immediately after the opening session.*	
8:00pm-9:30pm	Reception	M – Chicago Ballroom, 5th Floor

MONDAY, AUGUST 24

7:30am-5:00pm	Registration	M – Chicago Foyer, 5th Floor
8:30am-5:00pm	Exhibits	M – Chicago Foyer, 5th Floor
9:00am-9:50am	Plenary: Stephen Boyd	M – Chicago DE, 5th Floor
10:00am-10:30am	Coffee Break*	
10:30am-12:00pm	Technical Sessions (MA)	Marriott & Gleacher Center
12:00pm-1:00pm	COSP Meeting	G – Room 208
12:00pm-1:15pm	Lunch Break (on your own)	
1:15pm-2:45pm	Technical Sessions (MB)	Marriott & Gleacher Center
2:45pm-3:15pm	Coffee Break*	
3:15pm-4:45pm	Technical Sessions (MC)	Marriott & Gleacher Center
5:00pm-5:50pm	Semi-Plenary: Éva Tardos	M – Chicago D
5:00pm-5:50pm	Semi-Plenary: Mihai Anitescu	M – Chicago E
7:00pm-11:00pm	MPS Council Meeting	G – 420 South Lounge

TUESDAY, AUGUST 25

7:30am-5:00pm	Registration	M – Chicago Foyer, 5th Floor
8:30am-5:00pm	Exhibits	M – Chicago Foyer, 5th Floor
9:00am-9:50am	Plenary: Friedrich Eisenbrand	M – Chicago DE, 5th Floor
10:00am-10:30am	Coffee Break*	
10:30am-12:00pm	Technical Sessions (TA)	Marriott & Gleacher Center
12:00pm-1:15pm	Lunch Break (on your own)	
1:15pm-2:45pm	Technical Sessions (TB)	Marriott & Gleacher Center
2:45pm-3:15pm	Coffee Break*	
3:15pm-4:45pm	Technical Sessions (TC)	Marriott & Gleacher Center
5:00pm-5:50pm	Semi-Plenary: Martin Skutella	M – Chicago D
5:00pm-5:50pm	Semi-Plenary: Paul Tseng	M – Chicago E
6:15pm-7:15pm	MPS Business Meeting	M – Chicago D

NOTE:
Technical sessions are held at the Marriott Chicago Downtown and the Gleacher Center, University of Chicago. Check the Track Schedule on pages 17-21 for specific room locations.

KEY
M - Marriott
G - Gleacher Center

BADGES REQUIRED FOR TECHNICAL SESSIONS

ISMP 2009 badges must be worn to all sessions and events. Attendees without badges will be directed to the registration desk to register and pick up their badges. *All attendees, including speakers, cluster chairs and session chairs, must register and pay the registration fee.*

* COFFEE BREAKS

M – Chicago Foyer, 5th Floor
G – 220 South Lounge
250 North Lounge
320 South Lounge
350 North Lounge

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✱ COFFEE BREAKS

M – Chicago Foyer, 5th Floor
G – 220 South Lounge
250 North Lounge
320 South Lounge
350 North Lounge

WEDNESDAY, AUGUST 26

8:00am-5:00pm	Registration	M – Chicago Foyer, 5th Floor
8:30am-5:00pm	Exhibits	M – Chicago Foyer, 5th Floor
9:00am-9:50am	Plenary: Matteo Fischetti	M – Chicago DE, 5th Floor
10:00am-10:30am	Coffee Break*	
10:30am-12:00pm	Technical Sessions (WA)	Marriott & Gleacher Center
12:00pm-1:15pm	MP Editorial Luncheon	G - 320 South Lounge
12:00pm-1:15pm	Lunch Break (on your own)	
1:15pm-2:45pm	Technical Sessions (WB)	Marriott & Gleacher Center
2:45pm-3:15pm	Coffee Break*	
3:15pm-4:45pm	Technical Sessions (WC)	Marriott & Gleacher Center
5:00pm-5:50pm	Semi-Plenary: Shuzhong Zhang	M – Chicago D
5:00pm-5:50pm	Semi-Plenary: David Shmoys	M – Chicago E
7:00pm-10:00pm	Conference Banquet	Field Museum

Buses depart from the Marriott (on Ohio Street, around the corner to the left from the Michigan Avenue exit, see map on page 9) ***from 6:30pm-6:45pm.*** *Buses leave the museum to return to the Marriott beginning at 9:30pm, with the last bus leaving at 10:00pm.*

THURSDAY, AUGUST 27

8:00am-5:00pm	Registration	M – Chicago Foyer, 5th Floor
9:00am-9:50am	Plenary: Lars Peter Hansen	M – Chicago DE, 5th Floor
10:00am-10:30am	Coffee Break*	
10:30am-12:00pm	Technical Sessions (ThA)	Marriott & Gleacher Center
12:00pm-1:15pm	Lunch Break (on your own)	
1:15pm-2:45pm	Technical Sessions (ThB)	Marriott & Gleacher Center
2:45pm-3:15pm	Coffee Break*	
3:15pm-4:45pm	Technical Sessions (ThC)	Marriott & Gleacher Center
5:00pm-5:50pm	Semi-Plenary: Eddie Anderson	M – Chicago D
5:00pm-5:50pm	Semi-Plenary: Jong-Shi Pang	M – Chicago E

FRIDAY, AUGUST 28

8:00am-1:00pm	Registration	M – Chicago Foyer, 5th Floor
8:30am-9:20am	Plenary: Andrzej Ruszczyński	M – Chicago DE, 5th Floor
9:30am-10:00am	Coffee Break	M – Chicago Foyer, 5th Floor G – 220 South Lounge Rooms 222, 226, 230
10:00am-11:30am	Technical Sessions (FA)	Marriott & Gleacher Center
11:30am-1:00pm	Lunch Break (on your own)	
1:00pm-1:50pm	Plenary: Pablo Parrilo	M – Chicago D
2:00pm-3:30pm	Technical Sessions (FB)	Marriott & Gleacher Center

Thank You

NSF National Science Foundation
WHERE DISCOVERIES BEGIN

For support from the Division of Mathematical Sciences at NSF for travel of early career U.S. attendees to ISMP.

SPEAKER GUIDELINES

Audio-Visual Services

Please follow these guidelines to ensure a successful presentation. All session rooms will be equipped with a computer projector, but please note that you must bring your own laptop or pre-arrange to share with others in your session.

- Bring your laptop to your session. We strongly recommend that you pre-arrange with other speakers in your session to ensure that at least one of you brings a laptop from which you can project your talks.
- Please bring a power adaptor with you. We recommend that you do not attempt to run your presentation off the laptop battery.
- If your laptop is not compatible with AC power, please bring an electrical adaptor so that you can connect to U.S. electricity.
- If your laptop is a Mac, you will need the appropriate adapter for the external video output.
- Arrive at your session at least 15 minutes before it begins. All presenters in a session should set up and test the connection to the projector before the session begins.
- We encourage speakers to put their presentations on a USB stick.

Presentation Guidelines

The room and location of your session are listed in the Technical Sessions section of this program and in the Track Schedule. Please arrive at your session at least 15 minutes early for AV set-up and to check in with the session chair. Time your presentation to fit within your designated time span, leaving time for audience questions.

Program Information Desk

If you have general questions about the meeting and/or questions about your own presentation, stop at the Program Information Desk located in the Marriott. We ask Session Chairs to notify the Information Desk about any last-minute changes or cancellations; these changes will be posted outside the meeting rooms.

For Assistance During Your Session: Session Monitor Desks

Session Monitor Desks are located in several areas in the Marriott and Gleacher Center (see maps on pages 22-23 for specific locations). If you have a problem in your session room related to AV needs or any other requests, please go to the Session Monitor Desk in the area to ask for assistance.

SESSION CHAIR GUIDELINES

The role of the Chair is to coordinate the smooth running of the session and introduce each speaker. The chair begins and ends each session on time. Each session lasts 90 minutes, with equal time given to each paper.

REGISTRATION & GENERAL INFORMATION

Registration

Your registration fee includes admittance to the complete technical program and most special programs. The following social/food events are also included: Sunday evening reception, and all morning and afternoon coffee breaks. The Wednesday evening banquet requires a separate payment of $95.

Badges Required for Conference Sessions

ISMP badges must be worn to all sessions and events. Attendees without badges will be asked to go to the registration desk to register and pick up their badges. All attendees, including speakers and session chairs, must register and pay the registration fee.

Conference Banquet Tickets

The Wednesday evening banquet is open to attendees and guests who registered and paid in advance for tickets. The ticket(s) is included in your registration envelope. There may be a limited number of tickets available on site. Go to the ISMP registration desk to inquire. Tickets are $95.

Messages

The best way for people to reach you is to contact you directly at your hotel. Please leave your hotel phone number with your colleagues and family members. For urgent messages, call the Marriott at 312-836-0100 and ask for the ISMP registration desk. Registration staff will transcribe the message and post it on the message board located near registration. You can also contact colleagues attending the meeting using this message board. Please check the board periodically to see if you have received any messages.

Business Centers & Internet

The business center in the Marriott is located on the second floor. Hours of operation are Sunday, 9:00am-5:00pm; Monday-Friday, 7:00am-7:00pm. There is a small, self-serve business center in the Gleacher Center, Suite 540, 5th floor.

See page 7 for information on Internet access.

The Field Museum

SOCIAL EVENTS

Opening Ceremony & Reception - Orchestra Hall & Marriott Hotel
Sunday, August 23
6:00pm-9:30pm
Buses depart from the Marriott (on Ohio Street, around the corner to the left from the Michigan Avenue exit, see map on page 9) to Chicago Symphony Center ***beginning at 5:30pm.*** *Some people may prefer to take the 15-minute walk; see map on page 9.*

We welcome you to Chicago and ISMP 2009 with an opening ceremony at famed Orchestra Hall, followed by a reception at the Marriott Magnificent Mile. Orchestra Hall, home of the Chicago Symphony, is a national landmark building opened in 1904 and the site of thousands of performances by musical legends from Toscanini to B.B. King.

The welcome ceremony will feature the presentation of awards by the Mathematical Programming Society. In addition, the Midwest Young Artists Big Band will perform and narrate a program on Chicago jazz – a combination of history and performance that will introduce you to the city's unique musical heritage.

Following the ceremony, we invite you to enjoy the Welcome Reception, held at the Marriott Magnificent Mile Hotel. Bus transportation will be provided between the Marriott Hotel and Orchestra Hall. *Some people may prefer to take the 15-minute walk; see map on page 9.*

Thank You

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Conference Banquet - Field Museum
Wednesday, August 26
7:00pm-10:00pm
Buses depart from the Marriott (on Ohio Street, around the corner to the left from the Michigan Avenue exit, see map on page 9) ***from 6:30pm-6:45pm.***

A Chicago icon, the Field Museum is one of the premier natural history museums in the United States. Our banquet will take place in Stanley Field Hall, a stunning architectural space with gleaming marble interiors and "Sue," the largest, most complete and best preserved Tyrannosaurus Rex specimen in the world. Key exhibits will be open for our exclusive viewing, including The Ancient Americas, a new installation that tells the 13,000-year story of human life on the American continents. To cap a wonderful evening, you are invited to step out onto the Museum Terrace at 9:30pm for a great view of the fireworks off Navy Pier, compliments of the City of Chicago.

The banquet is open to attendees and guests who registered and paid in advance for tickets. The ticket(s) is included in your registration envelope. There may be a limited number of tickets available on site. Go to the ISMP registration desk to inquire. Tickets are $95.

Program Schedule:

6:30-6:45pm	Buses depart Marriott Hotel (on Ohio Street, around the corner to the left from the Michigan Ave. exit, see map on page 9).
7:00-8:00pm	Beverage reception; museum exhibits open for viewing.
8:00-9:30pm	Dinner in Stanley Field Hall.
9:30pm	Step out onto the Museum Terrace for a great view of the fireworks off Navy Pier.
9:30-10:00pm	Buses return to Marriott.

Thank You

GAMS

IBM

EXCURSIONS

Buses will leave at the beginning time listed for each tour, and will return at the ending time listed. Meet in the Marriott lobby. The tour guide will direct you to the bus (or the tour boat for the Monday river cruise).

Highlights of Chicago Tour – SOLD OUT
Sunday, August 23, 9:00am-1:00pm
$42 (lunch not included)

This all-encompassing tour covers the city's major features and architecture in the downtown area, north and south sides. The guided tour visits Chicago's major parks, including Grant, Lincoln and Millennium Park. Purchase lunch on your own at Navy Pier, Chicago's number one tourist attraction. The tour provides many scenic opportunities to view Lake Michigan, a fresh water, "inland sea" over 300-miles long and 100 miles wide.

Exclusive Guided Tour of the Art Institute: Masterpieces & Modern Wing Art Institute of Chicago
Sunday, August 23, 12:00pm-3:30pm
$75 (lunch not included)

Explore the Art Institute of Chicago on this exclusive, escorted tour featuring acclaimed masterpieces. The Art Institute is renowned for its medieval masterpieces and French Impressionist works. The tour guide will take requests from the group and include these in this exclusive tour. Open in May 2009, the Modern Wing features painters such as Picasso, Matisse and Magritte.

Architectural River Cruise
Monday, August 24, 9:15am-12:00pm
$39
(Meet in the Marriott Lobby. The tour guide will direct you to the tour boat.)

A tour boat on the Chicago River takes you past an array of great structures, including Lake Point Tower, Wrigley Building, IBM Building, NBC Tower, Tribune Tower, Civic Opera House, Sears Tower (now Willis Tower), Marina City, Board of Trade, and many more. An architectural docent will provide live narration featuring an overview of architecture and history, including some of the scandals and conflicts involved.

Frank Lloyd Wright in Oak Park– Exclusive Escorted Tour
Tuesday, August 25, 9:00am-1:00pm
$66 (lunch not included)

Visit the place where Frank Lloyd Wright, lacking both formal training and an academic degree, began a quiet movement in the Oak Park house he designed and built for a growing family. From this home, his imaginative art and daring designs became world famous. More than a century later, it ranks as America's most influential architectural expression. Specially trained architectural docents will conduct comprehensive, small group inspections of the residence, now fully restored to its original 1889 appearance. A second visit will be made to nearby Unity Temple, one of Wright's most daring works.

INTERNET ACCESS

Marriott
Complimentary wireless access is available in the lobby of the Marriott (no codes are needed). There is no wireless in the Marriott meeting rooms. For a daily rate of $14.95, Marriott guests can obtain high-speed Internet access and unlimited local phone calls in their rooms.

Gleacher Center
There is wireless in the Gleacher Center. The ID codes are as follows:

Monday	meeting-skim
Tuesday	meeting-rb8y
Wednesday	meeting r5yk
Thursday	meeting-qk7g
Friday	meeting-vaxa

There are three steps to connect to the University of Chicago wireless network:

- Enable your wireless adapter. The process of enabling wireless adapters varies. Consult your laptop documentation for instructions.
- Connect your wireless adapter to a "uchicago" wireless access point. Look for the wireless connection icon on your taskbar. Move your mouse pointer over the icon – if the hover tip indicates "uchicago" and "connected," you are connected to a wireless access point but your Internet connection is not enabled yet.
- Authenticate your meeting-id (from list above) – be sure you have the correct ID for that day. A new ID is required each day, the first time you connect, and will remain in your wireless connection settings until midnight, even in you power off your laptop.

Launch Internet Explorer. The Authentication page appears. If the authentication page does not appear type the following address in the address bar and click GO: www.uchicago.edu. Enter your meeting-id, using all lower case, in the CNetID box and ***leave the password box empty.***

Click Authenticate - the Welcome page appears. (If a pop-up is blocked prompt appears, click to enable the pop-up.) ***Do not click the logout button*** – doing so will disconnect you from the wireless network. Your wireless Internet connection is now fully enabled. Close the Welcome page by exiting Internet Explorer or type another address in the address bar and click GO.

OPENING CEREMONY

Sunday, August 23
6:00pm-7:30pm
Orchestra Hall, Chicago Symphony Center
Buses depart from the Marriott (on Ohio Street, around the corner to the left from the Michigan Avenue exit, see map on page 9) to Chicago Symphony Center ***beginning at 5:30pm.*** *Some people may prefer to take the 15-minute walk; see map on page 9.*

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The opening session will feature the presentation of awards by the Mathematical Programming Society. In addition, the Midwest Young Artists Big Band will perform and narrate a program on Chicago jazz - a combination of history and performance that will introduce you to the city's unique musical heritage. Midwest Young Artists, founded in 1993, offers training in jazz, choral, chamber music and orchestra for students from 7 to 18 years old. Leading the nation in chamber music instruction, MYA groups have won numerous medals in the prestigious Fischoff competition.

Following the opening ceremony, we invite you to enjoy the Welcome Reception at the Marriott Magnificent Mile Hotel. Bus transportation will be provided. Some people may prefer to take the 15-minute walk; *see map on page 9.*

SCHEDULE OF EVENTS

Welcome to 20th ISMP
John Birge, Chair, ISMP 2009

MPS Chair's Message
Stephen Wright, Chair, Mathematical Programming Society

Awarding of Prizes

- Dantzig Prize - for original research having a major impact on mathematical programming. Awarded by committee chair Jong-Shi Pang.
- Tucker Prize - for an outstanding thesis in mathematical programming. Announcement and presentation of finalists by committee chair Franz Rendl.
- Lagrange Prize in Continuous Optimization - for outstanding work in continuous optimization. Presentation by committee member Philippe Toint.
- Beale-Orchard-Hays Prize - for outstanding work in computational mathematical programming. Presentation by committee chair Nicholas Sahinidis.
- Fulkerson Prize - for outstanding papers in discrete mathematics. Recognition of Fulkerson family. Presentation by committee chair Bill Cook.

Midwest Young Artists Big Band
Chicago Jazz: a Musical History

Thank You

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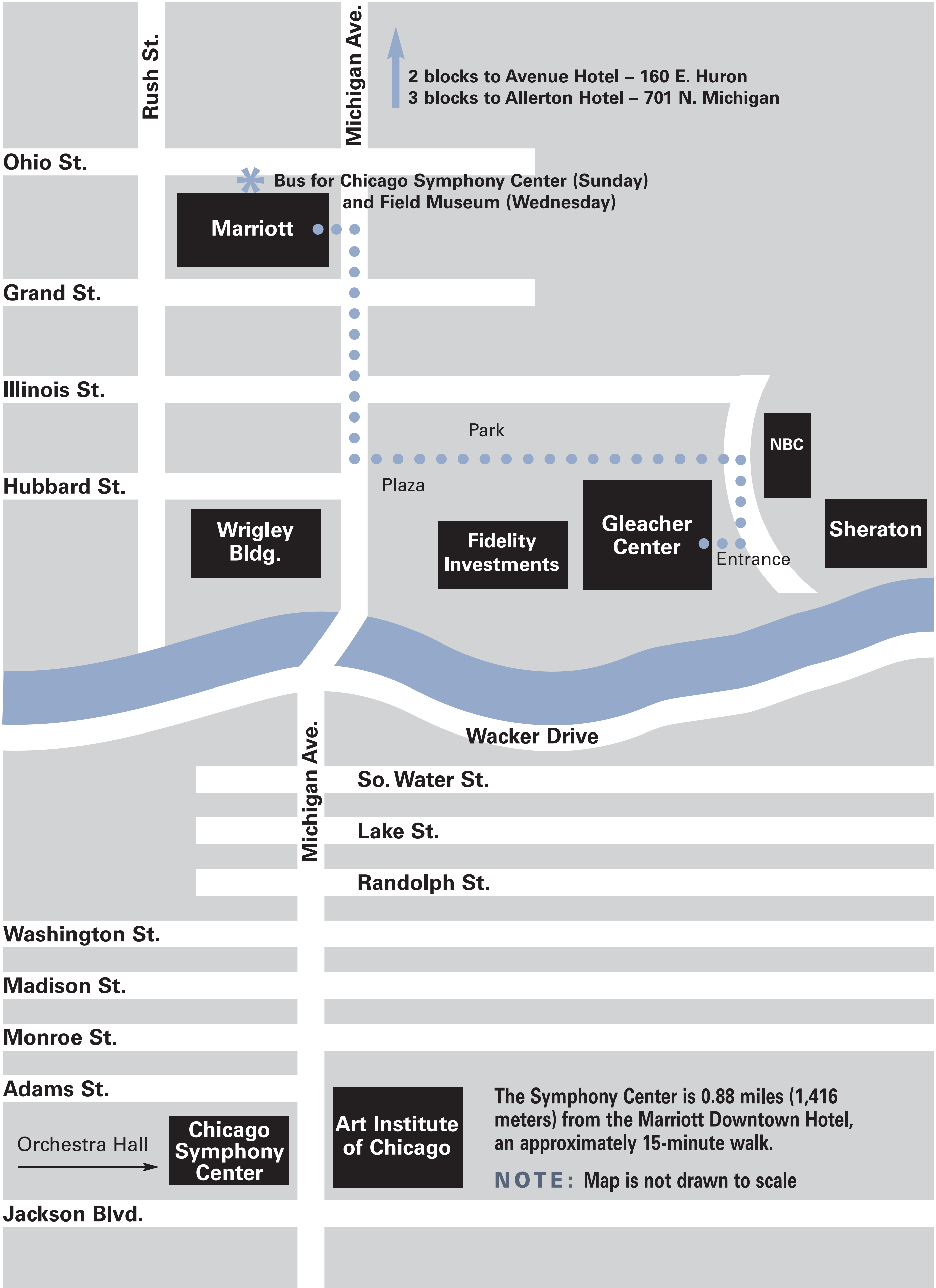
2009 ISMP

20TH INTERNATIONAL SYMPOSIUM ON MATHEMATICAL PROGRAMMING



The Symphony Center is 0.88 miles (1,416 meters) from the Marriott Downtown Hotel, an approximately 15-minute walk.

NOTE: Map is not drawn to scale

Exhibit Area
Marriott-Chicago Foyer, 5th Floor

Exhibit Hours
Mon.–Wed. 8:30am-5:00pm

AIMMS (Paragon Decision Technology)
5400 Carillon Point
Kirkland, WA 98033
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AIMMS is a solver independent development environment for building optimization (operations research) based solutions to support business decisions and/or research. AIMMS distinguishes itself from other optimization software through its advanced modeling concepts, the full interactive graphical user interface for developers, end-users and managers, as well as the variety of deployment options (including desktop, add-in, client-server and web services). Want to know more? Ask for a personal demo at our exhibit. New to AIMMS? Ask for a free trial CD at our exhibit, or go to www.aimms.com/trial. Educational user? Check out our attractive Educational Program, www.aimms.com/edu

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Mathematical Programming Society
3600 Market St, 6th Floor
Philadelphia, PA 19104-2688
www.mathprog.org
The Mathematical Programming Society is an international organization dedicated to the promotion and the maintenance of high professional standards in mathematical programming. MPS publishes the journals *Mathematical Programming A and B* and *Mathematical Programming Computation*; the MPS/SIAM *Series on Optimization*, and the newsletter *Optima*. The society awards a number of the most prestigious prizes in the field and is the primary sponsor of several of the most important conferences, including the International Symposium on Mathematical Programming (ISMP), the International Conference on Continuous Optimization (ICCOPT), and Integer Programming and Combinatorial Optimization (IPCO).

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Philadelphia, PA 19104
www.siam.org
Visit the SIAM display to browse through books in the MPS-SIAM *Series on Optimization* and other recently published and bestselling SIAM titles, all available at a 20-30% discount and with free shipping for onsite orders. Also available are sample issues of SIAM's renowned journals, including *SIOPT*, and information on becoming a SIAM member.

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COFFEE BREAKS

Monday-Thursday coffee breaks are located in:
Marriott - Chicago Foyer, 5th Floor
Gleacher Center - 220 South Lounge,
250 North Lounge,
320 South Lounge,
350 North Lounge

Friday coffee breaks are located in:
Marriott - Chicago Foyer, 5th Floor
Gleacher - 220 South Lounge,
Rooms 222, 226, 230

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MONDAY

PLENARY

9:00am-9:50am
Marriott, Chicago DE

Real-time Embedded Convex Optimization
Stephen P. Boyd
Samsung Professor of Engineering; Professor of Electrical Engineering
Stanford University, Information Systems Laboratory

This talk concerns the use of convex optimization, embedded as part of a larger system that executes automatically with newly arriving data, in areas such as automatic control, signal processing, real-time estimation, real-time resource allocation and decision making, and fast automated trading. We describe a code generation system that can generate solvers that can execute at the millisecond or microsecond time scale, by exploiting problem structure at code generation time.

Stephen P. Boyd received an AB degree in Mathematics from Harvard University in 1980, and a PhD in EECS from UC Berkeley in 1985. He is the author of many research articles and three books, and has received many awards and honors for his research in control systems engineering and optimization. In 1993 he was elected Distinguished Lecturer of the IEEE Control Systems Society, and in 1999, he was elected Fellow of the IEEE. In 1994 he received the Perrin Award for Outstanding Undergraduate Teaching in the School of Engineering, and he received the 2003 AACC Ragazzini Education award, for contributions to control education. His current research focus is on convex optimization applications in control, signal processing and circuit design.

SEMI-PLENARY

5:00pm-5:50pm
Marriott, Chicago D

Games in Networks: The Price of Anarchy, Stability, and Learning
Éva Tardos
Professor & Chair
Cornell University, Dept. of Computer Science

Network games are used to model selfish behavior in various domains. The price of anarchy compares Nash equilibria of a game to a centrally designed optimum, but says little about whether selfish players will coordinate on an equilibrium, nor which equilibrium they are likely to select if the game has more than one. Learning has been suggested as a natural model of players' behavior in games. In this talk, we consider the outcome of natural learning algorithms in a couple of simple games.

Éva Tardos received a Dipl. Math. in 1981, and a PhD in 1984 from Eötvös University, Budapest, Hungary. She is a member of the National Academy of Engineering and the American Academy of Arts and Sciences. Dr. Tardos received the George B. Dantzig Prize in 2006, and is an ACM Fellow. Her research interest focuses on the design and analysis of efficient methods for combinatorial-optimization problems on graphs or networks. She is working on problems that are related to the design, maintenance, and management of communication networks; problems that arise from vision. Her recent work focuses on algorithmic game theory, an emerging new area of designing systems and algorithms for selfish users. Dr. Tardos is most interested in network games and the price of anarchy.

SEMI-PLENARY

5:00pm-5:50pm
Marriott, Chicago E

The Challenge of Large-Scale Differential Variational Inequalities
Mihai Anitescu, Computational Mathematician
Argonne National Laboratory

Differential variational inequalities (DVIs) model some of the most challenging problems of modern science. An example is the most-manipulated material in industry after water: granular materials. After centuries of investigation, particle-by-particle simulation and experimentation are still the only widely applicable predictive tools. We demonstrate the excellent performance and predictive power of time-stepping schemes for solving the resulting large-scale DVIs, including on GPU architectures.

Mihai Anitescu is a Computational Mathematician, Mathematics and Computer Science Division, at Argonne National Laboratory. He received an MS in Electrical Engineering in 1992 from the Polytechnic University of Bucharest, Romania, and a PhD in Applied Mathematical and Computational Sciences from the University of Iowa in 1997. His areas of research interest include numerical optimization, numerical analysis, uncertainty quantification and multi-rigid body dynamics. Dr. Anitescu serves as an Associate Editor, *Mathematical Programming*, and Software Editor, *Optimization Methods and Software.*

TUESDAY

PLENARY

9:00am-9:50am
Marriott, Chicago DE

Algorithmic Geometry of Numbers and Integer Programming
Friedrich Eisenbrand, Professor
Ecole Polytechnique Fédérale de Lausanne

In this tutorial, I survey some classical results, recent developments and current trends from the interplay of integer programming, algorithms and complexity, and the geometry of numbers. I focus in particular on efficient algorithms for integer programming in fixed dimension (the quest for a linear-time algorithm), parametric integer programming and the complexity of some real-time periodic scheduling problems.

Friedrich Eisenbrand was a full professor of mathematics at the University of Paderborn before joining EPFL in March 2008. He received the Heinz Maier-Leibnitz award of the German Research Foundation (DFG) in 2004 and the Otto Hahn medal of the Max Planck Society in 2001. His main research interests lie in the field of discrete optimization, in particular in algorithms and complexity, integer programming, geometry of numbers, and applied optimization. Dr. Eisenbrand is best known for his work on efficient algorithms for integer programming in fixed dimension and the theory of cutting planes, which is an important tool to solve large-scale industrial optimization problems in practice.

SEMI-PLENARY

5:00pm-5:50pm
Marriott, Chicago D

Flows Over Time: Classical and More Recent Results
Martin Skutella, Professor
Technische Universität Berlin, Institut für Mathematik

Since the groundbreaking work of Ford and Fulkerson in the 1950s, the area of network flows has developed into many interesting directions. Network flows over time (also called "dynamic" network flows) form a particularly interesting area. They include a temporal dimension and therefore provide a more realistic modeling tool for numerous real-world applications. In this lecture, we give a survey of classical and more recent results on network flows over time.

Martin Skutella is a full professor of mathematics at TU Berlin and at the research center Matheon in Berlin. He received his PhD in Mathematics from TU Berlin in 1998. From 2003 to 2004 he was associate professor at the Max-Planck Institute for Computer Science before he moved to Dortmund University where he held the Chair of Discrete Optimization. His main research interests lie in the area of combinatorial optimization, in particular in network optimization and scheduling. Dr. Skutella is an associate editor of the journals *Mathematics of Operations Research, Operations Research Letters* (until 2008), *Networks*, and *Journal of Scheduling*. He is editor in chief of the *Notices of the German Mathematical Society*.

SEMI-PLENARY

5:00pm-5:50pm
Marriott, Chicago E

Approximations and Error Bounds for Structured Convex Optimization
Paul Tseng, Professor
University of Washington

Convex optimization problems arising in applications, possibly as approximations of intractable problems (e.g., sensor network localization, compressed sensing, regularized regression/denoising), are often structured and large scale. When the data are noisy, it is of interest to bound the solution error relative to the (unknown) true solution of the original noiseless problem. Such error bounds are also central to the convergence rate analysis of first-order methods for solving these problems.

Paul Tseng received a BSc from Queens University in 1981 and a PhD from Massachusetts Institute of Technology in 1986. After spending one year at the University of British Columbia and three years at Massachusetts Institute of Technology, he joined the faculty at the University of Washington in 1990. His research area is mainly in continuous optimization, with side interests in discrete optimization, distributed computation, network and graph algorithms.

WEDNESDAY

PLENARY

9:00am-9:50am
Marriott, Chicago DE

Pure Cutting Plane Methods for Integer Linear Programming: A Computational Perspective
Matteo Fischetti, Professor
University of Padova

Modern branch-and-cut methods for (mixed or pure) integer linear programs are heavily based on general-purpose cutting planes that are used to reduce the number of branching nodes needed to reach optimality. However, pure cutting plane methods alone are typically not used in practice, due to their poor convergence properties. Branching can be viewed as a symptomatic cure to the well-known drawbacks deriving from the use of a long sequence of cuts: saturation, bad numerical behavior, etc. From the cutting plane point of view, however, the cure is worse than the disease, in that it hides the real source of the troubles. Indeed, we believe that a deeper understanding of cut behavior can only be achieved if the cutting plane generation is pushed to its limit, i.e., if an important research effort is devoted to the design of a numerically stable pure cutting plane method–even if on most problems this approach is likely not to be competitive with enumerative methods. In this talk we address the main issues arising when designing a computationally sounded pure cutting plane method. In particular, we present a detailed computational analysis related to the massive dual degeneracy that pure cutting plane methods have to face when solving strongly NP-hard problems.

Matteo Fischetti received the Laurea in Ingegneria Elettronica (100/100 cum laude) in 1982 from the University of Bologna; he received a PhD degree (Dottorato di Ricerca in Ingegneria dei Sistemi) in 1987 from the University of Bologna. His research Interests include mixed integer programming, combinatorial optimization, vehicle routing and scheduling problems, graph theory, design and analysis of combinatorial algorithms, polyhedral combinatorics and 2-d nesting problems. Dr. Fischetti was a member of the 2008 Edelman Award winning team, the Netherlands Railways.

SEMI-PLENARY

5:00pm-5:50pm
Marriott, Chicago D

Approximation Algorithms for Homogeneous Polynomial Optimization with Quadratic Constraints
Shuzhong Zhang, Professor
The Chinese University of Hong Kong

We discuss approximation algorithms for optimizing a generic multi-variate homogeneous polynomial function, subject to homogeneous quadratic constraints. Such optimization models have wide applications. The problems under consideration are all NP-hard in general. We focus on the polynomial-time approximation algorithms and the worst-case performance ratios. Numerical experiments will be reported as well. Coauthors: Simai He and Zhening Li, The Chinese University of Hong Kong

Shuzhong Zhang received a BS in Mathematics from Fudan University in 1984 and a PhD from the Tinbergen Institute, Erasmus University in 1991. His research interests include optimization, operations research, mathematical programming, interior point methods, semidefinite programming, financial engineering and stochastic programming. He is an editorial board member on *Operations Research* and the *SIAM Journal on Optimization.*

SEMI-PLENARY

5:00pm-5:50pm
Marriott, Chicago E

Strong LP Formulations in the Design and Analysis of Approximation Algorithms
David Shmoys, Professor
Cornell University

The power of natural LP relaxations has long been the source of much progress in approximation algorithms. Combinatorially defined valid inequalities have led to great advances in computational IP, but had been used only rarely for approximation algorithms. We survey recent approximation results based on flow- and knapsack-cover inequalities for covering problems: LP-rounding methods of Levi, Lodi and Sviridenko, primal-dual results of Carnes and Shmoys, and a partial enumerative approach of Bienstock.

David Shmoys obtained his PhD in Computer Science from the University of California at Berkeley in 1984. He has faculty appointments in both the School of Operations Research and Information Engineering and the Department of Computer Science at Cornell University. His research has focused on the design and analysis of efficient algorithms for discrete optimization problems. His current work includes the application of discrete optimization techniques to several issues in computational biology, as well as in the development of approximation algorithms for stochastic models of clustering, inventory and related problems in logistics.

THURSDAY

PLENARY

9:00am-9:50am
Marriott, Chicago DE

Valuation in Dynamic Stochastic Economies
Lars Peter Hansen
Homer J. Livingston Distinguished Service Professor
University of Chicago

I explore the equilibrium value implications of economic models that incorporate reactions to a stochastic environment. I propose a dynamic value decomposition (DVD) designed to distinguish components of an underlying economic model that influence values over long horizons from components that impact only the short run. To quantify the role of parameter sensitivity and to impute long-term risk prices, I develop an associated perturbation technique. Finally, I use DVD methods to study formally some example economies and to speculate about others. A DVD is enabled by constructing operators indexed by the elapsed time between the date of pricing and the date of the future payoff. Thus formulated, methods from applied mathematics permit me to characterize valuation behavior as the time between price determination and payoff realization becomes large. An outcome of this analysis is the construction of a *multiplicative* martingale component of a process that is used to represent valuation in a dynamic economy with stochastic growth.

Lars Peter Hansen is an economist at the University of Chicago. He received a BS in Mathematics and Political Science (1974) from Utah State University and a PhD in Economics (1978) from the University of Minnesota, and is a member of the National Academy of Sciences. He is the co-winner of the Frisch Medal (with Kenneth Singleton in 1984), was awarded the Erwin Plein Nemmers Prize in Economics in 2006, and the CME Group-MSRI Prize in Innovative Quantitative Applications in 2008. Dr. Hansen is best known as the developer of the econometric technique GMM or generalized method of moments. His current research interests include pricing long run macroeconomic risk.

SEMI-PLENARY

5:00pm-5:50pm
Marriott, Chicago D

Supply Functions for Electricity Markets: The Priority of Optimization Over Equilibrium
Eddie Anderson, Professor
University of Sydney

This paper provides an introduction to the theory of supply functions, particularly as developed for electricity markets. It includes a brief review of work in this area over the last two decades. We will argue that a thorough understanding of the difficulties of finding optimal monotonic supply functions in a stochastic environment is helpful in attacking some of the difficulties that occur in looking for supply function equilibrium in an electricity market oligopoly. We will discuss both pay-as-bid and uniform price auction formats. We also briefly discuss some of the practical difficulties of applying this theory, arising from: networks and demand correlation, implicit collusion, and the non-existence of an equilibrium.

Eddie Anderson has an honours degree in Mathematics and a PhD in Engineering from the University of Cambridge. His recent research has looked at the problems of optimal decisions in a stochastic environment, for example when firms bid in auctions or decide on investments. He also uses game theory to investigate equilibrium outcomes. Dr. Anderson has published three books and over 50 papers in international academic journals. His recent research on the behavior of participants in electricity markets, such as the NEM in Australia, has been supported by two ARC Discovery grants.

SEMI-PLENARY

5:00pm-5:50pm
Marriott, Chicago E

Some Paths in Mathematical Programming
Jong-Shi Pang, Caterpillar Professor and Head of the Department of Industrial and Enterprise Systems Engineering
University of Illinois at Urbana-Champaign

Celebrating the sixtieth anniversary since the Zeroth International Symposium on Mathematical Programming in 1949, this paper discusses several recent paradigms in mathematical programming: competition, dynamics, hierarchy and inverse problems. The discussion emphasizes the interplay between these paradigms and their connections with existing subfields. We will describe the modeling approaches and formulations of these paradigms, provide state-of-the-art summaries of existing results, and identify open mathematical and computational challenges arising from the resulting optimization and equilibrium problems.

Jong-Shi Pang received a PhD in Operations Research from Stanford University in 1976 and joined the University of Illinois at Urbana-Champaign in August 2007. He was a winner of the 2003 George B. Dantzig Prize awarded jointly by MPS and SIAM for his work on finite-dimensional variational inequalities, and a co-winner of the 1994 Frederick W. Lanchester Prize awarded by INFORMS. Some of his most recent research topics include: the novel subject of differential variational inequalities, nonsmooth dynamical systems, the global solution of certain nonconvex optimization problems with disjunctive constraints, frictional contact problems and their optimization, dynamic traffic equilibrium problems, game-theoretic models in communication networks, electricity markets and supply chain systems.

FRIDAY

PLENARY

8:30am-9:20am
Marriott, Chicago DE

Risk-Averse Optimization
Andrzej Ruszczyński, Professor
Rutgers University, Dept. of Management Science and Information Systems

We shall discuss ways to model risk aversion in stochastic optimization problems: utility theory, risk measures, and stochastic dominance constraints. We shall review optimality and duality theory for the resulting risk-averse optimization problems. Particular attention will be paid to dynamic problems, for which we shall outline our new theory of risk-averse dynamic programming. Finally, we shall sketch ideas of numerical methods of risk-averse optimization.

Andrzej Ruszczyński received a PhD from the Warsaw University of Technology. He is author of numerous publications in operations research and applied mathematics journals such as *Mathematical Programming, Mathematics of Operations Research* and *Operations Research*, and is chairman of the Stochastic Programming Committee of the Mathematical Programming Society. Dr. Ruszczynski's interests are in the theory, numerical methods and applications of stochastic optimization.

PLENARY

1:00pm-1:50pm
Marriott, Chicago D

The Convex Algebraic Geometry of Rank Minimization
Pablo A. Parrilo, Finmeccanica Career Development Professor of Engineering at the Department of Electrical Engineering and Computer Science
Massachusetts Institute of Technology

Optimization problems involving ranks of matrices are of great importance in applied mathematics and engineering. They provide a rich and fruitful interaction between algebraic-geometric concepts and convex optimization, with strong synergies with popular techniques for sparsity minimization like compressed sensing. In this lecture we will provide a gentle introduction to this exciting research area, highlighting key geometric concepts as well as a survey of recent developments and algorithms

Pablo A. Parrilo received a PhD in Control and Dynamical Systems from the California Institute of Technology in 2000. He is the recipient of the 2005 Donald P. Eckman Award of the American Automatic Control Council, as well as the 2005 SIAM Activity Group on Control and Systems Theory (SIAG/CST) Prize. His research interests include optimization methods for engineering applications, control and identification of uncertain complex systems, robustness analysis and synthesis, and the development and application of computational tools based on convex optimization and algorithmic algebra to practically relevant engineering problems.

Track	Room	Plenary 9:00–9:50	MA 10:30-12:00	MB 1:15-2:45	MC 3:15-4:45	Semi-Plenaries 5:00-5:50
1	M - Chicago A		Approximation Algorithms	Approximation Algorithms	Approximation Algorithms	
2	M - Chicago B		Complementarity Problems & Variational Inequalities	Complementarity Problems & Variational Inequalities	Complementarity Problems & Variational Inequalities	
3	M - Chicago C		Complementarity Problems & Variational Inequalities	Complementarity Problems & Variational Inequalities	Complementarity Problems & Variational Inequalities	
4	M - Denver		Combinatorial Optimization	Combinatorial Optimization	Combinatorial Optimization	
5	M - Houston		Conic Optimization	Conic Optimization	Conic Optimization	
6	M - Kansas City		Conic Programming	Conic Programming	Conic Programming	
7	M - Chicago D		Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	
8	M - Chicago E	Stephen Boyd	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Éva Tardos
9	M - Chicago F	Marriott	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Marriott
10	M - Chicago G	Chicago D E	Global Optimization	Global Optimization	Global Optimization	Chicago D
11	M - Chicago H	5th Floor	Global Optimization	Global Optimization	Global Optimization	5th Floor
12	M - Los Angeles		Derivative-free & Simulation-based Optimization	Derivative-free & Simulation-based Optimization	Derivative-free & Simulation-based Optimization	
13	M - Miami		Optimization in Energy Systems	Optimization in Energy Systems	Optimization in Energy Systems	Mihai Anitescu
14	M - Scottsdale		Game Theory	Game Theory	Game Theory	Marriott
15	G - 100		No Session	No Session	No Session	Chicago E
16	G - 200		Stochastic Optimization	Stochastic Optimization	Stochastic Optimization	5th Floor
17	G - 204		Logistics & Transportation	Logistics & Transportation	Logistics & Transportation	
18	G - 206		Nonlinear Mixed Integer Programming	Nonlinear Mixed Integer Programming	Nonlinear Mixed Integer Programming	
19	G - 208		Telecommunications & Networks	Stochastic Optimization	Stochastic Optimization	
20	G - 300		Nonlinear Programming	Nonlinear Programming	Nonlinear Programming	
21	G - 304		Telecommunications & Networks	Telecommunications & Networks	Telecommunications & Networks	
22	G - 306		Implementations, Software	Implementations, Software	Implementations, Software	
23	G - 308		No Session	No Session	No Session	
24	G - 400		Telecommunications & Networks	Telecommunications & Networks	Telecommunications & Networks	
25	G - 404		Variational Analysis	Variational Analysis	Variational Analysis	
26	G - 406		Portfolio & Option Problems	Portfolio & Option Problems	Portfolio & Option Problems	
27	G - 408		Variational Analysis	Variational Analysis	Variational Analysis	
28	G - 600		No Session	No Session	No Session	
29	G - 602		No Session	No Session	No Session	

M – Marriott
G – Gleacher Center

Track	Room	Plenary 9:00–9:50	TA 10:30-12:00	TB 1:15-2:45	TC 3:15-4:45	Semi-Plenaries 5:00-5:50
1	M - Chicago A		Approximation Algorithms	Approximation Algorithms	Approximation Algorithms	
2	M - Chicago B		Complementarity Problems & Variational Inequalities	Complementarity Problems & Variational Inequalities	Complementarity Problems & Variational Inequalities	
3	M - Chicago C		Complementarity Problems & Variational Inequalities	Complementarity Problems & Variational Inequalities	Complementarity Problems & Variational Inequalities	
4	M - Denver		Combinatorial Optimization	Combinatorial Optimization	Combinatorial Optimization	
5	M - Houston		Combinatorial Optimization	Combinatorial Optimization	Combinatorial Optimization	
6	M - Kansas City		Conic Programming	Conic Programming	Conic Programming	
7	M - Chicago D		Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	
8	M - Chicago E	Friedrich Eisenbrand	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Martin Skutella
9	M - Chicago F	Marriott	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Marriott
10	M - Chicago G	Chicago D E	Global Optimization	Global Optimization	Global Optimization	Chicago D
11	M - Chicago H	5th Floor	Global Optimization	Global Optimization	Global Optimization	5th Floor
12	M - Los Angeles		Derivative-free & Simulation-based Optimization	Derivative-free & Simulation-based Optimization	Derivative-free & Simulation-based Optimization	
13	M - Miami		Optimization in Energy Systems	Optimization in Energy Systems	Optimization in Energy Systems	Paul Tseng
14	M - Scottsdale		Game Theory	Game Theory	Game Theory	Marriott
15	G - 100		Stochastic Optimization	Stochastic Optimization	Stochastic Optimization	Chicago E
16	G - 200		Stochastic Optimization	Stochastic Optimization	Stochastic Optimization	5th Floor
17	G - 204		Logistics & Transportation	Logistics & Transportation	Logistics & Transportation	
18	G - 206		Nonlinear Mixed Integer Programming	Nonlinear Mixed Integer Programming	Nonlinear Mixed Integer Programming	
19	G - 208		Nonlinear Programming	Nonlinear Programming	Nonlinear Programming	
20	G - 300		Nonlinear Programming	Nonlinear Programming	Nonlinear Programming	
21	G - 304		Telecommunications & Networks	Telecommunications & Networks	Telecommunications & Networks	
22	G - 306		Implementations, Software	Implementations, Software	Implementations, Software	
23	G - 308		Sparse Optimization	Sparse Optimization	Sparse Optimization	
24	G - 400		No Session	No Session	No Session	
25	G - 404		Variational Analysis	Variational Analysis	Variational Analysis	
26	G - 406		No Session	No Session	No Session	
27	G - 408		Variational Analysis	Variational Analysis	Variational Analysis	
28	G - 600		Nonsmooth & Convex Optimization	Nonsmooth & Convex Optimization	Nonsmooth & Convex Optimization	
29	G - 602		No Session	No Session	No Session	

Track	Room	Plenary 9:00–9:50	WA 10:30-12:00	WB 1:15-2:45	WC 3:15-4:45	Semi-Plenaries 5:00-5:50
1	M - Chicago A		Approximation Algorithms	Approximation Algorithms	Approximation Algorithms	
2	M - Chicago B		Complementarity Problems & Variational Inequalities	Complementarity Problems & Variational Inequalities	Complementarity Problems & Variational Inequalities	
3	M - Chicago C		Complementarity Problems & Variational Inequalities	Global Optimization	Optimization in Energy Systems	
4	M - Denver		Combinatorial Optimization	Combinatorial Optimization	Combinatorial Optimization	
5	M - Houston		Combinatorial Optimization	Combinatorial Optimization	Complementarity Problems & Variational Inequalities	
6	M - Kansas City		Conic Programming	Conic Programming	Conic Programming	
7	M - Chicago D		Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	
8	M - Chicago E	Matteo Fischetti	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Shuzhong Zhang
9	M - Chicago F	Marriott	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Marriott
10	M - Chicago G	Chicago D E	Global Optimization	Global Optimization	Global Optimization	Chicago D
11	M - Chicago H	5th Floor	Global Optimization	Robust Optimization	Robust Optimization	5th Floor
12	M - Los Angeles		Derivative-free & Simulation-based Optimization	PDE-Constrained Optimization	PDE-Constrained Optimization	
13	M - Miami		Optimization in Energy Systems	Optimization in Energy Systems	Optimization in Energy Systems	David Shmoys
14	M - Scottsdale		Game Theory	Game Theory	Game Theory	Marriott
15	G - 100		Stochastic Optimization	Stochastic Optimization	Stochastic Optimization	Chicago E
16	G - 200		Stochastic Optimization	Stochastic Optimization	Stochastic Optimization	5th Floor
17	G - 204		Logistics & Transportation	Logistics & Transportation	Logistics & Transportation	
18	G - 206		Nonlinear Mixed Integer Programming	Nonlinear Mixed Integer Programming	Nonlinear Mixed Integer Programming	
19	G - 208		Nonlinear Programming	Nonlinear Programming	Multicriteria & Global Optimization	
20	G - 300		Nonlinear Programming	Nonlinear Programming	Nonlinear Programming	
21	G - 304		Telecommunications & Networks	Telecommunications & Networks	Telecommunications & Networks	
22	G - 306		Implementations, Software	Implementations, Software	Implementations, Software	
23	G - 308		Sparse Optimization	Sparse Optimization	Sparse Optimization	
24	G - 400		No Session	No Session	No Session	
25	G - 404		Variational Analysis	Variational Analysis	Variational Analysis	
26	G - 406		No Session	No Session	No Session	
27	G - 408		No Session	No Session	No Session	
28	G - 600		Nonsmooth & Convex Optimization	Nonsmooth & Convex Optimization	Nonsmooth & Convex Optimization	
29	G - 602		Finance & Economics	Finance & Economics	Finance & Economics	

Track Schedule – THURSDAY

M – Marriott
G – Gleacher Center

Track	Room	Plenary 9:00–9:50	ThA 10:30-12:00	ThB 1:15-2:45	ThC 3:15-4:45	Semi-Plenaries 5:00-5:50
1	M - Chicago A		Approximation Algorithms	Approximation Algorithms	Approximation Algorithms	
2	M - Chicago B		Complementarity Problems & Variational Inequalities	Complementarity Problems & Variational Inequalities	Complementarity Problems & Variational Inequalities	
3	M - Chicago C		Optimization in Energy Systems	Optimization in Energy Systems	Optimization in Energy Systems	
4	M - Denver		Combinatorial Optimization	Combinatorial Optimization	Combinatorial Optimization	
5	M - Houston		Combinatorial Optimization	Combinatorial Optimization	Combinatorial Optimization	
6	M - Kansas City		Conic Programming	Conic Programming	Conic Programming	
7	M - Chicago D		Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	
8	M - Chicago E	Lars Peter Hansen	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Eddie Anderson
9	M - Chicago F	Marriott	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Integer & Mixed Integer Programming	Marriott
10	M - Chicago G	Chicago D E	Global Optimization	Global Optimization	Global Optimization	Chicago D
11	M - Chicago H	5th Floor	Robust Optimization	Robust Optimization	Robust Optimization	5th Floor
12	M - Los Angeles		PDE-Constrained Optimization	PDE-Constrained Optimization	PDE-Constrained Optimization	
13	M - Miami		Optimization in Energy Systems	Optimization in Energy Systems	Optimization in Energy Systems	Jong-Shi Pang
14	M - Scottsdale		No Session	Game Theory	Game Theory	Marriott
15	G - 100		Stochastic Optimization	Stochastic Optimization	Stochastic Optimization	Chicago E
16	G - 200		Stochastic Optimization	Stochastic Optimization	Stochastic Optimization	5th Floor
17	G - 204		Logistics & Transportation	Logistics & Transportation	Logistics & Transportation	
18	G - 206		Nonlinear Mixed Integer Programming	Nonlinear Mixed Integer Programming	Nonlinear Mixed Integer Programming	
19	G - 208		Nonlinear Mixed Integer Programming	Nonlinear Mixed Integer Programming	Stochastic Optimization	
20	G - 300		Nonlinear Programming	Nonlinear Programming	Nonlinear Programming	
21	G - 304		Telecommunications & Networks	Telecommunications & Networks	Telecommunications & Networks	
22	G - 306		Implementations, Software	Implementations, Software	Optimization in Energy Systems	
23	G - 308		Sparse Optimization	Sparse Optimization	Sparse Optimization	
24	G - 400		No Session	No Session	No Session	
25	G - 404		Variational Analysis	Variational Analysis	Variational Analysis	
26	G - 406		No Session	No Session	No Session	
27	G - 408		No Session	No Session	No Session	
28	G - 600		Nonsmooth & Convex Optimization	Nonsmooth & Convex Optimization	Nonsmooth & Convex Optimization	
29	G - 602		Finance & Economics	No Session	No Session	

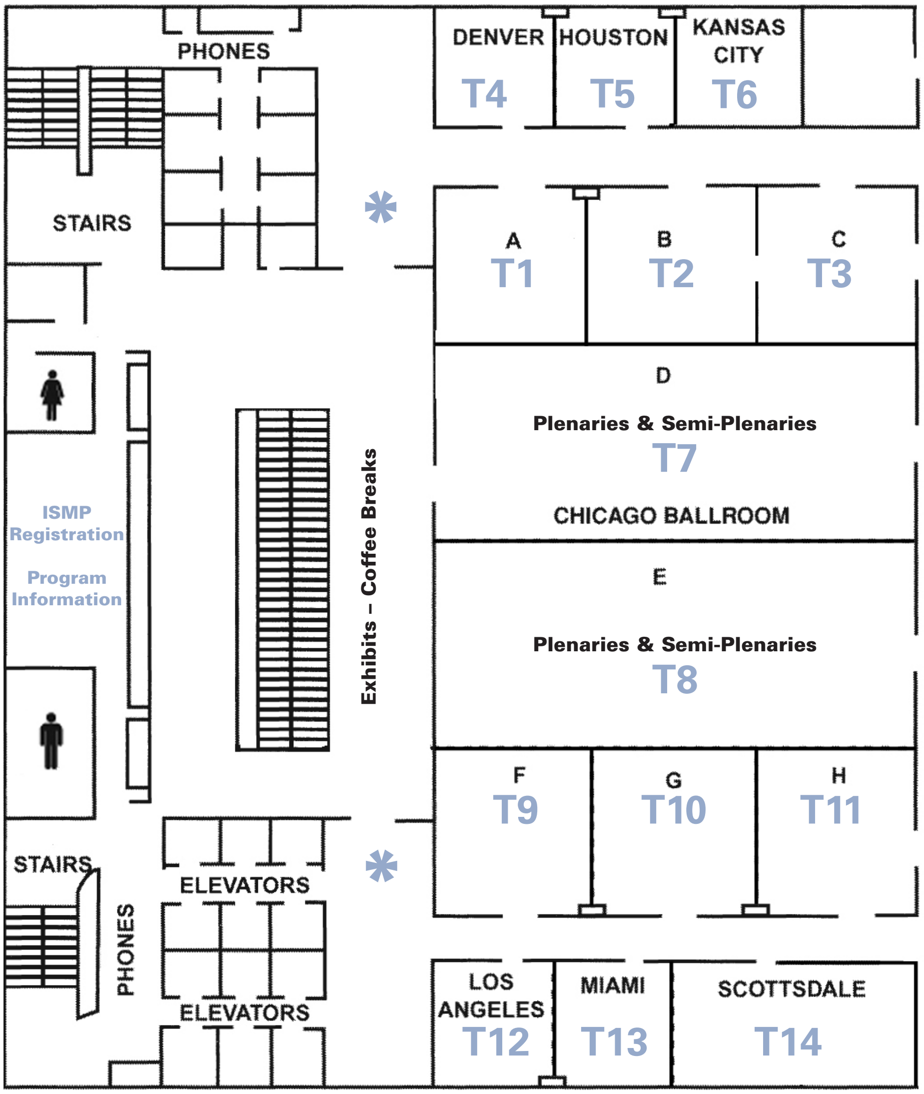
Track	Room	Plenary 8:30–9:20	FA 10:00-11:30	Plenary 1:00-1:50	FB 2:00-3:30
1	M - Chicago A		Approximation Algorithms		Linear Algorithms
2	M - Chicago B		Complementarity Problems & Variational Inequalities		Discrete Optimization
3	M - Chicago C		Optimization in Energy Systems		Optimization in Energy Systems
4	M - Denver		Combinatorial Optimization		Combinatorial Optimization
5	M - Houston		No Session		Combinatorial Optimization
6	M - Kansas City		Conic Programming		Conic Programming
7	M - Chicago D		Integer & Mixed Integer Programming		Integer & Mixed Integer Programming
8	M - Chicago E	Andrzej Ruszczyński	Integer & Mixed Integer Programming	Pablo Parrilo	Integer & Mixed Integer Programming
9	M - Chicago F	Marriott	Integer & Mixed Integer Programming	Marriott	Integer & Mixed Integer Programming
10	M - Chicago G	Chicago D E	Global Optimization	Chicago D	Global Optimization
11	M - Chicago H	5th Floor	Robust Optimization	5th Floor	Robust Optimization
12	M - Los Angeles		PDE-Constrained Optimization		PDE-Constrained Optimization
13	M - Miami		No Session		Derivative-Free & Simulation-Based Optimization
14	M - Scottsdale		PDE-Constrained Optimization		Game Theory
15	G - 100		Stochastic Optimization		Stochastic Optimization
16	G - 200		Stochastic Optimization		Stochastic Optimization
17	G - 204		Logistics & Transportation		Logistics & Transportation
18	G - 206		Nonlinear Mixed Integer Programming		Nonlinear Mixed Integer Programming
19	G - 208		Nonlinear Programming		No Session
20	G - 300		Nonlinear Programming		Nonlinear Programming
21	G - 304		Telecommunications & Networks		Telecommunications & Networks
22	G - 306		Implementations, Software		No Session
23	G - 308		Sparse Optimization		No Session
24	G - 400		No Session		No Session
25	G - 404		Variational Analysis		Variational Analysis
26	G - 406		No Session		No Session
27	G - 408		No Session		No Session
28	G - 600		No Session		No Session
29	G - 602		No Session		No Session

FLOOR 5

TRACKS

1-14

✱ Session Monitor Desk



FLOOR 1

TRACK

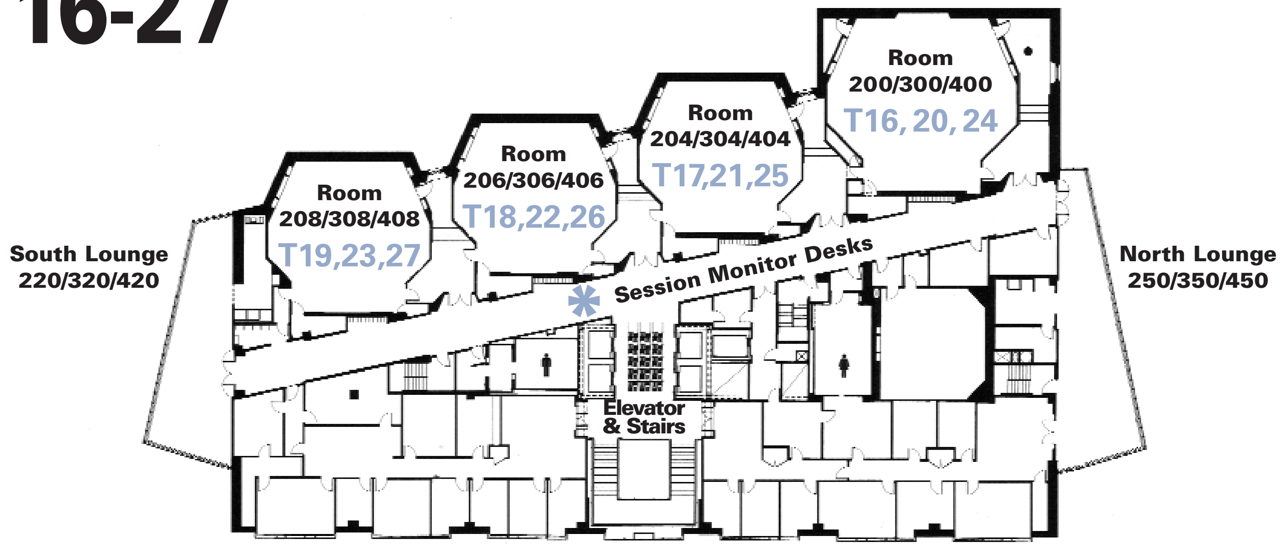
15

Follow signs to Room 100

FLOOR 2, 3 & 4

TRACKS

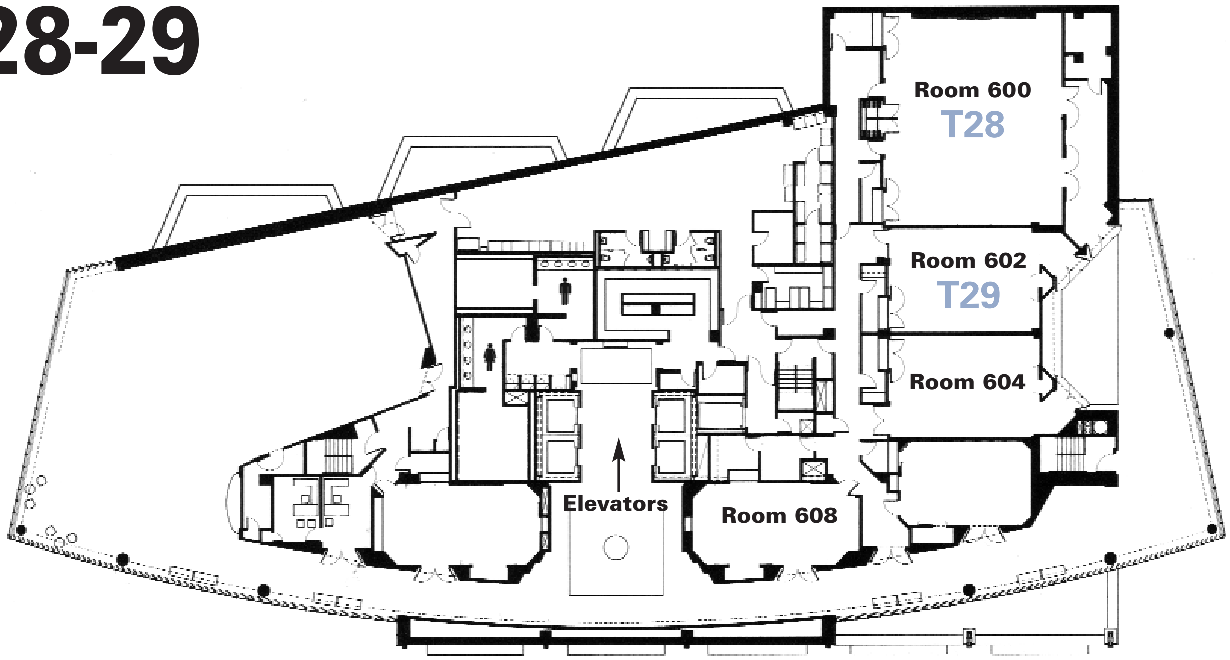
16-27



FLOOR 6

TRACKS

28-29



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How to Navigate the Technical Sessions

There are three primary resources to help you understand and navigate the Technical Sessions:

- This Technical Session listing, which provides the most detailed information. The listing is presented chronologically by day/time, showing each session and the papers/abstracts/authors within each session.
- The Session Chair, Author, and Session indices provide cross-reference assistance (pages 137-150).
- The Track Schedule is on pages 17-21. This is an overview of the tracks (general topic areas) and when/where they are scheduled.

Quickest Way to Find Your Own Session

Use the Author Index (pages 139-145) — the session code for your presentation(s) will be shown along with the track number. You can also refer to the full session listing for the room location of your session(s).

The Session Codes

SB01

Track number. Coordinates with the room locations shown in the Track Schedule. Room locations are also indicated in the listing for each session.

Time Block. Matches the time blocks shown in the Track Schedule.

The day of the week

Time Blocks

Monday-Thursday
A - 10:30am – 12:00pm
B - 1:15pm - 2:45pm
C - 3:15pm - 4:45pm

Friday
A - 10:00am – 11:30am
B - 2:00pm - 3:30pm

Room Locations/Tracks

All tracks and technical session are held in the Chicago Marriott Downtown Magnificent Mile and the Gleacher Center. Room numbers are shown on the Track Schedule and in the technical session listing.

Monday, 10:30am - 12:00pm

■ MA01

Marriott - Chicago A

Approximation Algorithms I

Cluster: Approximation Algorithms
Invited Session

Chair: Cliff Stein, Columbia University, 326 S W Mudd Building, 500 W. 120th Street, New York, NY, 10027, cliff@ieor.columbia.edu

1 - Spectral Methods, Semidefinite Programming and Approximation

Satish Rao, UC Berkeley, Soda Hall, UC Berkeley, Berkeley, CA, 94705, United States of America, satishr@eecs.berkeley.edu

Semidefinite programming has been used recently to give approximations algorithms with better approximation bounds and suprisingly that are faster. We will discuss these advances for the sparsest cut problem. We will also give some intuition as to the power of these approaches.

2 - Packing Multiway Cuts in Capacitated Graphs

Shuchi Chawla, University of Wisconsin-Madison, 1210 W. Dayton St Computer Science, UW M, Madison, 53706, United States of America, shuchi@cs.wisc.edu

We study the following multiway cut packing problem: given k commodities, each corresponding to a set of terminals, our goal is to produce a collection of cuts {E_1, ...,E_k} such that E_i is a multiway cut for commodity i and the maximum load on any edge is minimized. Multiway cut packing arises in the context of graph labeling. We present the first constant factor approx in arbitrary undirected graphs, based on the observation that there always exists a near-optimal laminar solution.

3 - The Rank Aggregation Problem

David Williamson, Professor, Cornell University, 236 Rhodes Hall, Ithaca, NY, 14850, United States of America, dpw@cs.cornell.edu, Anke van Zuylen

The rank aggregation problem was introduced by Dwork, Kumar, Naor, and Sivakumar in the context of finding good rankings of web pages by drawing on multiple input rankings from various search engines. I will give an overview of the rank aggregation problem and some of its applications. I will also cover recent work done on finding good approximation algorithms for the problem, and recent experimental work of these various algorithms in practice.

■ MA02

Marriott - Chicago B

Complementarity and Related Topics in Euclidean Jordan Algebras

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Seetharama Gowda, Professor of Mathematics, University of Maryland-Baltimore County, 1000 Hilltop Circle, Baltimore, MD, 21250, United States of America, gowda@math.umbc.edu

1 - A Proximal Point Method for Matrix Least Squares Problem with Nuclear Norm Regularization

Defeng Sun, Associate Professor, National University of Singapore, Department of Mathematics, 2, Science Drive 2, Singapore, 117543, Singapore, matsundf@nus.edu.sg, Kaifeng Jiang, Kim-Chuan Toh

We consider a Newton-CG proximal point method for solving matrix least squares problem with nuclear norm regularization. For the symmetric problem in which the matrix variable is symmetric, the proximal point method is the same as the augmented Lagrangian method applied to the dual problem. For the inner problems in the non-symmetric problem, we show that the soft thresholding operator is strongly semi-smooth everywhere, which is a key property for successfully applying semi-smooth Newton-CG method to solve the inner problems. Numerical experiments on a variety of large scale SDP problems arising from regularized kernel estimation and matrix completion show that the proposed method is very efficient.

2 - Schur Complements and Determinantal Formula in Euclidean Jordan Algebras

Roman Sznajder, Professor of Mathematics, Bowie State University, 14000 Jericho Park Road, Bowie, MD, 20715, United States of America, rsznajder@bowiestate.edu

We introduce the concept of Schur complement in the setting of Euclidean Jordan algebras and prove Schur determinantal formula and Haynsworth inertia formula. As a consequence, we obtain the rank additivity formula and characterization of positive elements in terms of positivity of the corresponding Schur complements.

3 - On Common Linear/Quadratic Lyapunov Functions for Switched Linear Systems

Seetharama Gowda, Professor of Mathematics, University of Maryland-Baltimore County, 1000 Hilltop Circle, Baltimore, MD, 21250, United States of America, gowda@math.umbc.edu

Using duality and complementarity ideas and Z-transformations, we discuss equivalent ways of describing the existence of common linear/quadratic Lyapunov functions for switched linear systems. In particular, we describe an extension of a recent result of Mason-Shorten on positive switched system with two constituent time-invariant systems to an arbitrary finite system.

■ MA03

Marriott - Chicago C

Variational Methods

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Stephen Robinson, Professor Emeritus, University of Wisconsin-Madison, ISyE/UW-Madison, 1513 University Ave Rm 3015, Madison, WI, 53706-1539, United States of America, smrobins@wisc.edu

1 - Approaches to Stability Characterizations for Solution Maps of Perturbed Inclusions

Diethard Klatte, Professor, University of Zurich, Institute for Operations Research, Moussonstrasse 15, 8044 Zurich, 8044, Switzerland, klatte@ior.uzh.ch, Bernd Kummer

We characterize calmness, the Aubin property and other stability properties of perturbed inclusions via several approaches: by monotonicity of assigned distance maps, by local convergence rates of suitable iteration schemes of descent and approximate projection type, and we relate this to criteria in terms of generalized derivatives. This is specialized to constraint or stationary point systems in mathematical programming.

2 - Splitting for Large-scale LCP via Parametric LCP: Application to Newton's Method for MCP

Jesse Holzer, Dissertator, Department of Mathematics, University of Wisconsin - Madison, 480 Lincoln Dr, Madison, WI, 53713, United States of America, holzer@math.wisc.edu

In Newton's method for Nonlinear Complementarity Problems, the step is computed using an approximating Linear Complementarity Problem. We consider a splitting method for this LCP, iterating the solution map of a much easier LCP via a parametric adaptation of Lemke's method. The resulting method is tested on CP's arising from Applied General Equilibrium models and compared with PATH and the Sequential Joint Maximization method for such problems.

■ MA04

Marriott - Denver

Combinatorial Optimization A

Contributed Session

Chair: Yasuko Matsui, Associate Profrofessor, Tokai University, Kitakaname 1117, Hiratsuka, 259-1292, Japan, yasuko@ss.u-tokai.ac.jp

1 - A Branch-and-cut-and-price Algorithm for the Capacitated M-ring-star Problem

Cid de Souza, Professor, University of Campinas, Av. Albert Einstein 1251, Cidade Universiteria -B. Geraldo, Campinas, 13083-970, Brazil, cid.souza@gmail.com, Edna Hoshino

The capacitated m-ring-star problem (CmRSP) is a variant of the classical one-depot capacitated vehicle routing problem in which a customer is either on a route or is connected to another customer or to some connection (Steiner) point present in a route. The goal is to minimize the total sum of routing and connection costs. The problem is NP-hard and has applications in network design and logistics. In this work we propose a new exact algorithm for the CmRSP using the branch-and-cut-and-price (BCP) approach. We implemented the BCP algorithm and a branch-and-cut (BC) algorithm based on an early paper from the literature. The empirical results show that the BCP is highly competitive with the BC.

2 - A Branch-and-price Approach for the Partition Coloring Problem

Yuri Frota, Institute of Computing (IC) - University of Campinas (UNICAMP), Caixa Postal 6176, Campinas, SP, 13083-970, Brazil, abitbol1976@yahoo.com, Edna Hoshino, Cid de Souza

Let G be an undirected graph having V as its vertex set. Let Q = (V_1,...,V_q) be a partition of V into q disjoint sets. The Partition Coloring Problem (PCP) consists of finding a subset V' of V with exactly one vertex in each subset of Q and such that the chromatic number of the graph induced by V' in G is minimum. The PCP is NP-hard since it generalizes the graph coloring problem. This work proposes a new integer programming model for the PCP and a branch-and-price algorithm to compute it. Computational experiments are reported for random graphs and for instances originating from routing and wavelength assignment problems in all-optical WDM networks. We show that our method largely outperforms previously existing approaches.

3 - Enumeration of Perfect Sequences of Chordal Graph

Yasuko Matsui, Associate Profrofessor, Tokai University, Kitakaname 1117, Hiratsuka, 259-1292, Japan, yasuko@ss.u-tokai.ac.jp, Ryuhei Uehara, Takeaki Uno

The set of maximal cliques in a chordal graph admits special tree structures called clique trees. A perfect sequence is a sequence of maximal cliques obtained by using the reverse order of repeatedly removing the leaves of a clique tree. In this talk, we propose a method to enumerate perfect sequences without constructing clique trees. In particular, the time complexity of the algorithm on average is O(1) for each perfect sequence.

■ MA05

Marriott - Houston

Conic Programming A

Contributed Session

Chair: Nandakishore Santhi, Member Technical Staff, Los Alamos National Laboratory, P.O. Box 1663, MS B256, Los Alamos, NM, 87545, United States of America, nsanthi@lanl.gov

1 - A Derivative Free Method for Nonlinear SDP

Ralf Werner, Hypo Real Estate / TU München, Planegger Str. 112, Munich, 81241, Germany, werner_ralf@gmx.net

At the moment, most available algorithms for SDPs aim at the efficient solution of (high dimensional) linear, maybe even nonlinear, problems. Most methods therefore rely on first or even second-order information. In contrast to this, we will focus on a completely derivative-free method for nonlinear SDPs. We will highlight both theoretical and practical aspects of the algorithm, which actually is the derivative-free version of the penalty-barrier-multiplier method used for example in pennon.

2 - Asymptotic Behavior of Underlying NT Paths in Interior Point Methods for Monotone SDLCP

Chee-Khian Sim, Lecturer, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Kowloon, Hong Kong - ROC, macksim@inet.polyu.edu.hk

An IPM defines a search direction at each interior point of the feasible region. These search directions give rise to a ODE system, which is used to define the underlying paths of the IPM. These off-central paths are shown to be well-defined analytic curves and their accumulation points are solutions to the given monotone SDLCP. In this talk, we discuss off-central paths corresponding to a well-known direction, the NT search direction. We give necessary and sufficient conditions for when these off-central paths are analytic w.r.t. \sqrt{\mu} and \mu, at solutions of a general SDLCP. Also, we present off-central path examples using a simple SDP, whose first derivatives are likely to be unbounded as they approach the solution of the SDP.

3 - A Heuristic for Restricted Rank Semi-definite Programming with Combinatorial Applications

Nandakishore Santhi, Member Technical Staff, Los Alamos National Laboratory, P.O. Box 1663, MS B256, Los Alamos, NM, 87545, United States of America, nsanthi@lanl.gov, Feng Pan

Several hard combinatorial optimization problems are known to have semi-definite programs which obtain theoretically tight (provided that P is not equal to NP) approximate solutions. Here the rank restriction on the semi-definite matrix, being a difficult non-linear constraint, is often relaxed which results in coarse approximations. We give a heuristic algorithm for such a restricted rank SDP, by iterating between a Semi-definite Least Squares step and a Rank Reduction step, both of which have efficient algorithms. The algorithm has the desirable property that if it converges, it does so with an optimal solution to the hard combinatorial question. We will discuss some combinatorial applications.

■ MA06

Marriott - Kansas City

Conic Programming Algorithms

Cluster: Conic Programming
Invited Session

Chair: Alexandre d'Aspremont, Princeton University, School of Engineering and Applied Science, Room 207, ORFE Buidling, Princeton, NJ, 08544, aspremon@princeton.edu

1 - Fast Gradient Methods for Network Flow Problems

Yurii Nesterov, Professor, Université catholique de Louvain, Faculté des sciences appliquées, 34, Voie du Roman Pays, Louvain-la-Neuve, B-1348, Belgium, yurii.nesterov@uclouvain.be

We propose a new approach for finding approximate solution to network problems related to multi-commodity flows. The fastest of our schemes (smoothing technique) solves the maximal concurrent flow problem in \$O({mq/\delta}\ln n)\$ iterations, where \$\delta\$ is the relative accuracy, \$m\$, \$n\$ and \$q\$ are the number of arcs, nodes, or commodity sources in the graph. The iterations are very simple, but we need a preliminary stage for finding all node-to-node maximal flows.

2 - A Modified Frank-Wolfe Algorithm for Computing Minimum-Area Enclosing Ellipsoidal Cylinders

Selin Damla Ahipasaoglu, Cornell University, Ithaca, NY, 14853, United States of America, dse8@cornell.edu, Michael J. Todd

Given an arbitrary set in the Euclidean space, we are interested in finding an ellipsoidal cylinder, centered at the origin, such that its intersection with a certain subspace has minimum area. This problem is referred to as the Minimum-Area Enclosing Ellipsoidal Cylinder (MAEC) problem. We present a Frank-Wolfe type algorithm with away steps and discuss global and local convergence properties of the algorithm.

3 - A Unified Optimal First-order Method for Convex Optimization

Guanghui Lan, Assistant Professor, University of Florida, 303 Weil Hall, Gainesville, FL, 32611, United States of America, glan@isye.gatech.edu

We consider the so-called stochastic composite optimization (SCO) which covers non-smooth, smooth and stochastic convex optimization as certain special cases. Although a valid lower bound on the rate of convergence for solving SCO is known, the optimization algorithms that can achieve this lower bound had never been developed. We present an accelerated stochastic approximation (AC-SA) algorithm which can achieve the aforementioned lower bound on the convergence rate.

■ MA07

Marriott - Chicago D

Cutting Planes from Several Rows of a Mixed-integer Program

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Quentin Louveaux, Université de Liège, Grande Traverse, 10, Liège, 4000, Belgium, Q.Louveaux@ulg.ac.be

1 - On the Relative Strength of Split, Triangle and Quadrialateral Cuts

Francois Margot, Professor, Tepper School of Business, Carnegie Mellon University, 5000 Forbes Ave., Pittsburgh, PA, 15213-3890, United States of America, fmargot@andrew.cmu.edu, Gerard Cornuejols, Pierre Bonami, Amitabh Basu

Integer programs defined by two equations with two free integer variables and nonnegative continuous variables have three types of nontrivial facets: split, triangle or quadrilateral inequalities. In this talk, we study how well each family approximates the integer hull. We show that triangle and quadrilateral inequalities provide a good approximation of the integer hull but that the approximation produced by split inequalities may be arbitrarily bad.

2 - A Lower Bound on the Split Rank of Intersection Cuts

Santanu Dey, Université Catholique de Louvain, 1348 Louvain-la-Neuve, Belgium, Santanu.Dey@uclouvain.be

We present a simple geometric argument to determine a lower bound on the split rank of intersection cuts. As a first step of this argument, a polyhedral subset of the lattice-free convex set that is used to generate the intersection cut is constructed. We call this subset the restricted lattice-free set. It is then shown that log(l) is a lower bound on the split rank of the intersection cut, where l is the number of integer points lying on distinct facets of the restricted lattice-free set.

3 - On Mixing Inequalities: Rank, Closure and Cutting Plane Proofs

Oktay Gunluk, IBM T.J. Watson Research, 1101 Kitchawan Road, Route 134, Yorktown Heights, NY, 10598, United States of America, gunluk@us.ibm.com, Sanjeeb Dash

We study the mixing inequalities which were introduced by Gunluk and Pochet (2001). We show that a mixing inequality which mixes n MIR inequalities has MIR rank at most n if it is a type I mixing inequality and at most n-1 if it is a type II mixing inequality. We also show that these bounds are tight for n=2. We define mixing inequalities for a general mixed-integer set and show that the elementary mixing closure can be described using a bounded number of mixing inequalities, each of which has a bounded number of terms. This implies that the elementary mixing closure is a polyhedron. Finally, we show that any mixing inequality can be derived via a polynomial length MIR cutting plane proof. Combined with results of Dash (2006) and Pudlak (1997), this implies that there are valid inequalities for a certain mixed-integer set that cannot be obtained via a polynomial-size mixing cutting-plane proof.

■ MA08

Marriott - Chicago E

Trends in Mixed Integer Programming

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Alexander Martin, Technische Universitaet Darmstadt, FB Mathematik, AG 7, Schlossgartenstr. 7, Darmstadt, D-64289, Germany, martin@mathematik.tu-darmstadt.de

1 - Facets of Value Reformulation

Dennis Michaels, University of Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, michaels@mail.math.uni-magdeburg.de, Anton Savchenko, Utz-Uwe Haus

For integer valued functions f, we consider how polyhedral descriptions of sets of integral points of the form (x,f(x)) can be obtained. We generalize a value reformulation technique by Koeppe, Louveaux, and Weismantel to non-linear functions. This technique can be used to derive an extended formulation describing the set of integral points (x,f(x)) and connected systems of such sets. In particular, we will discuss the case when the functions f are given by the product of two integer variables.

2 - Analysing Infeasible MIPs

Marc Pfetsch, Technische Universitaet Braunschweig Institut fuer Mathematische Optimierung, Pockelsstr. 14, Braunschweig, Germany, m.pfetsch@tu-bs.de, Stefan Heinz

The analysis of infeasible mixed integer programs (MIPs) is hard, since no nice characterization of infeasibility exists unless P equals coNP. We show, that one can nevertheless compute maximum feasible subsystems for practical instances in reasonable time, using the MIP-framework SCIP. We apply the techniques to MIPs resulting from linear approximations of gas networks.

3 - Integer Programming Equivalents in Risk Averse Stochastic Programming

Ruediger Schultz, University of Duisburg Essen, Department of Mathematics, Lotharstr 65, D-47048 Duisburg, D-47048, Germany, schultz@math.uni-duisburg.de

In stochastic integer programming, different modes of risk aversion induce different coupling structures in the constraints of the mixed-integer linear programming (MILP) equivalents. In the talk we discuss risk aversion via various risk measures and by means of stochastic dominance constraints. We compare MILP equivalents regarding their amenability to decomposition methods and conclude with some computational results.

■ MA09

Marriott - Chicago F

Recent Improvements in MIP Solvers I

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Tobias Achterberg, IBM, Zuse Institute Berlin, Takustr. 7, Berlin, 14195, Germany, achterberg@de.ibm.com

1 - Solution Strategies for Hard MIP Problems

Richard Laundy, Principal, FICO, Leam House, 64 Trinity Street, Leamington Spa, CV32 5YN, United Kingdom, richardlaundy@fico.com, Alkis Vazacopoulos

In this talk we describe strategies for solving hard MIP problems. We show how problems which seem intractable can be solved by using different techniques. Good strategies for one class of problem may not work on other problem classes and choosing the best strategy is often the key to solving hard MIPs.

2 - The Gurobi Solver

Robert Bixby, Gurobi Optimization, P.O. Box 1001, Houston, TX, 77019, United States of America, bixby@gurobi.com, Edward Rothberg, Zonghao Gu

This talk will begin with a description of the solver design both in terms of accessibility and the underlying algorithmic framework. This framework has been built to provide maximum flexibility in exploiting recent strategies for solving mixed-integer programs (MIP). We will discuss our approaches to handling the important MIP issues including deterministic parallel, MIP search, and cutting planes. Finally, we will present computational results for the Gurobi MIP solver.

3 - Recent Improvements in CPLEX

Tobias Achterberg, IBM, Zuse Institute Berlin, Takustr. 7, Berlin, 14195, Germany, achterberg@de.ibm.com

We present new features that have been added to CPLEX and give detailed benchmarking results that demonstrate the performance improvements in CPLEX 12.

■ MA10

Marriott - Chicago G

Novel Approaches to Nonconvex Optimization Problems

Cluster: Global Optimization
Invited Session

Chair: Jeff Linderoth, Associate Professor, University of Wisconsin-Madison, 1513 University Avenue, Madison, WI, 53706, United States of America, linderot@cae.wisc.edu

1 - Parametric Nonlinear Discrete Optimization

Jon Lee, IBM TJ Watson Research Center, P.O. Box 218, Yorktown Heights, NY, 10598, United States of America, jonlee@us.ibm.com

We discuss algorithms for optimizing f(Wx), over x in F, where f is nonlinear, the fixed number of rows of the matrix W describe linear objectives, and F is finite. The function f balances the linear objs. We look at various combinatorial choices of F. So our work fits somewhere on the landscape between multi-criteria optimization and nonlinear discrete optimization. The general model is intractable, so we look at broad cases that yield poly-time algs and approx schemes. Regarding f, concave and convex functions, etc. For W, we assume that the entries are small. Our algorithms were designed for theoretical efficiency, but we have implemented some of these methods, solving ultra-high precision linear systems, on a BlueGene supercomputer.

2 - Nonconvex Quadratic Programming: Return of the Boolean Quadric Polytope

Kurt Anstreicher, University of Iowa, Dept. of Management Sciences, S210 Pappajohn Business Bldg, Iowa City, IA, 52242, United States of America, kurt-anstreicher@uiowa.edu, Adam Letchford, Samuel Burer

Relaxations for nonconvex quadratic optimization commonly use the “Reformulation-Linearization Technique” (RLT) to replace bilinear and quadratic terms with new variables, adding constraints that are implied by upper and lower bounds on original variables. For two original variables, RLT constraints and semidefiniteness give an exact convex reformulation for nonconvex box-constrained quadratic programming (QPB). In any dimension, projecting out the quadratic variables produces the Boolean Quadric Polytope (BQP), associated with quadratic optimization over Boolean variables. Polyhedral combinatorics of the BQP can therefore be used to strengthen convex relaxations for QPB. We describe recent theoretical and computational results.

3 - Convex Relaxation Methods for Nonconvex Optimization Problems

Pietro Belotti, Visiting Professor, Lehigh University, 200 W Packer Ave, Bethlehem, PA, 18015, United States of America, belotti@lehigh.edu

Exact solvers for nonconvex Optimization need a valid lower bound for any subproblem that results from partitioning the solution set. We review some methods to find a valid convex underestimator for a non-convex quadratic function defined on a convex set. Generalizations to non-quadratic functions are discussed. This technique can also find linear relaxations to nonconvex constraints. We present preliminary computational results on non-convex problems.

■ MA11

Marriott - Chicago H

Recent Advances in Global Optimization

Cluster: Global Optimization
Invited Session

Chair: Takahito Kuno, Professor, University of Tsukuba, School of Systems and Information Eng, Tennoh-dai 1-1-1, Tsukuba, 305-8573, Japan, takahito@cs.tsukuba.ac.jp

1 - A Genetic Algorithm for Inferring S-system from Microarray Time-course Data Using Co-Expression

Yang Dai, Associate Professor, Department of Bioengineering, University of Illinois at Chicago, 851 S. Morgan Street, SEO218 (MC 063), Chicago, IL, 60607, United States of America, yangdai@uic.edu, Damian Roqueiro

The inference of biochemical networks from time-course data is one of the challenging tasks in systems biology. The S-system is considered as a general model representing underlying biological mechanism for the observations. We use a genetic algorithm to solve the S-system with structural constraints derived from the co-expression pattern. The computational results will be presented.

2 - Non-convex Optimization of Extended nu-Support Vector Machine

Akiko Takeda, Keio University, 3-14-1 Hiyoshi, Kouhoku, Yokohama, Kanagawa, 223-8522, Japan, takeda@ae.keio.ac.jp, Masashi Sugiyama

Support vector classification (SVC) is one of the most successful classification methods in modern machine learning. A non-convex extension of nu-SVC was experimentally shown to be better than original nu-SVC. However, an algorithm with convergence properties has not been devised yet for extended nu-SVC. In this talk, we give a new local optimization algorithm that is guaranteed to converge to a local solution within a finite number of iterations. By combining the local optimization algorithm with the use of cutting planes, we further show that a global solution can be actually obtained for several datasets.

3 - On Convergence of the Simplicial Algorithm for Convex Maximization

Takahito Kuno, Professor, University of Tsukuba, School of Systems and Information Eng, Tennoh-dai 1-1-1, Tsukuba, 305-8573, Japan, takahito@cs.tsukuba.ac.jp

The simplicial algorithm is a kind of branch-and-bound method for computing a globally optimal solution of convex maximization problems. Its convergence under the omega-subdivision branching strategy was an open problem for years until Locatelli and Raber proved it in 2000. In this talk, we modify the linear programming relaxation and give a different and simpler proof of the convergence, based on the concept of nondegenerate subdivision process. We further show that the simplicial algorithm converges even under a certain generalization of the omega-subdivision strategy, which enhances the practical efficiency of the algorithm.

■ MA12

Marriott - Los Angeles

Derivative-free Algorithms: Applications

Cluster: Derivative-free and Simulation-based Optimization
Invited Session

Chair: Christine Shoemaker, Professor, Civil & Environmental Engineering, Cornell University, Ithaca, NY, United States of America, cas12@cornell.edu

1 - Applications of Simulation-constrained Optimization with Objective Function Approximation

Christine Shoemaker, Professor, Civil & Environmental Engineering, Cornell University, Ithaca, NY, United States of America, cas12@cornell.edu

We compare the application of continuous optimization algorithms that utilize approximations of simulation-constrained objective functions. The simulation models are computationally expensive so relatively few algoriithm iterations can be made. Both multi-modal and uni-modal optimization problems are considered. The applications include complex, data-based simulation models of water quality.

2 - Derivative-free Hybrid Optimization Approaches to Hydraulic Capture

Genetha Anne Gray, Sandia National Labs, P.O. Box 969, MS 9159, Livermore, CA, 94550, United States of America, gagray@sandia.gov, Katie Fowler, Josh Griffin

In this talk, we investigate the problem of plume containment and illustrate the applicability of a new hybrid optimization algorithm which makes use of an evolutionary algorithm to guide a local direct search (EAGLS). We describe the characteristics of the problem which make it amenable to this approach. Specifically, we focus on difficulties introduced by the mixed integer formulation and describe how EAGLS was designed to target its computational bottlenecks.

3 - Large-scale Multidisciplinary Mass Optimization in the Auto Industry

Don Jones, General Motors, 3023 Sylvan Drive, Royal Oak, MI, 48073, don.jones@gm.com

In the automotive industry, minimizing vehicle mass is a challenging non-smooth optimization problem. The variables are the gages and shapes of different parts and can number 50-200. The objective is mass, which is usually linear but can be nonlinear if there are shape variables. The constraints, which can number 50-100, are nonlinear and represent the requirement to meet targets for noise, vibration, durability, crash, etc. The crash simulations do not provide analytical derivatives and can be extremely time-consuming, thereby limiting the number of function evaluations. I will present a benchmark test problem that reflects these characteristics and review the performance of several existing methods.

■ MA13

Marriott - Miami

Transmission and Generation Capacity in Electricity Markets

Cluster: Optimization in Energy Systems

Invited Session

Chair: Gul Gurkan, Associate Professor, Tilburg University, P.O. Box 90153, Tilburg, 5000LE, Netherlands, ggurkan@uvt.nl

1 - Aggregation Choices in Zonal Pricing Algorithms for Managing Transmission Congestion

Mette Bjorndal, NHH, Helleveien 30, Bergen, 5045, Norway, mette.bjorndal@nhh.no

Locational marginal prices constitute a well known benchmark for managing capacity constraints in electricity markets. We study aggregation choices when simplifying nodal prices into zonal or area prices. We discuss two different aggregation concepts, which we call economic and physical aggregation, and their relation to optimal nodal prices and feasibility. As an illustration we consider the approximations and simplifications of the present Nord Pool spot price algorithm.

2 - Integer and Stochastic Programming Model for Capacity Expansion Problem

Takayuki Shiina, Chiba Institute of Technology, 2-17-1 Tsudanuma, Narashino, Chiba, 275-0016, Japan, shiina.takayuki@it-chiba.ac.jp

We consider a class of stochastic programming problem with fixed charge recourse in which a fixed cost is imposed if the value of the recourse variable is strictly positive. The algorithm of a branch-and-cut to solve the problem is developed by using the property of the expected recourse function. The problem is applied to the capacity expansion problem of power system. The numerical experiments show that the proposed algorithm is quite efficient.

3 - Generation Capacity Investments in Electricity Markets: Perfect Competition

Gul Gurkan, Associate Professor, Tilburg University, P.O. Box 90153, Tilburg, 5000LE, Netherlands, ggurkan@uvt.nl, Yves Smeers, Ozge Ozdemir

We analyze capacity investments in different market designs using a two stage game. With known future spot market conditions, the two stage game is equivalent to a single optimization problem in an energy-only market. When future spot market conditions are unknown (eg. under demand uncertainty), an equilibrium point can be found by solving a stochastic program, with both inelastic and elastic demand. This simplicity is preserved when a capacity market is included or operating reserves are priced based on observed demand; it is lost when operating reserves are priced based on installed capacities and a complementarity problem is needed. We provide extensions for other uncertain parameters (eg. fuel costs, transmission capacities).

■ MA14

Marriott - Scottsdale

Computational Game Theory

Cluster: Game Theory

Invited Session

Chair: Noah Stein, Graduate Student, Massachusetts Institute of Technology, 41 Cameron Ave., Apt. #1, Somerville, MA, 02144, United States of America, nstein@mit.edu

1 - Polynomial Games: Characterization and Computation of Equilibria

Noah Stein, Graduate Student, Massachusetts Institute of Technology, 41 Cameron Ave., Apt. #1, Somerville, MA, 02144, United States of America, nstein@mit.edu, Pablo A. Parrilo, Asu Ozdaglar

We consider games in which each player chooses his action from an interval on the real line and has a polynomial utility function. We characterize the correlated equilibria and develop algorithms to approximate a sample correlated equilibrium and the entire set of correlated equilibria. Time permitting we will sketch our progress on the conjecture that computing Nash equilibria of polynomial games is PPAD-complete, i.e., computationally equivalent to the corresponding problem for finite games.

2 - Polynomial Graphs with Applications to Game Theory

Ruchira Datta, Postdoctoral Researcher, Berkeley, 324D Stanley Hall, QB3 Institute, Berkeley, CA, 94720-3220, United States of America, ruchira@berkeley.edu

We prove a theorem computing the number of solutions to a system of equations which is generic subject to the sparsity conditions embodied in a graph. We apply this theorem to games obeying graphical models and to extensive-form games. We define emergent-node tree structures as additional structures which normal form games may have. We apply our theorem to games having such structures. We briefly discuss how emergent node tree structures relate to cooperative games.

3 - Enumeration of Nash Equilibria for Two-player Games

Rahul Savani, Postdoctoral Research Fellow, University of Warwick, Department of Computer Science, Coventry, CV4 7AL, United Kingdom, rahul@dcs.warwick.ac.uk, Gabe Rosenberg, David Avis, Bernhard von Stengel

This talk describes algorithms for finding all Nash equilibria of a two-player game in strategic form. We present two algorithms that extend earlier work, explaining the two methods in a unified framework using faces of best-response polyhedra. The first method lrsNash is based on the known vertex enumeration program lrs, for "lexicographic reverse search". It enumerates the vertices of only one best-response polytope, and the vertices of the complementary faces that correspond to these vertices (if they are not empty) in the other polytope. The second method is a modification of the known EEE algorithm, for "enumeration of extreme equilibria". We discuss implementations and report on computational experiments.

■ MA16

Gleacher Center - 200

Stochastic Optimization with Learning

Cluster: Stochastic Optimization

Invited Session

Chair: Retsef Levi, MIT, Sloan School of Management, 30 Wadsworth St Bldg E53-389, Cambridge, MA, 02142, United States of America, retsef@MIT.EDU

1 - Towards a Data-Driven View of Customer Choice

Vivek Farias, MIT Sloan, 30 Wadsworth Street, E53-317, Cambridge, MA, United States of America, vivekf@mit.edu, Devavrat Shah, Srikanth Jagabathula

Given the rising importance of understanding customer choice behavior and the risks of incorrectly modeling such behavior in applications, we ask: For a 'generic' model of customer choice (namely, distributions over preference lists) and a limited amount of data on how customers actually make decisions (such as marginal preference information), how may one predict revenues from offering a particular assortment of choices? We present a framework and algorithms to answer such questions.

2 - Linearly Parameterized Bandits

Paat Rusmevichientong, Cornell University, 221 Rhodes Hall, Ithaca, United States of America, paatrus@cornell.edu, Adam Mersereau, John Tsitsiklis

Motivated by applications in revenue management, we consider multiarmed bandit problems involving a large (possibly infinite) collection of arms, in which the expected reward of each arm is a linear function of an unknown multivariate random variable. The objective is to choose a sequence of arms to minimize the cumulative regret and Bayes risk. We describe a policy whose performance is within a polylogarithmic factor from the optimal.

3 - Adaptive Data-driven Inventory Control Policies Based on Kaplan-Meier Estimator

Retsef Levi, MIT, Sloan School of Management, 30 Wadsworth St Bldg E53-389, Cambridge, MA, 02142, United States of America, retsef@MIT.EDU, Paat Rusmevichientong, Tim Huh, James Orlin

Using the well-known Kaplan-Meier estimator from statistics, we propose a new class of non-parametric adaptive data-driven policies for stochastic inventory control problems. We focus on the distribution-free newsvendor model with censored demands. We show that for discrete demand distributions they converge almost surely to the set of optimal solutions. Extensive computational experiments suggest that the new policies converge for general demand distributions, and perform well.

■ MA17

Gleacher Center - 204

Advanced Network Flow Problems

Cluster: Logistics and Transportation
Invited Session

Chair: Ozlem Ergun, Associate Professor, Georgia Tech, School of Industrial & Systems Engineeri, 765 Ferst Drive, Atlanta, GA, 30332, oergun@isye.gatech.edu

1 - Combinatorial Results for Network Interdiction

Kael Stilp, Georgia Institute of Technology, Industrial and Systems Engineering, Atlanta, GA, 30332, United States of America, mstilp3@isye.gatech.edu, Ozlem Ergun, Doug Altner

The Network Interdiction Problem is to minimize a resulting maximum flow by removing some set of arcs given a budget. Two-sided approximation algorithms are known, where a solution is bounded by at least one of two functions. We present a novel proof of these approximation results which eliminates one side of the approximation. Furthermore, we discuss cuts for specific budgets using the objective functions of Pareto optimal solutions over all budgets.

2 - Computing Maximum Flow on Massively Multithreaded Supercomputers

Cynthia Phillips, Distinguished Member of Technical Staff, Sandia National Laboratories, Mail Stop 1318, P.O. Box 5800, Albuquerque, NM, 87185-1318, United States of America, caphill@sandia.gov, Jonathan Berry, Bradley Mancke, Ali Pinar

Massively-multithreaded parallel computers such as the Cray XMT are promising platforms for algorithms on massive graphs. These machines have special hardware to hide memory latency, an issue for data sets without locality such as the WWW. We discuss a multithreaded implementation of the Edmonds-Karp maximum flow algorithm with experimental results for large networks. We discuss applications of this to computing graph conductance on sparse social networks, a step in community detection.

3 - Exact Solution Algorithms for Maximum Leaf Spanning Tree and Minimum Connected Dominating Set Problems

Abilio Lucena, Universidade Federal do Rio de Janeiro, Department of Adminand PESC/COPPE, Rio De Janiero, Brazil, abiliolucena@globo.com, Alexandre Salles da Cunha, Luidi Simonetti

We discuss formulations and exact solution algorithms for the maximum leaf spanning tree and minimum connected dominating set problems. In particular, we explore the close relationship that exists between these two problems to adapt valid inequalities from one to the other. In computational testing,the resulting algorithms proved to be competitive with those available in the literature.

■ MA18

Gleacher Center - 206

Nonlinear Mixed Integer Programming A

Contributed Session

Chair: Inacio Andruski-Guimaraes, UTFPR - Universidade Tecnologica Federal do Parana, Rua Sete de Setembro 3165, Curitiba, PR, 80230-901, Brazil, andruski@utfpr.edu.br

1 - A Surrogate Dual Heuristics for the 0-1 Exact K-item Quadratic Knapsack Problem

Lucas Létocart, Université Paris 13, 99 Avenue J-B. Clément, Villetaneuse, 93430, France, lucas.letocart@lipn.fr, Gérard Plateau, Marie-Christine Plateau

The 0-1 exact k-item quadratic knapsack problem consists of maximizing a quadratic function subject to a linear capacity constraint and to an equality cardinality constraint. A dichotomic search is designed for solving a surrogate dual of this NP-Hard problem. The heuristics exploits the solutions of the classical 0-1 quadratic knapsack problems produced by the dual resolution. Numerical experiments over randomly generated instances validate the relevance of this approach.

2 - Principal Components Analysis Applied to Quadratic Logistic Regression

Inacio Andruski-Guimaraes, UTFPR - Universidade Tecnologica Federal do Parana, Rua Sete de Setembro 3165, Curitiba, PR, 80230-901, Brazil, andruski@utfpr.edu.br, Anselmo Chaves-Neto

The quadratic logistic regression model involves a great number of parameters, and this leads to computational difficulties. We use a set of principal components of the covariates, in order to reduce the dimensions in the problem. The maximum likelihood estimates for the parameters are given by maximizing the log-likelihood function, which can be solved as a convex optimization problem. The purpose is to propose an alternative approach for the parameter estimation problem in logistic regression.

■ MA19

Gleacher Center - 208

Wireless Networking

Cluster: Telecommunications and Networks
Invited Session

Chair: Aravind Srinivasan, Professor, University of Maryland, Dept. of Computer Science, University of Maryland, College Park, MD, 20742, United States of America, srin@cs.umd.edu

1 - Wireless Network Capacity in the Physical Model

Michael Dinitz, Graduate Student, Carnegie Mellon University, Computer Science Department, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States of America, mdinitz@cs.cmu.edu

We consider the problem of choosing transmission powers in order to maximize the number of supported connections in an arbitrary wireless network, where a transmission is supported if and only if the signal-to-interference-plus-noise ratio at the receiver is greater than some threshold. We prove that this problem is NP-hard, design both centralized and distributed approximation algorithms, and consider the price of anarchy of a related game.

2 - New Algorithmic Challenges in Wireless Networking

Thomas Moscibroda, Researcher, Microsoft Research, One Microsoft Way, Building 99/2383, Redmond, WA, 98052, United States of America, moscitho@microsoft.com

Wireless Networking is in the midst of a paradigm shift, at the core of which is a more flexible use of “spectrum” as the medium of communication. In my talk, I discuss algorithmic implications of new techniques such as dynamic spectrum access or adaptive channel width. I will give examples of new optimization problems, including a discovery problem in fragmented spectrum. Finally, I will motivate “local approximations” for global optimization problems, and give an overview of known results.

3 - Throughput Capacity Maximization in Wireless Networks

Anil Vullikanti, Assistant Professor, Dept. of Computer Science, and Virginia Bioinformatics Institute, Virginia Tech, Res. Bldg XV (0477), 1880 Pratt Drive, Blacksburg, VA, 24061, United States of America, akumar@vbi.vt.edu

With rapid advances in radio technology, various types of large scale multi-hop wireless networks are becoming increasingly common. However, fundamental limits on the throughput capacity of the network are poorly understood. These questions become complicated because of a number of factors, including wireless intereference constraints, multiple (and often inconsistent) criteria, such as fairness, total rate, latency and power consumption, as well specific protocols used in the different layers of the network. In this talk, we will discuss a generic convex programming framework for estimating the cross-layer throughput capacity for any given wireless network, under a variety of interference models and performance objectives.

■ MA20

Gleacher Center - 300

Nonlinear Programming: Interior Point Methods

Cluster: Nonlinear Programming
Invited Session

Chair: Sven Leyffer, Argonne National Laboratory, MCS Division 9700 South Cass Avenue, Argonne, IL, 60439, United States of America, leyffer@mcs.anl.gov

Co-Chair: Annick Sartenaer, Professor, University of Namur (FUNDP), Rempart de la Vierge, 8, Namur, B-5000, Belgium, annick.sartenaer@fundp.ac.be

1 - An Interior Point Algorithm for Large-scale Optimization with Inexact Step Computations

Frank Curtis, Courant Institute, New York University, New York, NY, United States of America, fecurt@gmail.com, Olaf Schenk, Andreas Waechter

An algorithm for large-scale constrained optimization is presented. The method is a full-space (primal-dual) approach that is designed to make use of iterative linear algebra techniques, rather than direct factorization methods, for computing search directions. We describe global convergence guarantees that apply even for non-convex and ill-conditioned problems and illustrate the practical performance of the approach on PDE-constrained optimization applications.

2 - A Subspace Minimization Method for Computing the Trust-region Step

Jennifer Erway, Wake Forest University, P.O. Box 7388, Winston Salem, NC, 27109, United States of America, erwayjb@wfu.edu, Philip E. Gill

We consider methods for large-scale unconstrained optimization based on finding an approximate solution of a quadratically constrained trust-region subproblem. The solver is based on sequential subspace minimization with a modified barrier “accelerator” direction in the subspace basis. The method is able to find solutions of the subproblem to any prescribed accuracy. Numerical results will be presented. This is joint work with Philip Gill.

3 - An Affine-scaling Interior-point Method for Continuous Knapsack Constraints

William Hager, University of Florida, P.O. Box 118105, Gainesville, FL, 32611, hager@math.ufl.edu, Maria Gonzalez-Lima, Hongchao Zhang

An affine-scaling algorithm is presented. The algorithm can be used for box constrained optimization problems which may have an additional linear equality constraint. Each iterate lies in the relative interior of the feasible set. The search direction is obtained by approximating the Hessian of the objective function in Newton’s method by a multiple of the identity matrix. The algorithm is particularly well suited for optimization problems where the Hessian of the objective function is a large, dense, and possibly ill-conditioned matrix. Global convergence is established for a nonmonotone line search. Numerical results are reported.

■ MA21

Gleacher Center - 304

Network Design

Cluster: Telecommunications and Networks
Invited Session

Chair: Vincenzo Bonifaci, Sapienza University of Rome, via Ariosto, 25, Roma, RM, 00185, Italy, bonifaci@dis.uniroma1.it

1 - On Generalizations of Network Design Problems with Degree Bounds

Jochen Könemann, University of Waterloo, Waterloo, Canada, jochen@math.uwaterloo.ca

The problem of designing efficient networks satisfying prescribed connectivity and degree constraints has recently received significant attention. One of the premier methods for designing algorithms for such problems is Jain’s technique of Iterative Rounding & Relaxation. In this talk we generalize this technique in the following ways: (1) Generalize vertex-degree constraints to constraints on the number of edges in edge-cuts. (2) Generalize the underlying network design problem to other combinatorial optimization problems like polymatroid intersection and lattice polyhedra. We present improved results for the Crossing Spanning Tree, and the mincost degree-bounded arborescence problems.

2 - On the VPN Problem, and a Generalization

Neil Olver, McGill University, Montreal, Canada, olver@math.mcgill.ca

Robust network design considers the problem of designing a network to support a given set of demand patterns. We first discuss (at a high level) the proof of the VPN conjecture, which states that the optimal solution to a well-studied robust problem has the form of a tree, and hence the problem is polynomially solvable. We also propose and investigate a natural generalization of this VPN problem: the designed network must support all demands that are routable in a given capacitated tree.

3 - Set Covering with our Eyes Closed

Fabrizio Grandoni, University of Rome Tor Vergata, via del Politecnico 1, 00133, Rome, Italy, grandoni@disp.uniroma2.it, Piotr Sankowski, Pauli Miettinen, Mohit Singh, Anupam Gupta, Stefano Leonardi

Given a universe \$U\$ of \$n\$ elements and a collection \$S\$ of \$m\$ subsets of \$U\$, the universal set cover problem is to a-priori map each element \$u \in U\$ to a set \$S(u) \in S\$ containing \$u\$, so that any given \$X\subseteq U\$ is covered by \$S(X)=\cup_{u\in X}S(u)\$ at minimum cost. In this work we give a \$O(\log mn)\$ approximation algorithm for this problem in the case \$X\$ is randomly chosen. In fact, we give a slightly improved analysis and show that this is the best possible. We extend our ideas to facility location, multi-cut and disc-covering. All these universal mappings give us stochastic online algorithms with the same competitive factors.

■ MA22

Gleacher Center - 306

Warmstarts with Interior Point Methods I

Cluster: Implementations, Software
Invited Session

Chair: Andreas Grothey, Lecturer, University of Edinburgh, Edinburgh, United Kingdom, A.Grothey@ed.ac.uk

1 - Warmstarting for Interior Point Methods Applied to the Long-term Power Planning Problem

Adela Pages, Norwegian University of Science and Technology, Alfred Getz vei 3, Trondheim, 7058, Norway, adela.pages@iot.ntnu.no, Jacek Gondzio, Narcìs Nabona

Medium-term planning of electricity generation in a liberalised market can be posed as a quadratic programming problem with an exponential number of inequality constraints. Direct solution methods are inefficient and a heuristic procedure is used. The problem is then solved as a finite succession of quadratic problems, which are solved with an interior-point algorithm. Warm starting between successive solutions helps in reducing the number of iterations necessary to reach the optimiser.

2 - A Family of Algorithms Based on the Optimal Pair Adjustment Algorithm as an Approach for Warm-start

Carla Ghidini, UNICAMP, Sérgio Buarque de Holanda, 651, Campinas, Brazil, carla@ime.unicamp.br, Aurelio Oliveira, Jair Silva

In this work, a new family of algorithms for solving linear programming problems is used as an approach to determine a warm-start point in the interior point methods. This family arose from the generalization of the optimal pair adjustment algorithm, which is based on Von Neumann’s algorithm. Its main advantages are simplicity and fast initial convergence. Numerical experiments show that this approach reduces the total number of iterations for many tested problems.

3 - Warmstarting Interior-point Methods for Second-order Cone Programming

Vivek Mahanta, Drexel University, Department of Decision Sciences, 3141 Chestnut Street, Philadelphia, PA, 19104, United States of America, vsm24@drexel.edu, Hande Benson

In this talk, we will investigate the re-optimization of a series of closely related SOCPs after a warmstart. Interior-point methods are highly efficient approaches for solving SOCPs, however, their warmstart capabilities are limited. We will present suitable modifications to a primal-dual penalty method and a homogeneous self-dual method that will enable such warmstarts within an interior-point framework. Numerical results will be provided.

■ MA24

Gleacher Center - 400

Network Optimization

Cluster: Telecommunications and Networks
Invited Session

Chair: Andreas Bley, TU Berlin / Matheon, Strafle des 17. Juni 136, Berlin, D, 10623, Germany, bley@math.tu-berlin.de

1 - A Unified Model for Pre-planned Protection

Thomas Stidsen, Associate Professor, Technical University of Denmark, Holsteinsgade 16, 1. tv., 2100, Denmark, tks@imm.dtu.dk, Brigitte Jaumard, Samir Sebbah

Pre-planned protection offers fast and reliable protection of communication networks using overlaid network structures like rings. Over the last 10 years several other structures have been proposed e.g. p-cycles, p-trees. Here we will present a unified modelling approach to pre-planned protection. This enables a better understanding of pre-planned protection. Furthermore, we can use the implemented models to test the protection efficiency of 6 different types of pre-planned protection structures on test networks of medium size.

2 - Robust Network Optimization with Submodular Functions

Manuel Kutschka, Research Assistant / PhD Student, RWTH Aachen, Lehrstuhl II für Mathematik, Templergraben 55, Aachen, 52062, Germany, kutschka@math2.rwth-aachen.de, Arie M.C.A. Koster

We study the approach to describe demand uncertainty in network optimization by submodular functions. This description generalizes the model for statistical multiplexing used in MPLS nodes. The approach is illustrated by a capacitated multi-commodity network flow problem with submodular bandwidth consumption. Here, the link capacity constraints are submodular knapsacks.We extend results for this subproblem and present computational results for several problems and specific submodular functions.

3 - An Optimization Approach to Radio Resource Management

Mikael Fallgren, PhD Student, Royal Institute of Technology, Department of Mathematics, Stockholm, SE-100 44, Sweden, werty@kth.se, Anders Forsgren

In this talk we consider a radio cellular system in which each cell manages the orthogonal radio resources for its own users and services. However, inter-cell interference is an issue if nearby cells simultaneously use the same resorce. The overall scheduling problem is posed as a mathematical optimization problem, which is proved to be NP-complete. A restricted problem is shown to be nonconvex in general, but is convexifiable for an even more restricted formulation.

■ MA25

Gleacher Center - 404

Maximal Monotone Operator and Duality

Cluster: Variational Analysis

Invited Session

Chair: Stephen Simons, Professor Emeritus, University of California, Santa Barbara, Santa Barbara, Ca, 93106, United States of America, simons@math.ucsb.edu

1 - Recent Results on Maximal Monotone Operators in Nonreflexive Banach Spaces

Maicon Marques Alves, Dr., Instituto de Matematica Pura e Aplicada, Estrada Dona Castorina, 110, Rio de Janeiro, Brazil, maicon@impa.br, Benar Svaiter

In this talk we will present some results recently obtained in collaboration with B.F.Svaiter on maximal monotone operators in nonreflexive Banach spaces. The focus will be on the use of concept of convex representation of a maximal monotone operator for obtaining results on these operators of type: surjectivity of perturbations by duality mappings, uniqueness of the extension to the bidual, Brondsted-Rockafellar property, etc.

2 - On Borwein-Wiersma Decompositions of Monotone Operators with Linear Graphs

Liangjin Yao, University of British Columbia Okanagan, Department of Mathematics, Kelowna, BC, V1V 1V7, Canada, liangjinyao@gmail.com, Heinz Bauschke, Xianfu Wang

In 1970, Asplund studied decompositions of a monotone mapping as the sum of a maximal subdifferential mapping and a ``irreducible” monotone mapping. In 2007, Browein and Wiersma introduced skew decompositions of a monotone mapping as the sum of a maximal subdifferential mapping and a ``skew” monotone mapping. These decompositions provide intrinsic insights to monotone operators In this paper, we consider the Borwein-Wiersma decomposition of maximal monotone operators with linear graphs. We give sufficient conditions and characterizations for a maximal monotone operator with linear graph to be Borwein-Wiersma decomposable.

3 - Necessary Conditions for Optimal Solutions in Constrained Multiobjective Optimization

Truong Bao, Northern Michigan University, United States of America, btruong@nmu.edu

This talk discusses necessary optimality conditions for Pareto, super, and Benson minimizers of a multiobjective optimization problem, where the cost is a set-valued mapping with its images in a partially ordered vector space. Since in most infinite dimensional spaces the natural ordering cone has an empty interior we do not impose the nonempty interiority condition on the ordering cone. We derive necessary conditions for all three types of minimizers on the base of advanced tools of variational analysis.

■ MA26

Gleacher Center - 406

Portfolio and Option Problems A

Contributed Session

Chair: Hongxia Yin, Associate Professor, Minnesota State University Mankato, 273 Wissink Hall, Mankato, MN, 56001, United States of America, hongxia.yin@mnsu.edu

1 - A Regularized Robust Optimization Approach for the Portfolio Execution Cost Problem

Somayeh Moazeni, PhD Candidate, University of Waterloo, 200 University Avenue West, Waterloo, On, N2L 3G1, Canada, smoazeni@math.uwaterloo.ca

Execution cost problem minimizes total cost and risk of the execution of a portfolio of risky assets. Execution cost is defined by (erroneously estimated) price impact functions. We use a regularized uncertainty set to obtain a solution robust to the uncertainty in price impact functions. Obtained solution is stable to possible changes in the specification of the uncertainty set. Regularization parameter controls diversity of the portfolio, degree of conservatism and the objective value.

2 - A Semidefinite Approach for Robust Option Pricing Bounds

Roy Kwon, Associate Professor, University of Toronto, 5 King’s College Road, Toronto, Canada, rkwon@mie.utoronto.ca, Jonathan Li

We consider robust upper and lower bounds for the price of a European option. Recently semidefinite programming methods have been used to derive tight bounds on option prices, given the moments of the prices of the underlying security. We present a stochastic semi-definite programming model providing robust upper and lower bounds for pricing European call option under regime switching. We illustrate the benefits of the model for an call option on the SP 500.

3 - Robust Portfolio Selection with Maximum Risk Adjusted Return on Capital

Hongxia Yin, Associate Professor, Minnesota State University Mankato, 273 Wissink Hall, Mankato, MN, 56001, United States of America, hongxia.yin@mnsu.edu, Daoyu Wu, Ernest Boyd

We investigate the portfolio selection by maximizing its risk adjusted return on capital (RAROC). It is shown that the problem can be solved by solving a second order cone optimization problem. Robust optimization technique are used for solving the maximum RAROC problem with random return variable. Multi-period investment problem were also considered. Numerical results show that the method is promising.

■ MA27

Gleacher Center - 408

Min-type Functions, Generalized Derivatives and Optimal Control

Cluster: Variational Analysis

Invited Session

Chair: Lionel Thibault, Professor, Université Montpellier 2, Place Eugene Bataillon, Montpellier, 34095, France, thibault@math.univ-montp2.fr

1 - Abstract Convexity with Respect to Min-type Functions

Ivan Ginchev, Professor, University of Insubria, Department of Economics, Varese, 21100, Italy, iginchev@yahoo.com, Matteo Rocca, Giovanni P. Crespi

Two problems of abstract convex analysis are to characterize when a function f is: a) L-subdifferentiable, and b) H-convex, where L and H are the sets of abstract linear and abstract affine functions. Dealing with functions from R^n to R_{+\infty}, and occupying with these problems in the case when L=L_k consists of minima of k linear functions, Rubinov obtains characterizations in the case k>=n+1. So, the case k=n becomes crucial, and our goal is to solve it. Actually, we report a continuation of the investigation initiated in a joint paper with Alex Rubinov, J. Convex Anal. 14 (2007), 185-204.

2 - Optimal Control of Semilinear Delay-differential Inclusions in Infinite-Dimensional Spaces

Lianwen Wang, Associate Professor, University of Central Missouri, Department of Math. and Computer Science, Warrensburg, 64093, United States of America, lwang@ucmo.edu, Boris Mordukhovich, Dong Wang

This talk is devoted to the study of a class of optimal control problems described by semilinear delay-differential inclusions in infinite-dimensional state spaces. First, we construct a well-posed sequence of discrete-time problems that approximate to the original continuous-time problem. Then, we derive necessary optimality conditions for the approximating discrete-time problems by reducing them to infinite-dimensional problems of mathematical programming. Finally, we establish necessary conditions for the given optimal solutions to the original problem by passing to the limit in the obtained results for discrete approximations.

Monday, 1:15pm - 2:45pm

■ MB01

Marriott - Chicago A

Approximation Algorithms A

Contributed Session

Chair: Nicole Megow, Max-Planck-Institut Informatik, Campus E1.4, Saarbrucken, 66123, Germany, nmegow@mpi-inf.mpg.de

1 - A Branch-and-cut Algorithm for the Min-span Frequency Assignment Problem

Nelson Maculan, Professor, Federal University of Rio de Janeiro, P.O. Box 68511, Rio de Janeiro, RJ, 21941-972, Brazil, nelson.maculan@gmail.com, Yuri Frota, Luidi Simonetti, Marcia Fampa

In this paper we deal with the Min-Span frequency assignment problem (FAPs), that is the problem of assigning frequencies to a set of network transmitters in order to satisfy the interference requirement and minimize the bandwidth occupancy. We introduce new classes of valid inequalities for a well know formulation of FAPs and we describe the implementation of a branch and cut algorithm based on the proposed formulation, discussing its advantages and limitations.

2 - Primal-Dual Schema for the Generalized Assignment Problem

Timothy Carnes, PhD Candidate, Cornell University, 206 Rhodes Hall, Ithaca, NY, 14853, United States of America, tcarnes@orie.cornell.edu, David Shmoys

The generalized assignment problem can be thought of as scheduling jobs on parallel machines with costs. If an instance is feasible, our primal-dual schema will produce a solution with cost no greater than optimal, while extending the amount of time available on each machine by a factor of 2. We show first a simple approach for the case that all of the processing times for each job j are either p_j or infinity, and then also discuss the extension to the case of general processing times p_{ij}.

3 - The Price of Robustness for Single Machine Scheduling

Nicole Megow, Max-Planck-Institut Informatik, Campus E1.4, Saarbrucken, 66123, Germany, nmegow@mpi-inf.mpg.de, Martin Skutella, Alberto Marchetti Spaccamela, Leen Stougie

We consider scheduling on a single machine that may experience unexpected changes in processing speed or even full breakdowns. We design deterministic (and randomized) polynomial-time algorithms that find robust prefixed scheduling sequences with a solution value within 4 (and e) times the value an optimal clairvoyant algorithm can achieve, knowing the disruptions in advance. We complement these results by an FPTAS for the special case of a single known non-available period.

■ MB02

Marriott - Chicago B

Complementarity Systems, Dynamic Equilibrium, and Multi-body Contact Problems I

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Lanshan Han, University of Illinois at Urbana Champaign, 117 Transportation Building, 104 South Mathews Avenue, Urbana, IL, 61801, United States of America, hanlsh@illinois.edu

1 - Using Optimization-based Software for Simulating Large Multibody Systems

Mihai Anitescu, Computational Mathematician, Argonne National Laboratory, 9700 South Cass Avenue, Bldg. 221-C219, Argonne, IL, 60439, United States of America, anitescu@mcs.anl.gov, Florian Potra, Cosmin Petra, Bogdan Gavrea

We compare the performance of several quadratic programming (QP) solvers for simulating large-scale frictional rigid-body systems.We report on the results obtained solving that subproblem when using the QP solvers MOSEK, OOQP, TRON, and BLMVM. OOQP is presented with both the symmetric indefinite solver MA27 and our Cholesky reformulation using the CHOLMOD package. We conclude that the OOQP solver, particularly with the CHOLMOD linear algebra solver, has predictable performance and memory use patterns and is far more competitive for these problems than are the other solvers.

2 - Uniqueness and Sensitivity for Differential Variational Inequalilties

David Stewart, Professor, University of Iowa, Department of Mathematics, Iowa City, IA, 52242, United States of America, dstewart@math.uiowa.edu

Differential variational inequalities provide a way of modeling a wide variety of systems from engineering and the physical and social sciences where there are natural or imposed boundaries on a dynamic process. In this talk we will see some recent results on uniqueness of solutions to these problems. Once uniqueness has been established, sensitivity becomes an important issue, especially for problems of optimal control and optimal design. An example involving bouncing behavior is presented.

3 - A DAVI Method for LQ Control and Differential Games

Lanshan Han, University of Illinois at Urbana Champaign, 117 Transportation Building, 104 South Mathews Avenue, Urbana, IL, 61801, United States of America, hanlsh@illinois.edu, Jong-Shi Pang

In this paper, we provide a differential affine variational inequality (DAVI) framework for a finite-horizon, linear-quadratic optimal control problem with possibly unbounded, polyhedral control constraints. Based on this framework, we perform a comprehensive study on this optimal control problem including the regularity and a non-Zenoness property. We also extend our results to linear-quadratic differential Nash games.

■ MB03

Marriott - Chicago C

Numerical Algorithms and Error Bounds for Complementarity Problems

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Florian Potra, University of Maryland-Baltimore County, Dept of Math and Stat, 1000 Hilltop Circle, Baltimore, MD, 21250, United States of America, potra@umbc.edu

1 - Error Bounds for Complementarity Problems Arising from Free Boundary Problems

Goetz Alefeld, University of Karlsruhe, Kaiserstrasse 12 - 76131, Karlsruhe, Germany, goetz.alefeld@math.uni-karlsruhe.de

In this paper we consider the nonlinear complementarity problem with a mapping F consisting additively of a linear part and a nonlinear part. This problem occurs, for example, if certain classes of free boundary problems are discretized. We compute error bounds for approximations to a solution of the discretized problems. The error bounds are improved by an iterative method and can be made arbitrarily small. The ideas are illustrated by numerical experiments.

2 - Generalized Primal-dual Interior Point Algorithms for LCPs with Arbitrary Matrices

Marianna Nagy, Department of Operations Research, Eotvos Lorand University of Sciences, Pazmany P. setany 1/C., Budapest, 1117, Hungary, nmariann@cs.elte.hu, Tibor Illes, Tamas Terlaky

We have generalized some interior point algorithms (IPA) to solve LCPs in the sense of the EP-theorem. These algorithms stop in polynomial time with one of the following: (i) a solution for LCP is obtained, (ii) a solution for dual LCP is obtained, (iii) the matrix of the problem is not in the class of P*(k)-matrices for an a priori given k. The practical applicability of our algorithms will be illustrated on the Arrow-Debreu exchange market model, that was reformulated as an LCP by Ye.

3 - Path Following Algorithms for Complementarity Problems in Wide Neighborhoods of the Central Path

Florian Potra, University of Maryland-Baltimore County, Dept. of Math and Stat, 1000 Hilltop Circle, Baltimore, MD, 21250, United States of America, potra@umbc.edu

Until recently, the best complexity results for linear complementarity problems were obtained by path following algorithms acting in a small neighborhood of the central path, while the best practical performance was obtained by algorithms acting wide neighborhoods. The talk presents an overview of recent theoretical results that have closed this gap, and proposes new path following algorithms that act in a wide neighborhood of the central path and have optimal computational complexity.

■ MB04

Marriott - Denver

Combinatorial Optimization J

Contributed Session

Chair: Marika Neumann, Zuse Institute Berlin, Takustr 7, Berlin, 14195, Germany, marika.neumann@zib.de

1 - The Balanced Minimum Evolution Problem

Daniele Catanzaro, Dr., Service Graphes et Optimization Mathematique Université Libre de Bruxelles, Bd. du Triomphe CP 210/01, Brussels, 1050, Belgium, dacatanz@ulb.ac.be, Raffaele Pesenti, Martine Labbe', Juan Jose' Salazar

The balanced minimum evolution criterion is one of the possible criteria for phylogenetic reconstruction. It states that the phylogeny of a set S of n molecular sequences is the one whose sum of edge weights is minimal. Finding the phylogeny that satisfies the balanced minimum evolution criterion involves solving an optimization problem, called BME, which is based on Pauplin's edge weight estimation model. At present deciding the complexity of BME is an open problem. In this article we investigate a number of mixed integer programming models for BME and present valid inequalities to further strengthen them. Computational results show that our models are well suited for the analysis of datasets containing up 20 taxa.

2 - The Circuit Polytope

latife Genc-Kaya, Carnegie Mellon University, 5000 Forbes Ave., Pittsburgh, PA, United States of America, latife@gmail.com, John Hooker

The circuit constraint requires that a sequence of n vertices in a directed graph describe a hamiltonian cycle.The constraint is useful for the succinct formulation of sequencing problems, such as the traveling salesman problem.We analyze the circuit polytope as an alternative to the traveling salesman polytope as a means of obtaining linear relaxations for sequencing problems.We provide a characterization of the polytope by showing how to generate, using a greedy algorithm, all facet-defining inequalities that contain at most n-4 terms.We suggest efficient separation heuristics.We also show that proper choice of the numerical values that index the vertices can allow the resulting relaxation to exploit structure in the objective function.

3 - The Steiner Connectivity Problem

Marika Neumann, Zuse Institute Berlin, Takustr 7, Berlin, 14195, Germany, marika.neumann@zib.de, Ralf Borndoerfer, Marc Pfetsch

The Steiner connectivity problem (SCP) consists in finding a minimum cost set of paths to connect a subset of nodes. This problem is a generalization of the well-known Steiner tree problem, in which all paths have length one. We show that the important results on the Steiner tree polytope as well as the associated separation algorithms can be carried over to the SCP case. Furthermore, we generalize the famous relation between undirected and directed Steiner tree formulations.

■ MB05

Marriott - Houston

Conic Programming B

Contributed Session

Chair: David Papp, Rutgers Center for Operations Research, Rutgers University, 640 Bartholomew Rd, Piscataway, NJ, 08854, United States of America, dpapp@rutcor.rutgers.edu

1 - Characterization of Matrix-valued Sum-of-squares Functions with Applications

Alizadeh Farid, Professor, RUTCOR and MSIS Department, Rutgers, State University of New Jersey, 640 Bartholomew Rd, Piscataway, NJ, 08854, United States of America, alizadeh@rutcor.rutgers.edu, Ricardo Collado, David Papp

We extend Nesterov's characterization of sum-of-squares of functional systems as semidefinite programs, to function systems whose range is the set of symmetric matrices. We show that the cones of matrix-valued functions of several scalar valued variables which can be expressed as sums of squares of matrix-valued functions are representable by positive semidefinite matrices. Some applications of such functions in estimation of multivariate convex functions will be reviewed.

2 - ISPCA: A Semidefinite Programming Based Heuristic for Sparse Principal Component Analysis

Stephen Billups, Associate Professor, University of Colorado Denver, 1250 14th St., Ste. 600, Denver, CO, 80202, United States of America, Stephen.Billups@ucdenver.edu, Changhui Choi

We present a new heuristic for sparse principal component analysis, which was inspired by DSPCA by d'Aspremont et al. Our computational study indicates that ISPCA's empirical running time is $O(n^2)$ with a small coefficient for the quadratic term whereas DSPCA runs in $O(n^3)$. ISPCA consistently generates solutions that are slightly better than those of DSPCA with an advantage of matching the target cardinality and a small memory requirement.

3 - Shape-constrained Spline Estimation of Multivariate Functions Using Conic Programming

David Papp, Rutgers Center for Operations Research, Rutgers University, 640 Bartholomew Rd, Piscataway, NJ, 08854, United States of America, dpapp@rutcor.rutgers.edu, Alizadeh Farid

Function estimation problems can often be formulated as optimization problems where the approximating function must satisfy certain shape constraints, such as nonnegativity, monotonicity, unimodality or convexity. Such constraints reduce to the nonnegativity of linear functionals of the approximating function. A frequently used approach to function estimation problems is approximation by splines, where shape constraints take the form of conic inequalities with respect to cones of nonnegative polynomials. In the multivariate setting these constraints are intractable; hence we consider tractable restrictions involving weighted-sum-of-squares cones. We present both theoretical justifications of the proposed approach and computational results.

■ MB06

Marriott - Kansas City

Convex Optimization Based Approaches to Discrete and Nonconvex Optimization

Cluster: Conic Programming

Invited Session

Chair: Jiming Peng, UIUC, IESE Department, 104 S. Mathews Ave., Urbana, IL, 61801, United States of America, pengj@illinois.edu

1 - Half-Integrality Based Algorithms for Cosegmentation of Images

Lopamudra Mukherjee, Assistant Professor, University at Wisconsin Whitewater, Department of Math and Computer Science, Whitewater, WI, 53190, United States of America, mukherjl@uww.edu, Vikas Singh

We discuss an optimization framework for the cosegmentation problem from computer vision. Here, the goal is to segment the same object from a pair of images. The segmentation for each image can be cast as a partition function with additional terms that seek to make the histograms of the segmented regions similar. Using MRF based objective for the segmentation, together with histogram consistency using squared L2 distance, yields a model with half-integrality properties of the solution.

2 - A Revisit to Convex Quadratic Programming Relaxation for Binary Quadratic Programming Problems

Rui Yang, Graduate Student, UIUC, IESE, 104 S. Mathews Ave., Urbana, IL, 61801, United States of America, ruiyang1@illinois.edu, Jiming Peng

We consider a special class of (0,1) binary quadratic programming problems (BQP) where the number of nonzero elements is fixed. Such problems arise frequently from various applications and have been proved to be NP-hard. We reconsider a classical simple convex quadratic programming relaxation for the underlying BQP and recast it as a second order conic optimization relaxation. Such a reformulation allows us to use graph modeling techniques to improve the relaxation model. Secondly, we use the convex quadratic relaxation as a geometric embedding tool to reformulate the underlying BQP as a clustering problem where the target is to find a single cluster of fixed size. A simple 2-approximation algorithm for the clustering problem is proposed.

3 - New Relaxation Schemes for Polynomial Programming

Juan Vera, Visiting Assistant Professor, University of Waterloo, Department of Management Sciences, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, jvera@uwaterloo.ca, Miguel Anjos

We present a new representation theorem for positiveness of polynomials with degree bounds. This new result has a elementary proof, and interesting consequences for polynomial programming (PP). In particular we present how to exploit this theorem to obtain cheaper relaxations for PP's.

■ MB07

Marriott - Chicago D

Cutting Planes from Several Rows of a Mixed-integer Program II

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Daniel Espinoza, Universidad de Chile, Republica 701, Santiago, RM, 837-0439, Chile, daespino@dii.uchile.cl

1 - Geometric Study of Mixed-integer Sets from Two Rows of Two Adjacent Simplex Bases

Quentin Louveaux, Université de Liège, Grande Traverse, 10, Liège, 4000, Belgium, Q.Louveaux@ulg.ac.be, Kent Andersen, Robert Weismantel

We generalize the study of sets arising from two rows of a simplex tableau by considering bounds on the nonbasic variables. We show that new classes of facets arise that cannot be obtained from triangles and quadrilaterals. Specifically, when exactly one upper bound on a non-basic variable is introduced, inequalities that can be derived from pentagons involving up to six variables also appear.

2 - Maximal Lattice-free Convex Sets in Linear Subspaces

Gerard Cornuejols, Professor, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States of America, gc0v@andrew.cmu.edu

We consider a relaxation of mixed integer linear programs. We show that minimal valid inequalities for this relaxation correspond to maximal lattice-free convex sets in a linear subspace, and that they arise from piecewise-linear sublinear functions. The proof relies on an extension of a theorem of Lovasz stating that a maximal lattice-free convex set in R^n is either an irrational hyperplane or a cylinder over a polytope. Joint work with Amitabh Basu, Michele Conforti, Giacomo Zambelli.

3 - A Computational Study of Generalized MIR Cuts

Jean-Philippe Richard, University of Florida, Department of Industrial and Systems Eng, 303 Weil Hall, P.O. Box 116595, Gainesville, FL, 32611, richard@ise.ufl.edu, Santanu Dey, Young Park

We study an extension of the simple MIR set that has an arbitrary number of unstructured constraints and that contains two integer and one continuous variable. We describe a polynomial algorithm to generate the facet-defining inequalities of the convex hull of mixed integer solutions to this set, and shows that it yields a polynomial algorithm to generate cuts that consider multiple rows of the problem simultaneously. We report on our computational experience with these new cutting planes.

■ MB08

Marriott - Chicago E

Trends in Mixed Integer Programming II

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Alper Atamturk, University of California- Berkeley, 4141 Etcheverry Hall, Berkeley, CA, United States of America, atamturk@berkeley.edu

Co-Chair: Andrea Lodi, DEIS, University of Bologna, Viale Risorgimento, 2, Bologna, 40136, Italy, andrea.lodi@unibo.it

1 - A Heuristic to Generate Rank-1 GMI Cuts

Sanjeeb Dash, IBM T.J. Watson Research Center, 1101 Kitchawan Road, Yorktown Heights, NY, 10598, United States of America, sanjeebd@us.ibm.com, Marcos Goycoolea

Gomory mixed-integer (GMI) cuts are among the most effective cuts for solving general mixed-integer programs (MIPs), and are traditionally generated from an optimal basis of a linear programming (LP) relaxation of an MIP, usually in rounds. In this talk we demonstrate that the family of rank-1 GMI cuts based on non-optimal tableaus of the initial LP relaxation form a useful subclass of all rank-1 mixed-integer rounding (MIR) cuts, and we give a heuristic to find a violated GMI cut from this subclass, given an arbitrary point.

2 - Lifting for Conic Mixed-integer Programming

Vishnu Narayanan, Industrial Engineering and Operations Research, Indian Institute of Technology Bombay, Mumbai, India, vishnu@iitb.ac.in, Alper Atamturk

Lifting is very effective in developing strong valid inequalities for linear integer programs and has been successfully used to solve such problems with branch-and-cut algorithms. Here we generalize the theory of lifting to conic integer programs. We show how to derive conic valid inequalities for a conic integer program from conic inequalities valid for lower-dimensional restrictions. In order to simplify computations, we also discuss sequence-independent lifting for conic integer programs.

3 - MIP Approaches for Probabilistic Set Covering

Shabbir Ahmed, Georgia Tech, School of Industrial & Systems Engineeri, 765 Ferst Drive, Atlanta, GA, 30332, sahmed@isye.gatech.edu, Alper Atamturk, Dimitri Papageorgiou

We consider integer programming models for probabilistic set covering problems with correlated uncertainties. By exploiting the sub- and super-modularity properties of the probabilistic covering constraints and analyzing their polyhedral structure, we develop strong valid inequalities to strengthen the formulations.

■ MB09

Marriott - Chicago F

Recent Improvements in MIP Solvers II

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Tobias Achterberg, IBM, Zuse Institute Berlin, Takustr. 7, Berlin, 14195, Germany, achterberg@de.ibm.com

1 - Latest Developments of the SAS MILP Solver

Yan Xu, Analytical Solutions Manager, SAS Institute Inc., 500 SAS Campus Drive, Cary, NC, 27513, United States of America, Yan.Xu@sas.com, Amar Narisetty

The SAS MILP solver implements a branch-and-cut algorithm for solving large scale mixed integer linear programs. In this talk, we present the details of latest developments to the solver. These developments include addition of some prevailing and some new techniques to presolve, heuristic, cutting plane and search handling methods of the branch-and-cut algorithm. We present computation results to demonstrate the effectiveness of these techniques.

2 - SCIP/SoPlex/Zimpl — The ZIB Optimization Suite

Thorsten Koch, ZIB / Matheon, Takustr. 7, Berlin, 14195, Germany, koch@zib.de, Timo Berthold, Stefan Vigerske, Stefan Heinz, Kati Wolter, Marc Pfetsch

The software SCIP is a solver and framework for constraint integer programming that also features SAT solving techniques. SCIP comes with all of the necessary components to solve mixed integer programs and is currently one of the fastest non-commercial mixed integer programming solvers. Together with the SoPlex LP Solver and the Zimpl modelling language it builds the ZIB Optimization Suite. In this talk we give an overview of the current status and an outlook to comming developments.

3 - Keeping It SIMPL: Recent Developments for an Integrated Solver

John Hooker, Carnegie Mellon University, Tepper School of Business, 5000 Forbes Ave, Pittsburgh, PA, 15213, United States of America, john@hooker.tepper.cmu.edu, Tallys Yunes, Ionut Aron

A central trend in the optimization community over the past several years has been the steady improvement of general-purpose solvers. A logical next step in this evolution is to combine mixed integer linear programming, constraint programming, and global optimization in a single system. In this talk I describe recent developments in SIMPL, which attempts to implement low-level integration of solution techniques using a high-level modeling language, based on a unifying theoretical framework. SIMPL matches or surpasses the hand-coded integrated methods at a fraction of the implementation effort. It is superior to state-of-the-art MILP and global solvers on most instances we tried, by orders of magnitude on some.

■ MB10

Marriott - Chicago G

Optimization Approaches in Data Mining

Cluster: Global Optimization
Invited Session

Chair: Oleg Prokopyev, University of Pittsburgh, Industrial Engineering, Pittsburgh, PA, 15260, United States of America, prokopyev@engr.pitt.edu

1 - Network Based Techniques for Mining Stock Market Data

Anurag Verma, Graduate Student, Texas A&M University, 238 Zachry, 3131 TAMU, College Station, TX, 77843-3131, United States of America, anuragverma@neo.tamu.edu, Sergiy Butenko, Jean Paul Baharet

We consider a network representation of the stock market data referred to as market graph, which is constructed using cross-correlations between pairs of stocks based on their prices over a certain period of time. We study the application of dominating sets for designing novel and systematic methods for market index creation, portfolio replication and portfolio diversification. We provide heuristic algorithms used for the sample numerical experiments based on data from the U.S. stock markets.

2 - Solving the Order-preserving Submatrix Problem via Integer Programming

Andrew Trapp, Doctoral Student, University of Pittsburgh, 806 Norwich Ave., Apt. 2, Pittsburgh, PA, 15226, United States of America, trapp.andrew@gmail.com, Oleg Prokopyev

In this talk we present our work on using exact solution approaches to solve the Order Preserving Submatrix (OPSM) problem. This problem is known to be NP-hard, and although in recent years some heuristic methods have been presented to find OPSMs, they lack the guarantee of optimality. We present exact solution approaches based on linear mixed 0-1 programming formulations, and develop algorithmic enhancements to aid in solvability. Encouraging computational results are reported both for synthetic and real biological data.

3 - Sequential Minimal Optimization for Relaxed Support Vector Machines

Onur Seref, Assitant Professor, Virginia Tech, 1007 Pamplin Hall 0235, Blacksburg, VA, 24061, United States of America, seref@vt.edu

In this talk, we introduce a modification to the standard support vector machine (SVM) formulation, in which a restricted amount of unpenalized slack is provided to relax the support vectors. The Lagrangian dual of this formulation is similar to the SVM dual formulation, which can be solved efficiently via sequential minimal optimization (SMO), an iterative decomposition technique based on analytical solution of two variables in each iteration. We focus on the adaptation of the SMO technique for the new dual formulation. We present comparative results against a leading optimization software on various multiple instance learning benchmark data sets.

■ MB11

Marriott - Chicago H

Global Optimization and Control Theory

Cluster: Global Optimization
Invited Session

Chair: Zelda Zabinsky, Professor, University of Washington, Industrial Engineering, Box 352650, Seattle, WA, 98195, United States of America, zelda@u.washington.edu

1 - Hybrid Interior Point-lagrange Solver

Yanfang Shen, Associate, Citi Alternative Investment, Quantitative Strategies, 399 Park Ave., Floor 7, New York, NY, 10022, United States of America, yanfang.shen@citi.com, Wolf Kohn

We present an algorithm for solving mixed integer problems. It reformulates them as a feedback control problems with dynamics given by gradient descent differential equations. The variables controlling the descent are Lagrange multipliers and Field Intensity coefficients; defined by the equality and inequality constraints. The feedback is defined by two iterations on the control variables. The algorithm is robust and stable for both closed and semi-closed domains. Numerical results are given.

2 - Optimization of Dynamic Rule-based Systems

Wolf Kohn, Director, Citi Alternative Investment, Quantitative Strategies, 399 Park Avenue, 7th floor, New York, NY, 10022, United States of America, wolf.kohn@citi.com, Zelda Zabinsky, Hongrui Liu

We formulate a theory for the solution of systems whose dynamics are given by Horn Clauses. It is based on the characterization of a navigation procedure, not by inference. This procedure is described by a locally finite state automaton. Its frequency response encodes the dynamics of the rules, the goal of the optimization and the active Horn clauses. The solution is synthesized as Feedback Clauses by a transformation procedure. We present a power system forecasting and dispatch example.

3 - Meta-control Approach To Large-scale Binary Integer Programs

Zelda Zabinsky, Professor, University of Washington, Industrial Engineering, Box 352650, Seattle, WA, 98195, United States of America, zelda@u.washington.edu, Wolf Kohn, Kathrine von Haartman

We develop a meta-control approach using trajectory mapping to approximately solve large-scale binary integer programs (BIPs). Whereas the class of BIPs is known to be NP-hard, optimal control problems can be solved in polynomial time in terms of the number of state and control variables. The algorithm constructs a sequence of approximations using a reduced set of constraints. We prove convergence in the error of the approximation, and present numerical results.

■ MB12

Marriott - Los Angeles

Derivative-free Algorithms: Direct Search

Cluster: Derivative-free and Simulation-based Optimization
Invited Session

Chair: Trond Steihaug, Professor, University Bergen, Department of Informatics, PB 7803, Bergen 5020, NorwayTrond.Steihaug@ii.uib.no

1 - Randomness in Direct Search Methods: Boon or Bane?

Margaret Wright, Professor, New York University, Courant Institute, 251 Mercer Street, New York, NY, 10012, United States of America, mhw@cs.nyu.edu

Some non-derivative optimization methods, notably evolutionary algorithms, are fundamentally based on randomness, which also enters modern direct search algorithms such as APPSPACK and LTMADS. We explore the use of randomness in an alternative spirit, as proposed by Brent in the 1970s, to allow movement away from regions of ill-conditioning that cause methods to fail. A major question is whether the gains in efficiency are offset by the loss of reproducible results or convergence guarantees.

2 - Challenges Using Derivative-free Optimization Methods in Scientific Applications

Juan Meza, Doctor, Lawrence Berkeley Nat. Lab., 1 Cyclotron Road, 50B-4230, Berkeley, CA 94720JCMeza@lbl.gov

Optimization has taken an increasingly larger role in scientific problems today. This is due in large part to the rise of computational modeling and simulation in all scientific fields. Some examples include the determination of the surface structure of nanosystems, fitting supernova models to data, and the design and operation of particle accelerators. I will discuss some of the challenges and the approaches one can take for addressing optimization problems arising from these applications.

3 - Generating Set Search with Convergence to Second-order Stationary Points and the Impact of Sparsity

Trond Steihaug, Professor, University Bergen, Department of Informatics, PB 7803, Bergen 5020, Norway, Trond.Steihaug@ii.uib.no, Mark Abramson, Lennart Frimannslund

Certain limit points of pattern search have been shown to satisfy second-order necessary condition. The second-order condition can be ensured if the set of positive spanning directions used by the algorithm happens to include the eigenvectors of the Hessian at the limit point. Approximate second derivative information can be gathered during the iteration process and normalized eigenvectors of the approximation can be computed. The set of 2n orthonormal directions used by the algorithm can be rotated to include these eigenvectors. The approximation can be proved to converge to the actual Hessian and satisfaction of the second-order necessary condition is achieved. In this talk we will discuss the effect of sparsity of the Hessian matrix.

■ MB13

Marriott - Miami

Multistage Stochastic Programming in Energy Systems

Cluster: Optimization in Energy Systems
Invited Session

Chair: Georg Pflug, Professor, University of Vienna, Department of Statistics and Decision Support, Universitatsstrasse 5, Vienna, A-1010, Austria, georg.pflug@univie.ac.at

1 - Stochastic Stackelberg Games and the Pricing of Flexible Energy Delivery Contracts

Georg Pflug, Professor, University of Vienna, Department of Statistics and Decision Support, Universitatsstrasse 5, Vienna, A-1010, Austria, georg.pflug@univie.ac.at

Flexible energy delivery contracts as swing options can be seen as stochastic leader-follower games. The contract issuer, who sets the price in advance is the leader, the contract holder, who may exercise his delivery rights is the follower. Both sides are subject to risk. We propose an algorithmic way how to find a reasonable price for such contract, which takes the anticipated behavior of the follower into account and thus depends on assumptions about his exercise strategy. From a theoretical side, the problem type is a stochastic optimization problem with a multistage stochastic equilibrium constraint.

2 - Risk Measurement in the Electric Power Industry

Karl Frauendorfer, Professor, University of St. Gallen, Bodanstrasse 6, St. Gallen, Switzerland, karl.frauendorfer@unisg.ch

Since price and volume uncertainties create both risks and opportunities for electricity companies, financial risk management practices need to be enhanced and translated to meet the specific requirements of the electric power industry. Applying mathematical programming we will focus on full service contracts and associated key tasks which are sensitive to the risk management process. Stochastic models are introduced that allow for optimal sourcing and the evaluation of market risk premiums. Numerical results will be represented based on the historical price dynamics of the EEX.

3 - A Multi-stage Stochastic Programming Model for Managing Risk-optimal Electricity Portfolios

David Wozabal, University of Vienna, Branner Strasse 72, Vienna, 1210, Austria, david.wozabal@univie.ac.at, Ronald Hochreiter

A multi-stage decision model, which serves as a building block for solving various electricity portfolio management problems, is presented. The basic setup consists of a portfolio optimization model for a large energy consumer, that has to decide about its mid-term electricity portfolio composition. The problem is formulated in a dynamic stochastic optimization framework, whose flexibility allows for extensive parameter studies and comparative analysis of different types of supply contracts. Apart from the question of an optimal energy policy mix for a energy consumer the pricing problem for flexible supply contracts from the perspective of an energy trader is investigated, demonstrating the wide applicability of the framework.

■ MB14

Marriott - Scottsdale

New Trends in Auction Design

Cluster: Game Theory

Invited Session

Chair: Nina Balcan, Microsoft Research, One Memorial Drive, 14th Floor, Cambridge, MA, 02142, United States of America, ninamf@cs.cmu.edu

1 - Efficiency of Revenue-maximizing Mechanisms

Gagan Goel, Georgia Institute of Technology, gagan.goel@gmail.com, Aranyak Mehta, Gagan Aggarwal

We show that the efficiency of the revenue-maximizing mechanism for selling a single item with k + log k bidders is at least as much as the efficiency of the efficiency-maximizing mechanism with k bidders, when bidder valuations are drawn i.i.d. from a M.H.R distribution. This is in contrast to the result of Bulow and Klemperer, who showed that one extra bidder suffice for the efficiency-maximizing mechanism to match the revenue of revenue-maximizing mechanism.

2 - Social Lending

Arpita Ghosh, Yahoo! Research, 701 1st Avenue, Sunnyvale, United States of America, arpita@yahoo-inc.com, Ning Chen, Nicholas Lambert

Prosper, the largest online social lending marketplace with nearly a million members and $\$178$ million in funded loans, uses an auction amongst lenders to finance each loan. In each auction, the borrower specifies D, the amount he wants to borrow, and a maximum acceptable interest rate R. Lenders specify the amounts a_i they want to lend, and bid on the interest rate, b_i, they're willing to receive. Given that a basic premise of social lending is cheap loans for borrowers, how does the Prosper auction do in terms of the borrower's payment, when lenders are {\em strategic agents} with private true interest rates? The Prosper mechanism is exactly the same as the VCG mechanism applied to a {\em modified instance} of the problem, where lender i is replaced by a_i dummy lenders, each willing to lend one unit at interest rate b_i. However, the two mechanisms behave very differently —- the VCG mechanism is truthful, whereas Prosper is not, and the total payment of the borrower can be vastly different in the two mechanisms. We first provide a complete analysis and characterization of the Nash equilibria of the Prosper mechanism. Next, we show that while the borrower's payment in the VCG mechanism is {\em always} within a factor of $O(\log D)$ of the payment in any equilibrium of Prosper, even the cheapest Nash equilibrium of the Prosper mechanism can be as large as a factor D of the VCG payment; both factors are tight. Thus, while the Prosper mechanism is a simple uniform price mechanism, it can lead to much larger payments for the borrower than the VCG mechanism. Finally, we provide a model to study Prosper as a dynamic auction, and give tight bounds on the price for a general class of bidding strategies.

3 - Incentives in Online Auctions and Secretary Problems via Linear Programming

Niv Buchbinder, Microsoft Research, United States of America, nivbuchb@microsoft.com

Online auctions in which items are sold in an online fashion with little knowledge about future bids are common in the internet environment. We study a problem in which an auctioneer would like to sell an item. A bidder may make a bid at any time but expects an immediate decision. We study the issue of incentives in the online auction problem where bidders are allowed to change their arrival time if it benefits them. We show a LP based technique as a basic framework for analyzing the problem.

4 - An Optimal Lower Bound for Anonymous Scheduling Mechanisms

Itai Ashlagi, Harvard University, Baker Library, Boston, United States of America, iashlagi@hbs.edu, Ron Lavi, Shahar Dobzinski

We consider the problem of designing truthful mechanisms to minimize the makespan on m unrelated machines. In their seminal paper, Nisan and Ronen (99) showed a lower bound of 2, and an upper bound of m, thus leaving a large gap. The lower bound was only recently slightly increased to 2.61, while the best upper bound remained unchanged. In this paper we show the optimal lower bound on truthful anonymous mechanisms: no such mechanism can guarantee an approximation ratio better than m.

■ MB16

Gleacher Center - 200

Sampling in Stochastic Optimization: Methodology and Applications

Cluster: Stochastic Optimization

Invited Session

Chair: Guzin Bayraksan, University of Arizona, Systems and Industrial Engineering, P.O. Box 210020, Tucson, AZ, 85721, United States of America, guzinb@sie.arizona.edu

1 - Introducing CO2 Allowances: Higher Prices for All Consumers, Higher Revenues for Who?

Romeo Langestraat, PhD Student, Tilburg University, P.O. Box 90153, Tilburg, 5000LE, Netherlands, r.langestraat@uvt.nl, Gul Gurkan, Ozge Ozdemir

Related to efforts of reducing CO2 emissions, we analyze the effects of introducing a cap-and-trade system or taxation on capacity investments in a game theoretic setting. While there is a fixed merit order of technologies under taxation, there is a different merit order for different levels of demand under cap-and-trade. We illustrate how to solve these models as stochastic programs or complementarity problems under uncertainty, using sampling. We show that if there is shortage of transmission capacity in the system, only introducing a cap-and-trade system or taxation is neither sufficient to curb CO2 levels nor necessarily induces investment in cleaner technologies, respectively.

2 - Assessment of Solution Quality for Some Nonlinear Stochastic Problems Using Bootstrap

Fabian Bastin, Assistant Professor, University de Montreal, Dpt of Computing Science and Oper. Res., CP 6128, Succ Centre-Ville, Montreal, QC, H3C 3J7, Canada, bastin@iro.umontreal.ca, Cinzia Cirillo

We consider minimization of problems based on Monte-Carlo draws obtained using physical data, which can be costly to obtain. Since independent samples are then difficult to construct, bootstrap appears appealing to evaluate estimations accuracy. We apply this approach on some specific problem classes and compare it to other popular techniques, which can be deficient when some assumptions are relaxed. We also briefly explore the use bootstrap in stopping criteria for more general problems.

3 - A Probability Metrics Approach for Bias and Variance Reduction in Optimality Gap Estimation

Guzin Bayraksan, University of Arizona, Systems and Industrial Engineering, P.O. Box 210020, Tucson, AZ, 85721, United States of America, guzinb@sie.arizona.edu

Monte Carlo sampling-based statistical estimators of optimality gaps for stochastic programs are known to be biased. We present a method for bias reduction in these estimators via a probability metrics approach, which can be done in polynomial time in sample size. We show that the resulting estimators after bias reduction produce consistent point estimators and asymptotically valid confidence intervals. Our preliminary computational results show that this procedure can also reduce variance.

■ MB17

Gleacher Center - 204

Applications of Optimization and Complementarity Problems in Logistics

Cluster: Logistics and Transportation
Invited Session

Chair: Georgia Perakis, MIT, 50 Memorial Drive, Cambridge, MA, United States of America, georgiap@mit.edu

1 - Optimal Multi-product Pricing for Attraction Demand Models

Georgia Perakis, MIT, 50 Memorial Drive, Cambridge, MA, United States of America, georgiap@mit.edu, Retsef Levi, Philip Keller

We consider a multi-product pricing problem first under the multinomial demand model. The problem is non-concave and hence solving it efficiently is an issue. An added difficulty to the problem is also due to capacity constraints shared among products. We illustrate its efficient solution in theory as well as by conducting numerical experiments to contrast the proposed algorithm with other approaches. We also consider its extension to more general attraction models.

2 - Recent Results for Generalized Nash Equilibria

Jong-Shi Pang, Professor, University of Illinois at Urbana-Champaign, 117 Transportation Building MC-238, 104 S. Mathews Ave, Urbana, IL, 61801, jspang@illinois.edu

A generalized Nash equilibrium is a solution of a non-cooperative game wherein each player's strategy set is dependent on the rivals' strategies. This paper presents some new results for such equilibria: (a) existence using degree theory applied to a fixed-point formulation of an equilibrium based on a regularized Nikaido-Isoda function; (b) a matrix-theortic criterion for the contraction of the fixed-point map, implying the uniqueness of the Nash equilibrium and the convergence of a fixed-point iteration for its computation, (c) extension to a game with prices, and (d) discussion of a communication game with quality of service constraints under the cognitive radio paradigm.

3 - Equitable and Efficient Coordination in Traffic Flow Management

Douglas Fearing, PhD Candidate, MIT, Operations Research Center, Cambridge, MA, 02139, United States of America, dfearing@mit.edu, Cynthia Barnhart, Constatine Caramanis, Dimitris Bertsimas

We propose two optimization formulations balancing equity and delay for the multi-resource TFM scheduling problem. To evaluate these models and compare them to the current approach, we develop a metric for schedule fairness derived from highly-successful properties of RBS. Through regional and national scenarios derived from historical data, we demonstrate that both models lead to improved efficiency while maintaining an equivalent level of fairness as current practice.

■ MB18

Gleacher Center - 206

Nonlinear Mixed Integer Programming B

Contributed Session

Chair: Nobusumi Sagara, Professor, Hosei University, 4342, Aihara, Machida, Tokyo, 194-0298, Japan, nsagara@hosei.ac.jp

1 - A Nonlinear Approach to the Vehicle Positioning Problem

Carlos Cardonha, Zuse institute Berlin, Takustrasse 7, Berlin, Germany, cardonha@zib.de, Ralf Borndoerfer

The Vehicle Positioning Problem consists of the assignment of vehicles to parking positions and to trips. The assignments are constrained by the depot topology and by the vehicle types accepted by the trips. We present solutions based on linear and quadratic integer programming for the problem and compare then from a theoretical and a computational point of view. In particular, we can show that quadratic programming yields the first nontrivial lower bound on instances that require shunting.

2 - Comparison of Convex Relaxations for the Water Irrigation Network Design Problem

Graca Goncalves, CIO-FCUL, Departamento de Matematica, FCT, Universidade Nova de Lisboa, Quinta da Torre, Monte de Caparica, 2829-516, Portugal, gmsg@fct.unl.pt, Luis Gouveia, Margarida Vaz Pato

In this paper the water distribution network design problem within a pressurized irrigation system is considered along with a MBNLP model, which includes at the objective function some bilinear terms depending on the continuous and others on the binary variables. It also has non-convexities at the constraints. We present a model reformulation to reduce the non-convexities as well as convex relaxations to provide lower bounds for the global minimum. Computational results will be shown.

3 - A Lyapunov-type Theorem for Nonadditive Vector Measures

Nobusumi Sagara, Professor, Hosei University, 4342, Aihara, Machida, Tokyo, 194-0298, Japan, nsagara@hosei.ac.jp

The purpose of this paper is to establish a Lyapunov-type convexity theorem for the class of supermodular set functions (convex games). We prove the convexity and compactness of the closure of the lower partition range of an $\mathbb(R)^n$-valued, nonatomic, continuous, supermodular set function, employing a useful relationship between cores and Choquet integrals for convex games. The main result is applied to partitioning a measurable space among a finite number of players, and the existence of Pareto optimal α-fair partitions is demonstrated for the case of nonadditive measures.

■ MB19

Gleacher Center - 208

Stochastic Optimization B

Contributed Session

Chair: Ronald Hochreiter, University of Vienna, Universite Strasse 5/9, Vienna, 1010, Austria, ronald.hochreiter@univie.ac.at

1 - A Stochastic Dynamic Programming Approach to Large-scale Network Revenue Management

Dolores Romero Morales, University of Oxford, Park End Street, Oxford, ox1 1hp, United Kingdom, dolores.romero-morales@sbs.ox.ac.uk, Laureano Escudero, Juan Francisco Monge, Jingbo Wang

We apply the stochastic dynamic programming approach to the network revenue management problem. The advantages are twofold. First, and as opposed to the existing literature, our methodology can define bid prices for combination of resources directly. Second, this methodology can deal with large-scale problem instances more efficiently.

2 - A Stochastic Programming Approach to Mine Scheduling: Model Reductions, Heuristics, Disaggregation

Gary Froyland, University of New South Wales, School of Mathematics and Statistics, Sydney, 2052, Australia, g.froyland@unsw.edu.au, Irina Dumitrescu, Natashia Boland

The Open Pit Mine Production Scheduling Problem (OPMPSP) is usually based on a single geological estimate of material to be excavated and processed. While some attempts have been made to use such multiple stochastic geological estimates in mine production scheduling, none allow mining and processing decisions to flexibly adapt over time, in response to observation of the geology of the material mined. We discuss a number of reductions that lower the computational effort of solving a mixed integer stochastic programming model that allows this flexibility. We describe heuristics that further reduce solution times and outline an efficient disaggregation approach. We illustrate these techniques on realistic data sets.

3 - Multi-stage Stochastic Pension Fund Management

Ronald Hochreiter, University of Vienna, Universite Strasse 5/9, Vienna, 1010, Austria, ronald.hochreiter@univie.ac.at

The optimal management of pension funds is important for handling the growing challenges in keeping stable nation-wide pension systems. In contrast to standard Asset Liability Management, the goal of managing a pension fund is not solely based on a maximization of profits, while ensuring the coverage of liabilities. In addition, the contradictory interests of both the active members and the retired members have to be considered. Furthermore, the set of regulatory constraints is huge, and constantly evolving. A multi-stage stochastic programming model for managing pension funds will be presented - with a special focus on generating realistic scenarios.

■ MB20

Gleacher Center - 300

Nonlinear Programming: Theory and Algorithms

Cluster: Nonlinear Programming
Invited Session

Chair: Sven Leyffer, Argonne National Laboratory, MCS Division 9700 South Cass Avenue, Argonne, IL, 60439, United States of America, leyffer@mcs.anl.gov

Co-Chair: Annick Sartenaer, Professor, University of Namur (FUNDP), Rempart de la Vierge, 8, Namur, B-5000, Belgium, annick.sartenaer@fundp.ac.be

1 - When is Newton's Method Guaranteed to Converge for Optimization?

Daniel Crumly, Graduate Student, University of Colorado, 430 UCB, Boulder, CO, 80309, United States of America, Daniel.Crumly@Colorado.EDU, Richard Byrd

In unconstrained optimization, Newton's method with a line search is often the solver of choice. However, the standard global convergence theory does not apply when the Hessian approximation is singular in the limit. We discuss Newton-like methods and show general conditions for global convergence extending standard results. These imply specific conditions which give insight into some well-known Hessian modifications, such as adding a multiple of the identity, and the Gauss-Newton method.

2 - An Approach for Very Large-scale Nonlinear Programming

Jorge Nocedal, Professor, Northwestern University, EECS Dept, Evanston, IL, 60201, United States of America, nocedal@eecs.northwestern.edu, Richard Waltz, Roger Fletcher

We consider algorithms based on two design characteristics: a) the active-set identification phase is based on the solution of a linear program (that may implicitly include some second-order information); b) fast convergence is obtained by a second phase that aims directly at achieving optimality. We give careful consideration to the treatment of degeneracy and to the global convergence properties of the approach. We report results on problems with hundreds of thousands of variables.

3 - Local Convergence of Interior-point Methods in the Absence of Strict Complementarity

Dominique Orban, GERAD and Ecole Polytechnique, CP 6079 Succ. Centre-Ville, Montreal, QC, Canada, Dominique.Orban@polymtl.ca, Nick Gould, Andreas Waechter, Zoumana Coulibaly

Interior-point methods are currently recognized to be amongst the most powerful techniques for solving large-scale optimization problems. They are known to have a worst-case polynomial convergence bound for many convex problems, and may be globalized in the non-convex case. In addition, the achievable asymptotic convergence rate is Q-superlinear under suitable regularity assumptions. In this talk, we report on preliminary research on the recovery of fast local convergence properties of primal-dual interior-point methods in the absence of strict complementarity for general non-convex problems.

■ MB21

Gleacher Center - 304

Game Theory and Variational Inequalities

Cluster: Telecommunications and Networks
Invited Session

Chair: Anna Nagurney, John F. Smith Memorial Professor, Isenberg School of Management, University of Massachusetts, Amherst, MA, 01003, United States of America, nagurney@gbfin.umass.edu

1 - Evolutionary Variational Inequalities and the Internet

Anna Nagurney, John F. Smith Memorial Professor, Isenberg School of Management, University of Massachusetts, Amherst, MA, 01003, United States of America, nagurney@gbfin.umass.edu David Parkes, Patrizia Daniele

We present the evolutionary variational inequality formulation of the Internet with a focus on the multiclass flows, multiclass costs, and equilibria. In particular, we consider that there are different classes on the Internet and that the equilibrium conditions are associated with each class. We also illustrate the novelty of this framework in the context of a time-dependent Braess (1968) paradox.

2 - Modeling of Supply Chain Risk under Disruptions with Performance Measurement and Robustness Analysis

Patrick Qiang, Penn State University Great Valley, 30 East Swedesford Road, Malvern, PA, 19355, United States of America, patrick.qiang@gmail.com, Anna Nagurney, June Dong

We develop a supply chain network model with multiple decision-makers associated at different tiers and with multiple transportation modes for shipment of the good. The model captures the individual attitudes towards risks among the manufacturers and the retailers. We derive the governing equilibrium conditions and establish the finite-dimensional variational inequality formulation. A weighted supply chain performance and robustness measure is proposed.

3 - Formulation and Analysis of Horizontal Mergers Among Oligopolistic Firms with Insights into the Merger Paradox

Anna Nagurney, John F. Smith Memorial Professor, Isenberg School of Management, University of Massachusetts, Amherst, MA, 01003, United States of America, nagurney@gbfin.umass.edu

In this paper, we consider oligopolistic firms and explore what has become known in the literature as the "merger paradox." We present the oligopolistic network equilibrium model associated with the competing firms before the horizontal mergers and also develop the network optimization model post the complete merger. In addition, we develop the model in which only a subset of the firms in the industry merge. The governing concept of the competing firms is that of Cournot-Nash equilibrium. We utilize finite-dimensional variational inequality theory for the formulation, analysis, and solution of the pre and post-merger network problems. We provide numerical examples for which we compute the total costs, the total revenues, as well as the profits obtained for the firms pre and post the mergers for a variety of distinct oligopoly problems. The generality of the network models and the flexibility of the computational approach, which yields closed form expressions for the flows at each iteration, allows us to gain deeper insights into the merger paradox.

4 - An Integrated Electric Power Supply Chain and Fuel Market Network Framework: Theoretical Modeling with Empirical Analysis for New England

Zugang (Leo) Liu, Pennsylvania State University Hazleton, Department of Business and Economics, Hazelton, PA, zxl23@psu.edu

In this paper, we develop a novel electric power supply chain network model with fuel supply markets that captures both the economic network transactions in energy supply chains and the physical network transmission constraints in the electric power network. The theoretical derivation and analyses are done using the theory of variational inequalities. We then apply the model to a special case, the New England electric power supply chain, consisting of 6 states, 5 fuel types, 82 power generators, with a total of 573 generating units, and 10 demand market regions. The empirical case study demonstrates that the regional electric power prices simulated by the proposed model very well match the actual electricity prices in New England. We also compute the electric power prices under natural gas and oil price variations. The empirical examples illustrate that both the generating unit responsiveness and the electric power market responsiveness are crucial to the full understanding and determination of the impact of the residual fuel oil price on the natural gas price. Finally, we utilize the model to quantitatively investigate how changes in the demand for electricity influence the electric power and the fuel markets from a regional perspective. The theoretical model can be applied to other regions and multiple electricity markets under deregulation to quantify the interactions in electric power/energy supply chains and their effects on flows and prices.

■ MB22

Gleacher Center - 306

Warmstarts with Interior Point Methods II

Cluster: Implementations, Software
Invited Session

Chair: Jacek Gondzio, University of Edinburgh, School of Mathematics, Edinburgh, United Kingdom, J.Gondzio@ed.ac.uk

1 - IPM Warmstarts for Single Coefficient Perturbation on the Right Hand Side

Fernando Ordonez, University of Southern California, 3715 McClintock Avenue, Los Angeles, CA, fordon@usc.edu, Richard Waltz

A classic branch and bound method requires the solution of a series of problems which differ only in the bound constraint of a variable from a previously solved problem. We formulate this as single perturbations to the righthand side vector and propose a penalty approach. We study theoretical and efficient heuristic methods to reduce the number of IPM iterations of solving the modified problem.

2 - Recent Advances in Warm-starts in Interior-point Methods

E. Alper Yildirim, Bilkent University, Department of Industrial Engineering, Bilkent, Ankara, 06800, Turkey, yildirim@bilkent.edu.tr

The problem of solving a sequence of closely related optimization problems arises frequently in sequential optimization algorithms and branch-and-bound-like schemes. The information gained during the solution of an optimization problem can in principle be used to solve a closely related optimization problem with less computational effort. The proper use of this information constitutes warm-start techniques. In the last few years, there has been considerable progress in the design of warm-start techniques for reoptimization using interior-point methods. In this talk, we survey recent advances in this direction with an emphasis on potential improvement areas as well as limitations.

3 - A Decomposition-based Warm-start Method for Stochastic Programming

Andreas Grothey, Lecturer, University of Edinburgh, Edinburgh, United Kingdom, A.Grothey@ed.ac.uk, Marco Colombo

We propose a warm-start technique for interior point methods applicable to two-stage stochastic linear programming problems. The main idea is to solve a simplified problem to obtain estimates of the first stage component of the central path and subsequently perform half an iteration of a decomposition scheme to extend this to a full primal-dual point. The resulting point is used as a warm-start point to solve the full problem by IPM. The warm-start point can be shown to be in a neighbourhood of the central path under appropriate conditions on the simplified problems. We present both theoretical and numerical results for this algorithm. An extension to multi-stage stochastic programming is possible.

■ MB24

Gleacher Center - 400

Stackelberg, Steiner and Lovasz

Cluster: Telecommunications and Networks

Invited Session

Chair: Guido Schaefer, Centrum Wiskunde & Informatica, Science Park 123, Amsterdam, 1098 XG, Netherlands, Guido.Schaefer@cwi.nl

1 - Stackelberg Routing in Arbitrary Networks

Vincenzo Bonifaci, Sapienza University of Rome, via Ariosto, 25, Roma, RM, 00185, Italy, bonifaci@dis.uniroma1.it, Guido Schaefer, Tobias Harks

We study the impact of Stackelberg routing to reduce the price of anarchy in network routing games. In this setting, a constant fraction of the entire demand is routed centrally according to a predefined Stackelberg strategy and the remaining demand is routed selfishly by nonatomic players. We exhibit a family of single-commodity networks for which every Stackelberg strategy has price of anarchy at least proportional to the size of the network, and we exhibit a Stackelberg strategy with price of anarchy bounded by a function of the size of the network. We also give improved bounds on the price of anarchy induced by specific Stackelberg strategies in other cases, such as when the latency functions are polynomials of bounded degree.

2 - Hypergraphic LP Relaxations for the Steiner Tree Problem

David Pritchard, PhD Candidate, University of Waterloo, 200 University Ave. W., Waterloo, ON, N2L2C9, Canada, dagpritc@math.uwaterloo.ca, Yehua Wei, Jochen Könemann, Deeparnab Chakrabarty

The Steiner Tree problem is to find a cheapest subgraph connecting a given set of terminals. We study its linear program (LP) relaxations. A novel LP tool, uncrossing of partitions, yields (1) equivalence of several known hypergraphic LP relaxations and equivalence to the bidirected cut relaxation when terminals form a dominating set (quasi-bipartite graphs) (2) on quasi-bipartite graphs, the integrality gap is at most 73/60 (3) basic solutions are sparse and other structural results.

3 - Budgeted Matching and Budgeted Matroid Intersection via the Gasoline Puzzle

Andre Berger, Maastricht University, P.O. Box 616, Dept. KE, Maastricht, 6226 AP, Netherlands, berger.andre@gmail.com, Vincenzo Bonifaci, Fabrizio Grandoni, Guido Schaefer

Many polynomial-time solvable combinatorial optimization problems become NP-hard if an additional complicating constraint is added. In this paper we present the first polynomial-time approximation schemes for two such problems, the maximum-weight matching and maximum- weight matroid intersection with an additional budget constraint. Our schemes compute two solutions to the Lagrangian relaxation of the problem and patch them together to obtain a near-optimal solution. Standard patching techniques do not apply due to the rich combinatorial structure of the problems, and to circumvent this problem we crucially exploit the adjacency relation on the solution polytope and the solution to an old combinatorial puzzle.

■ MB25

Gleacher Center - 404

Regularity Properties of Optimal Solutions

Cluster: Variational Analysis

Invited Session

Chair: Ilya Shvartsman, Penn State Harrisburg, Dept. of Mathematics and Computer Science, 777 West Harrisburg Pike, Middletown, PA, 17057, United States of America, ius13@psu.edu

1 - Regularity of Optimal Control in a Problem with Mixed and Pure State Constraints

Ilya Shvartsman, Penn State Harrisburg, Dept of Mathematics and Computer Science, 777 West Harrisburg Pike, Middletown, PA, 17057, United States of America, ius13@psu.edu, Maria Rosario de Pinho

We report conditions ensuring Lipschitz continuity of optimal control and Lagrange multipliers for a dynamic optimization problem with inequality pure state and mixed state/control constraints.

2 - Regularity of Solutions of State Constrained Optimal Control Problems

Frederic Bonnans, INRIA-Saclay, Centre de Mathématiques Appliquées, Ecole Polytechnique, Palaiseau, 91128, France, Frederic.Bonnans@inria.fr

We will first analyze optimal control problems with several state constraints in [BH09], present second-order optimality conditions and their link with the shooting algorithm, and comment several extensions. Next we will discuss the extension to the optimal control of parabolic equations. Both studies strongly rely on the use of alternative optimality systems. REFERENCES: [BH09] J.F. Bonnans and A. Hermant: Second-order Analysis for Optimal Control Problems with Pure State Constraints and Mixed Control-State Constraints. Ann. Inst. H. Poincare (C), Non Lin. Anal. 26 (2009), 561-598. [BH08] J.F.Bonnans and P. Jaisson: Optimal control of a parabolic equation with time-dependent state constraints. INRIA Rep. 6784, 2008.

3 - Functions on Monotone Graphs: Analysis and Computation

Stephen Robinson, Professor Emeritus, University of Wisconsin-Madison, ISyE/UW-Madison, 1513 University Ave Rm 3015, Madison, WI, 53706-1539, United States of America, smrobins@wisc.edu

Many problems of practical interest, including but not limited to variational inequalities, require solution of an equation defined on the graph of a maximal monotone operator. We present a formulation for such problems that leads to an implicit-function theorem employing a basic regularity condition. The same underlying condition provides a convergence proof for a Newton algorithm for such problems. We will sketch the underlying analysis, discuss computational challenges, and present some examples.

■ MB26

Gleacher Center - 406

Portfolio and Option Problems B

Contributed Session

Chair: Andrey Lizyayev, PhD Student, Erasmus University Rotterdam, P.O. Box 1738, Rotterdam, 3000 DR, Netherlands, lizyayev@few.eur.nl

1 - Pricing and Advertising in the Manufacturer-retailer-consumer Channel

Andrea Ellero, Università Ca’ Foscari di Venezia, Dorsoduro 3825/e, Venezia, Italy, ellero@unive.it, Igor Bykadorov, Stefania Funari, Elena Moretti

We present two dynamic models. In the first one we consider a vertical control distribution channel. The optimal discount policy of the manufacturer turns out to depend on the efficiency of the retailer and his sale motivation. In the second one we model the dynamics of the communication activity of a firm with the aim of maximizing its efficiency. The model is formulated as a fractional optimal control problem. In order to solve it we use the Dinkelbach’s approach.

2 - Stochastic Dominance Efficiency Analysis of Diversified Portfolios: Majorization, Marginal Conditional, and Quantile Approaches with Refinements

Andrey Lizyayev, PhD Student, Erasmus University Rotterdam, P.O. Box 1738, Rotterdam, 3000 DR, Netherlands, lizyayev@few.eur.nl, Timo Kuosmanen

For more than three decades, empirical analysis of stochastic dominance was restricted to settings with mutually exclusive choice alternatives. In recent years, a number of methods for testing efficiency of diversified portfolios have emerged, that can be classified into tree main categories: 1) majorization, 2) marginal conditional and 3) quantile-based approaches. These three approaches and the specific methods within each approach differ in terms of their objectives, information content of the results, as well as their computational complexity.

Unfortunately, these three schools of thought are developing independently, with little interaction or cross-references among them. As a result, the relative merits of alternative approaches are not duly recognized. This paper presents a first systematic review of all three approaches in a unified methodological framework. We will examine the main developments in this emerging literature, critically evaluating the advantages and disadvantages of the alternative approaches. We will also propose improvements to some of the methods reviewed.

3- Portfolio Tracking Under Discrete Choice Constraints

Roy Kwon,Associate Professor, University of Toronto, 5 King's College Road, Toronto, Canada, rkwon@mie.utoronto.ca, Stephen Stoyan

We consider portfolio tracking under discrete choice constraints. Fully tracking an index can be challenging due to the need to hold many securities as well as the need to rebalance. We present two portfolio models that incorporate a comprehensive set of real world constraints, of which both focus on the number of securities to hold in the portfolio. One model also incorporates uncertainty and is a two-stage stochastic mixed-integer program. The resulting problems use two different model specific algorithms to generate solutions in reasonable time when compared to CPLEX. We discuss computational complexities involved with both approaches and illustrate their performance in terms of tracking quality and approximating efficient frontiers.

■ MB27

Gleacher Center - 408

Nonsmoothness with Applications

Cluster: Variational Analysis
Invited Session

Chair: Bingwu Wang, Associate Professor, Eastern Michigan University, 504D Pray-Harrold building, EMU, Ypsilanti, MI, 48187, United States of America, bwang@emunix.emich.edu

1 - Second-order Variational Analysis of Polyhedral Systems with Applications to Robust Stability

Nguyen Mau Nam, University of Texas-Pan American, 1201 West University Drive, Edinburg, TX, 78539, nguyenmn@utpa.edu, Rene Henrion, Boris Mordukhovich

This talk concerns second-order analysis variational analysis for a remarkable class of variational systems in infinite-dimensional spaces, which is particularly important for the study of optimization and equilibrium problems with equilibrium constraints. Systems of this type are described via variational inequalities over polyhedral convex sets. We compute the so-called coderivatives of the normal cone mappings exclusively via the initial data of polyhedral sets in reflexive Banach spaces. This provides the main tools of second-order variational analysis allowing us, in particular, to derive necessary and sufficient conditions for robust Lipschitzian stability of solution maps to parameterized variational inequalities.

2 - Necessary Optimality Conditions for Bilevel Programming Problems

Hung Phan, Wayne State University, 656 W.Kirby St, 1150 F/AB, Detroit, 48202, United States of America, pmhung@wayne.edu

In this paper, we study the optimistic version of bilevel programming using generalized differentiations. Using calculus rules for subdifferentials of generalized distance functions as well as some regularity conditions, we obtain necessary optimality conditions in bilevel programming problems without imposing partial-calmness condition. Our approach allows us to improve known recent results in this area.

3 - Subdifferentials of Value Functions and Optimality Condition for DC and Bilevel Infinite Programs

Nghia Tran, Wayne State University, Department of Mathematics, 1150 Faculty Admin Bldg, Detroit, MI, 48202, United States of America, ttannghia@gmail.com, Dinh Nguyen, Boris Mordukhovich

The paper concerns the study of new classes of parametric optimization problems of the so-called infinite programming that are generally defined on infinite-dimensional spaces of decision variables and contain infinitely many of inequality constraints. We focus on DC infinite programs with objectives given as the difference of convex functions subject to convex inequality constraints. The main results establish efficient upper estimates of certain subdifferentials of value functions in DC infinite programs. Then we employ this approach to the study of bilevel infinite programs with convex data. The results obtained in the paper are new not only for the classes of infinite programs but also for their semi-infinite counterparts.

Monday, 3:15pm - 4:45pm

■ MC01

Marriott - Chicago A

Approximation Algorithms B

Contributed Session

Chair: Francisco Barahona, IBM Research, P.O. Box 218, Yorktown Heights, NY, 10598, United States of America, francisco_barahona@yahoo.com

1 - An FPTAS for Continuous Knapsack with Generalized Upper and Lower Bounds

Bill Pun, Northwestern University, 2145 Sheridan Road, Room C210, Evanston, IL, 60208, United States of America, billpun@billpun.com, Diego Klabjan

We present an FPTAS for a very general continuous knapsack problem with generalized upper and lower bounds, for which the standard single-node fixed charge problem is a special case. In addition to the transformation process that allows us to transform the problem for analysis, our algorithm follows the dynamic programming framework for approximate algorithms, which includes defining variable types based on the magnitude of the cost coefficient, finding a polynomial approximation algorithm with a polynomial approximation ratio, and developing a pseudo-polynomial dynamic programming algorithm that is the core of the FPTAS.

2 - Randomized Approximation for Generalized Median Stable Matching

Shuji Kijima, Kyoto University, Kitashirakawa-Oiwakecho, Sakyo-ku, Kyoto, 606-8502, Japan, kijima@kurims.kyoto-u.ac.jp, Toshio Nemoto

We consider the problem of finding a generalized median stable matching (GMSM), introduced by Teo and Sethuraman (1998) as a fair stable marriage. We show that finding the i-th GSMS is #P-hard even when i=O(N^{1/c}), where N is the number of stable matchings and c is an arbitrary constant. Meanwhile, we give a polynomial time exact algorithm when i=O((log N)^C), and two randomized approximation schemes. This is the first result on randomized approximation schemes for the i-th GMSM.

3 - On the P-median Polytope and the Intersection Property

Francisco Barahona, IBM Research, P.O. Box 218, Yorktown Heights, NY, 10598, United States of America, francisco_barahona@yahoo.com, Mourad Baiou

We study a prize collecting version of the uncapacitated facility location problem and of the p-median problem. We say that uncapacitated facility location polytope has the intersection property, if adding the extra equation that fixes the number of opened facilities does not create any fractional extreme point. We characterize the graphs for which this polytope has the intersection property, and give a complete description of the polytope for this class of graphs.

■ MC02

Marriott - Chicago B

Equilibrium and Bi-level Optimization

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Diethard Klatte, Professor, University of Zurich, Institute for Operations Research, Moussonstrasse 15, 8044 Zurich, 8044, Switzerland, klatte@ior.uzh.ch

1 - Establishing Nash Equilibrium in Demand Allocation via Delivery Frequency Competition

Jie Sun, Professor, National University of Singapore, 1 Business Link, 02-05, Singapore, 117592, Singapore, jsun@nus.edu.sg, James Ang, Fanwen Meng

We examine the case of suuplier8 competing on the basis of delivery frequency to a manufacturer. We show that the Nash equilibrium can be obtained by solving a quadratic equation system. The existence and uniqueness of the Nash equilibrium are investigated under certain general conditions. As a special case we derive explicit sufficient conditions for the case when all suppliers offer identical prices.

2 - Lifting MPCCs

Oliver Stein, University of Karlsruhe (TH), Institute of Operations Research, Karlsruhe, 76128, Germany, stein@wior.uni-karlsruhe.de

We present a new smoothing approach for MPCCs, based on the orthogonal projection of a smooth manifold. We study regularity of the lifted feasible set and introduce a novel concept of tilting stability. A correspondence between the C-index in the original problem and the quadratic index in the lifted problem is shown. In particular, a local minimizer of the MPCC may be found by minimization of the lifted, smooth problem. We report preliminary computational experience.

3 - Bilevel Programming: Optimistic and Pessimistic Cases

Stephan Dempe, Technical University Bergakademie, Akademiestr. 6, Freiberg, Germany, dempe@tu-freiberg.de

While the objective function of the optimistic version of the bilevel programming problem is a lower semicontinuous function under weak assumptions on the lower level problem, the objective function of the pessimistic version needs to be replaced with its largest lower semicontinuous lower estimate. Aim of the talk is to show possible approaches to formulate optimality conditions for both versions using the basic subdifferential of Mordukhovich for both problem.

■ MC03

Marriott - Chicago C

Proximal-like Prediction and Correction Methods for Monotone Variational Inequalities— Algorithms and Applications

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Bingsheng He, Professor, Nanjing University, Department of Mathematics, Nanjing, 210093, China, hebma@nju.edu.cn

1 - Gradient Methods for Inverse Variational Inequalities with Application to Compressed Sensing Problem

Bingsheng He, Professor, Nanjing University, Department of Mathematics, Nanjing, 210093, China, hebma@nju.edu.cn

Being variants of regular variational inequalities, the inverse variational inequalities (IVI) capture many applications in various fields. This paper develops some easily-implementable algorithms for solving IVI, and applies these algorithms for solving compressed sensing problems. In particular, the widely-studied basic pursuit de-noising (BPDN) problem is shown to be characterized by an IVI with favorable structures: the involved constraint set is a ball in the maximum norm (which implies that the projection onto this set is easy to compute). The efficiency of the proposed algorithms is verified by some numerical experiments for the BPDN problem. In addition, comparison the fixed point continuation method will also be reported.

2 - An Inverse Variational Inequality Model for Road Pricing with Bounded Flows

Xiao-Zheng He, University of Minnesota, Department of Civil Engineering, MN, MN 55455, United States of America, hexxx069@umn.edu, Henry X. Liu, Bingsheng He

We formulate the bounded-flow road pricing problem as an inverse variational inequality (IVI) model. While remaining the advantage of variational inequalities for dealing with asymmetric link flow interactions, the proposed IVI model has a smaller problem size, which contributes to fast convergence and is desired for practical applications. An efficient self-adaptive projection algorithm is developed by exploiting the negative co-coercivity of the mapping in the pricing problem. This algorithm is tailored for the ease of real-life trial-and-error implementation. The only required input to the solution algorithm is the link volume counts, which are directly observable.

3 - The Unified Framework of Some Proximal-based Decomposition Methods for Variational Inequalities

Xiao-Ming Yuan, Assistant Professor, Hong Kong Baptist University, Department of Mathematics, Hong Kong, China, xmyuan@hkbu.edu.hk, Bingsheng He

This paper presents the unified framework of proximal-based decomposition methods in both exact and inexact versions, for solving a class of monotone variational inequalities with separable structure. In particular, by adopting the well-developed inexact criteria in the literature of the proximal point algorithm, some implementable algorithms that allow the involved subproblems to be solved under practical criteria will be developed.

■ MC04

Marriott - Denver

Combinatorial Optimization B

Contributed Session

Chair: Frits Spieksma, KULeuven, Naamsestraat 69, Leuven, Belgium, frits.spieksma@econ.kuleuven.be

1 - An O(n 4) Algorithm for the Maximum Weighted Stable Set Problem in Claw-free Graphs

Yuri Faenza, Università degli studi di Roma Tor Vergata, Via del Politecnico 1, Roma, 00133, Italy, faenza@disp.uniroma2.it, Gautier Stauffer, Gianpaolo Oriolo

Two combinatorial algorithms are known for the solution of the maximum weighted stable set problem (MWSS) on claw-free graphs: the one by Minty (revised by Nakamura and Tamura, and by Schrijver) is based on augmenting paths, while the one by Oriolo et al. relies on a decomposition theorem. Both algorithms can be implemented in time $O(n^6)$. By refining the decomposition results by Oriolo et al., we derive an $O(n^4)$ algorithm for decomposing claw-free graphs and an $O(n^4)$ algorithm for computing the MWSS in such class.

2 - An Exact Method for the (r|p)-centroid Problem

Ekaterina Alekseeva, Senior researcher, Sobolev Institute of Mathematics, prospekt Ak. Koptuga, 4, Novosibirsk, 630090, Russia, ekaterina2@math.nsc.ru, Yuri Kochetov, Alexander Plyasunov

The well-known discrete (r|p)-centroid problem is considered. Two players locate in turn p and r facilities to capture as much as possible an own market share. We reformulate this bilevel 0-1 problem as a mixed integer program with the exponential number of variables and constraints. An exact iterative method based on the column generation technique is proposed. It is tested on the benchmarks from the library http://math.nsc.ru/AP/benchmarks/english.html. The optimal solutions are found for r=p=5 and 100 clients and facilities.

3 - Coloring Graphs to Avoid Monochromatic Cycles

Frits Spieksma, KULeuven, Naamsestraat 69, Leuven, Belgium, frits.spieksma@econ.kuleuven.be, Roel Leus, Fabrice Talla Nobibon

We consider the problem of deciding whether a given directed graph can be vertex-partitoned into two acyclic subgraphs. The motivation for this problem comes from testing rationality of observed consumption behavior in multi-person households. We discuss the complexity of this problem, devise an exact algorithm for it, and perform computational experiments.

■ MC05

Marriott - Houston

Conic Programming C

Contributed Session

Chair: Peng Sun, Duke University, One Towerview Rd, Durham, NC, 27708, United States of America, psun@duke.edu

1 - Information Geometric Approach to Interior-point Algorithms in LP and SDP

Satoshi Kakihara, The University of Tokyo, Graduate School of Information Science and Technology, Faculty of Engineering Bldg. 6, Room 356, 7-3-1 Hongo, Bunkyo-ku, Tokyo, 113-8656, Japan, Satoshi_Kakihara@mist.i.u-tokyo.ac.jp, Renato Monteiro, Takashi Tsuchiya, Atsumi Ohara

In this talk, we present explicit relationships in iteration complexities between Primal (and Dual) algorithms and Primal-Dual algorithms based on information geometry. We make a proof of Pythagorean Theorem for SDP which associates their complexities. Numerical experiments with netlib LP instances of several thousand variables strongly suggest that the iteration count of interior-point algorithms be understood as the value of information geometric integral itself with a surprising accuracy.

2 - Variable Reduction for Interior-point Methods using Partial Minimization

Francois Glineur, UCL / CORE, Voie du Roman Pays, 34, Louvain-la-Neuve, B-1348, Belgium, Francois.Glineur@uclouvain.be, Robert Chares

Some convex sets with no known explicit self-concordant barrier can be seen as projections of higher-dimensional sets admitting such a barrier, allowing their resolution in polynomial time by IPMs. However, this sometimes greatly increases the problem size and hence the effort required to obtain a solution. We show how to reduce the number of variables involved in these extended formulations using a technique called approximate partial minimization, while preserving polynomial complexity.

3 - Information Relaxations and Duality in Stochastic Dynamic Programs

Peng Sun, Duke University, One Towerview Rd, Durham, NC, 27708, United States of America, psun@duke.edu, David Brown, James Smith

We describe a general technique for determining upper bounds on maximal values in stochastic dynamic programs, by relaxing the temporal feasibility constraints and imposing a "penalty" that punishes violations of temporal feasibility. We describe the theory underlying this dual approach. We also study properties of good penalties. Finally, we demonstrate the use of this dual approach in an adaptive inventory control problem and in valuing options with stochastic volatility and interest rates.

■ MC06

Marriott - Kansas City

Condition Numbers in Conic Optimization

Cluster: Conic Programming
Invited Session

Chair: Raphael Hauser, Reader in Mathematical Programming, University of Oxford, Wolfson Building, Parks Road, Oxford, 0X13QD, United Kingdom, hauser@comlab.ox.ac.uk

1 - Equivalence of Convex Problem Geometry and Computational Complexity in the Separation Oracle Model

Rob Freund, Professor, MIT Sloan School of Management, Building E52-476, 50 Memorial Drive, Cambridge, MA, 02142-1347, United States of America, rfreund@mit.edu, Jorge Vera

Consider the following supposedly-simple problem: "compute x in S" where S is a convex set conveyed by a separation oracle, with no further information (e.g., no bounding ball containing S). This problem gives rise to fundamental issues involving the interplay of computational complexity, the geometry of S, and the stability of S under perturbation. We show that problem instances with favorable geometry have favorable computational complexity, validating conventional wisdom. We also show a converse of this implication, by showing that there exist problem instances characterized by unfavorable geometry, that require more computational effort to solve. This lower-bound complexity relies on simple features of the separation oracle model.

2 - On the Probability Distribution of Condition Numbers in Linear Programming

Martin Lotz, Visiting Academic, Oxford University Computing Laboratory, OUCL - Wolfson Building, Parks Road, Oxford, OX1 3QN, United Kingdom, martin.lotz@comlab.ox.ac.uk

In this talk we present results on the probability distribution of condition numbers of random conic linear systems. In particular, we derive the exact probability distribution of the width of the feasible cone for normally distributed systems of linear inequalities. We discuss extensions and the relation to other measures of condition, as well as an application to a problem in geometric probability, namely the probability of covering a sphere with random caps. This presentation is based on joint work with Peter Buergisser, Felipe Cucker, and Raphael Hauser.

3 - Condition-number Based Complexity of a General Family of Short-step Ipms for LP

Raphael Hauser, Reader in Mathematical Programming, University of Oxford, Wolfson Building, Parks Road, Oxford, 0X13QD, United Kingdom, hauser@comlab.ox.ac.uk, Coralia Cartis

The convergence of a class of short-step interior point methods for linear programming that includes some methods with inexactly computed search directions is analyzed in terms of a simple fixed-point theorem. The complexity bounds are derived as a function of several known condition numbers.

■ MC07

Marriott - Chicago D

Cutting Planes from Several Rows of a Mixed-integer Program III

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Alper Atamturk, University of California- Berkeley, 4141 Etcheverry Hall, Berkeley, CA, United States of America, atamturk@berkeley.edu

Co-Chair: George Nemhauser, Institute Professor, Georgia Tech / School of ISyE, 765 Ferst Drive, Atlanta, GA, 30332-0205, United States of America, george.nemhauser@isye.gatech.edu

1 - Multiple-term Disjunctive Cuts and Intersection Cuts from Multiple Rows of a Simplex Tableau

Egon Balas, Professor, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States of America, eb17@andrew.cmu.edu

For a 0-1 program, pure or mixed, cuts from q rows of the simplex tableau are cuts from a q-term disjunction, whose disjunctive rank is at most q. For a general mixed integer program, a multiple term disjunction defines a disjunctive hull which is a relaxation of the integer hull, considerably easier to compute. We discuss the relationship of the two hulls and related issues.

2 - Maximal Lattice Point Free Simplices for Mixed Integer Optimization

Robert Weismantel, Professor, Otto-von-Guericke University Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, weismant@mail.math.uni-magdeburg.de, Kent Andersen, Christian Wagner

This talk focuses on connections between the cutting plane generation for mixed integer linear programs and the theory of maximal lattice point free polyhedra. We prove that any maximal lattice point free simplex in dimension three can be transformed by unimodular operations into one of nine explicit simplices. This enables us to develop a disjunctive programming approach based on three dimensional simplices to tackle mixed integer programs.

3 - (Some) Two-row Cuts from Lattice-free Triangles

Andrea Lodi, DEIS, University of Bologna, Viale Risorgimento, 2, Bologna, 40136, Italy, andrea.lodi@unibo.it, Andrea Tramontani, Santanu Dey, Laurence Wolsey

Gomory Mixed Integer (GMI) cuts are one of the most famous and effective general purpose cutting planes for MIP. They are obtained from the simplex tableau by applying a disjunctive argument on a mixed-integer set of a single row only. Recently, some papers have shown the possibility of generating cuts using more than one row of the simplex tableau by characterizing more complex lattice-free bodies instead of simple split disjunctions. Interesting theoretical results have been presented but it is not clear how to exploit them in practice. We discuss how to separate cuts from lattice-free triangles and two rows of the simplex tableau. Computational results on mixed integer knapsack instances show that two-row cuts are useful in practice.

■ MC08

Marriott - Chicago E

Exact Integer Programming

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Thorsten Koch, ZIB / Matheon, Takustr. 7, Berlin, 14195, Germany, koch@zib.de

1 - Exact Computation of Basic Solutions for Linear Programming

Daniel Steffy, Georgia Institute of Technology, 765 Ferst Drive, Atlanta, GA, 30332-0205, United States of America, desteffy@gatech.edu, William Cook

A successful approach for solving linear programming problems exactly has been to solve the problems with increasing levels of fixed precision, computing and checking the final basis in exact arithmetic and then doing additional pivots if necessary. In this computational study we compare several techniques for the core element of our exact computation: solving sparse rational systems of linear equations exactly.

2 - Solving LP's Exactly Revisited

Daniel Espinoza, Professor, Universidad de Chile, Republica 701, Santiago, RM, 837-0439, Chile, daespino@gmail.com

While solving a linear problem, one often wander abut the exactness of the solution obtained, specially when using floating-point based software.One way out is to solve the problem in rational form, and another possibility is to get rational (proven) bounds on the true objective. We compare both approaches numerically, and compare the time performance penalty paid for this extra precision.

3 - Exact Integer Programming in SCIP

Kati Wolter, ZIB, Takustr. 7, Berlin, 14195, Germany, wolter@zib.de

Most MIP solvers focus on quickly finding solutions that are accurate with respect to numerical tolerances. There are, however, applications, e.g., chip verification, for which this slight inaccuracy is not acceptable. We introduce an approach for the exact solution of MIPs in SCIP. It combines inefficient but always applicable rational computations with a safe floating-point approach, which is efficient but of limited applicability. Preliminary computational results will be presented.

■ MC09

Marriott - Chicago F

Structured Mixed-integer Programs

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Daniel Bienstock, Columbia University, 500 West 120th St., New York, NY, 10027, United States of America, dano@columbia.edu

1 - Single Item Lot-sizing Problem with Minimum Order Quantity

Linlin Li, Northwestern University, 2145 Sheridan Road, Room C210, Evanston, IL, 60208, United States of America, linlinli2008@u.northwestern.edu, Diego Klabjan, Bill Pun

Traditional lot-sizing problem is to find the least cost lot-sizes in several time periods. We consider the lot-sizing model with capacity and minimum order quantity constraints. We show that the lot-sizing problem with linear cost functions, general capacities and minimum order quantities is NP hard. We then show that the problem is polynomially solvable with constant capacities and minimum order quantities of finite time horizon. We identify a polynomially solvable case with general minimum order quantities and infinite capacities. In the case of general capacities and minimum order quantities, and in the presence of linear holding and procurement costs, and a possible fixed component, we exhibit a fully polynomial approximation scheme.

2 - Approximating MINLP Through Piecewise Linear Optimization

Ismael de Farias, Texas Tech, Department of Industrial Engineering, Lubbock, TX, United States of America, ismael.de-farias@ttu.edu

We present a branch-and-cut strategy to solve mixed-integer nonlinear programming (MINLP) by approximating it as a piecewise linear optimizaiton problem (PLO). We make no assumptions on whether the nonlinear funcion is convex or not. We show how to derive new and efficient cutting planes for the PLO set, and we extend our results to the case where PLO includes a number of combinatorial constraints that often arise in MINLP.

3 - Constrained Eigenvalue Techniques in Nonconvex Optimization

Daniel Bienstock, Columbia University, 500 West 120th St., New York, NY, 10027, United States of America, dano@columbia.edu

We consider the problem of minimizing a convex function (typically, a convex quadratic) subject to nonconvex structural constraints, such as a cardinality constraint on the support of the solution. We show how constrained eigenvalue techniques (such as the computation of eigenvalues of the quadratic restricted to a subspace), and methods from convex optimization (the S-lemma), can be used to prove tight bounds.

■ MC10

Marriott - Chicago G

Global Optimization

Cluster: Global Optimization
Invited Session

Chair: Nick Sahinidis, John E. Swearingen Professor, Carnegie Mellon University, Department of Chemical Engineering, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States of America, sahinidis@cmu.edu

1 - Multi-term, Polyhedral, Relaxations of Nonconvex, Quadratically-constrained Quadratic Programs

Xiaowei Bao, University of Illinois, Dept. of Chemical and Biomolecular Eng., 600 South Mathews Avenue, Urbana, IL, 61801, United States of America, xbao2@uiuc.edu, Nick Sahinidis, Mohit Tawarmalani

The general nonconvex quadratically constrained quadratic program (QCQP) is NP-hard and presents a significant challenge. We present a tight polyhedral relaxation scheme that can be used in the context of a branch-and-bound global optimization algorithm. Our relaxations account for multiple quadratic terms at the same time, and include a class of multilinear cutting planes. Computational experience demonstrates that global solvers stand to benefit significantly from the proposed relaxations.

2 - Global Optimization of an Extended Pooling Problem with EPA Emissions Constraints

Christodoulos Floudas, Stephen C. Macaleer '63 Professor in Engineering and Applied Science, Professor of Chemical Engineering, Princeton University, Dept of Chemical Engineering, Princeton, NJ, 08544, United States of America, floudas@titan.princeton.edu

Pooling problems maximize profit on a network of input feed streams, intermediate nodes, and final products. In this extension of the pooling problem, the Environmental Protection Agency (EPA) Complex Emissions Model, which certifies gasoline emissions, is explicitly introduced. We present novel relaxations of the formulation using piecewise-linear and edge-concave underestimators, their integration into a global optimization algorithm, and extensive computational results.

3 - Relaxations for Convex-transformable Functions

Aida Khajavirad, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, aida@cmu.edu, Nick Sahinidis, Jeremy Michalek

Factorable programming techniques are used widely in global optimization for bounding nonconvex functions. We propose an enhancement to the conventional factorable relaxation procedure via use of functional transformations. Instead of relying on convexity of simple intermediate expressions, we exploit convex transformability of the components functions of factorable programs as a tool in the generation of bounds for global optimization algorithms. We define suitable forms of transforming functions and provide theoretical comparisons of the sharpness of the resulting relaxations with existing schemes.

■ MC11

Marriott - Chicago H

Global Optimization in Engineering

Cluster: Global Optimization
Invited Session

Chair: Miguel Anjos, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, manjos@uwaterloo.ca

1 - Workforce Allocation and Utilization Across Parallel Workstations

Ada Barlatt, University of Waterloo, Waterloo, ON, Canada, abarlatt@uwaterloo.ca

An effective workforce plan has the right number of workers with the right skills for the right tasks at the right time. Unfortunately, simultaneously determining the number of workers available and the sequence of tasks scheduled is not a trivial task. In these problems one decision affects many others, resulting in many inter-connected, complicated constraints. We will present new models and algorithms to accurately model and efficiently solve workforce planning problems. Our discussion will focus how to on distribute a workforce across parallel workstations. Computational results based on data from an automotive manufacturer demonstrate how the models and algorithms developed provide high-quality, realistic workforce plans.

2 - Sparse Solutions of Standard Quadratic Programming with Random Matrices

Jiming Peng, UIUC, IESE Department, 104 S. Mathews Ave., Urbana, IL, 61801, United States of America, pengj@illinois.edu

In this talk, we study the standard quadratic programming problem of minimizing a quadratic form over the standard simplex. We focus on a special case of the standard QP where the involved matrix is random and show that with a high probability (close to 1), the global optimal solution of the standard QP with a random matrix is sparse. Expeimental validation of our theoretical conclusion will be discussed as well.

3 - Reformulation Linearization Techniques: An Application to Quantum Chemical Calculations

Keith Zorn, Graduate Student, Carnegie Mellon University, 260 Allison Avenue, Pittsburgh, PA 15202, kpz@andrew.cmu.edu, Nick Sahinidis

We consider continuous nonlinear programming problems that arise in ab-initio quantum chemical calculations and for which it is known that the reformulation-linearization technique (RLT) can strengthen the LP relaxation and accelerate convergence of a branch-and-bound algorithm. We use this chemical problem to gain insights to the problem of identifying strong RLT subsets with the aim of producing tight, lower-dimensional formulations.

■ MC12

Marriott - Los Angeles

Derivative-free Algorithms: Software

Cluster: Derivative-free and Simulation-based Optimization
Invited Session

Chair: Jorge More', Argonne National Laboratory, Mathematics and Computer Science Division, Building 221, Argonne, IL, 60439, United States of America, more@mcs.anl.gov

1 - IMFIL: Implicit Filtering in MATLAB

Carl T Kelley, North Carolina State University, Mathematics Dept, Box 8205, Raleigh, NC, 27695, United States of America, tim_kelley@ncsu.edu imfil.m is a new implementation of implicit filtering in MATLAB. This is a replacement for the older fortran code. New features include nonlinear least squares solvers, more robust computation of stencil gradients, user-defined stencils, and more elaborate documentation. In this presentation we will review the software and demonstrate it use on a case study from a medical application.

2 - HOPSPACK Software Framework for Parallel Derivative-free Optimization

Todd Plantenga, Principle Member Technical Staff, Sandia National Laboratories, MS 9159, 7011 East Ave, Livermore, CA, 94550, United States of America, tplante@sandia.gov, Tamara Kolda

HOPSPACK (Hybrid Optimization Parallel Search PACKage) is a successor to Sandia's APPSPACK product. HOPSPACK provides an open source C++ framework for solving derivative-free optimization problems. The framework enables parallel operation using MPI and multithreading. Multiple algorithms can be hybridized to run simultaneously, sharing a cache of computed objective and constraint function evaluations that eliminates duplicate work. Functions are computed in parallel to be compatible with both synchronous and asynchronous algorithms. HOPSPACK comes with a Generating Set Search algorithm, but the software is easily extended and is designed for developers to add new algorithms. The presentation will describe the software and applications.

3 - Software and Benchmarking for Model-Based Methods

Jorge More', Argonne National Laboratory, Mathematics and Computer Science Division, Building 221, Argonne, IL, 60439, United States of America, more@mcs.anl.gov, Stefan Wild

Model-based methods evaluate the objective function at trial points and construct a model of the function that is easier to evaluate and to optimize. We discuss algorithmic and software issues in a new model-based trust-region algorithm that constructs a quadratic model of least change that interpolates the function at a selected set of previous trial points. We also discuss the benchmarking of derivative-free algorithms on a new set of simulation-based optimization problems.

■ MC13

Marriott - Miami

Stochastic Optimization Methods for Energy Planning

Cluster: Optimization in Energy Systems

Invited Session

Chair: Frederic Bonnans, INRIA-Saclay, Centre de Mathématiques Appliquées, Ecole Polytechnique, Palaiseau, 91128, France, Frederic.Bonnans@inria.fr

1 - Gas Portfolio Optimization

Zhihao Cen, CMAP-Ecole Polytechnique, CMAP, Ecole Polytechnique, Palaiseau, 91128, France, zhihao.cen@polytechnique.edu, Thibault Christel, Frederic Bonnans

We study an energy portfolio optimization problem, which is modeled as a multi-stage stochastic optimization, where random variables are only present in the objective function. Firstly, we use the vector quantization tree method to discretize random variable space. Then, in order to solve the problem, we use the dual dynamic programming method (DDP) over this discretized tree. The combination of these 2 methods presents the advantage of dealing with high-dimension state variable problem. Finally, some numerical tests have been performed, such as swing options on multi-assets. The tests show that the method provides high convergence speed.

2 - A Comparison of Sample-based Stochastic Optimal Control Methods for Power Systems Management

Pierre Girardeau, EDF R&D, also with ENPC and ENSTA, 1, Avenue du General de Gaulle, Clamart, 92141, France, pierre.girardeau@cermics.enpc.fr, Pierre Carpentier, Guy Cohen

We consider stochastic optimal control problems in discrete time. Mainly on the basis of numerical examples, we enlighten the properties of different stochastic optimal control algorithms regarding error, defined as the distance between the optimal strategy and the strategy given by an algorithm. For a special instance of scenario tree-based methods, it has been shown by Shapiro that the error grows exponentially with respect to the time horizon. We recall his result and present others. We compare it with an adaptative mesh method (particle method) that does not require to build a scenario tree. We show on several examples that the error associated with this technique does not depend much on the time horizon.

3 - Modeling of Multiple Stochasticities in Energy Optimization Using SDP/SDDP

Steffen Rebennack, University of Florida, Industrial & Systems Engineering, 303 Weil Hall, Gainesville, Fl, 32611, United States of America, steffen@ufl.edu, Niko A. Iliadis, Mario Pereira, Panos Pardalos

We discuss a stochastic program optimizing a hydro-thermal power system in the mid-term horizon from a sub-systems perspective within a liberalized market. Particularly CO2 emission quotas and CO2 certificate prices are taken into account. The revenues are maximized while considering stochastic inflows, electricity, fuel and CO2 prices. We discuss in detail how the multiple stochasticities are handled in the framework of Stochastic (Dual) Dynamic Programming.

■ MC14

Marriott - Scottsdale

New Directions in Game-theoretic Inefficiency Bounds

Cluster: Game Theory

Invited Session

Chair: Tim Roughgarden, Stanford University, Department of Computer Science, 462 Gates 353 Serra Mall, Stanford, CA, 94305, tim@cipher.Stanford.EDU

1 - Pricing with Markups in Industries with Increasing Marginal Costs

Jose Correa, Universidad de Chile, Republica 701, Santiago, Chile, joser.correa@gmail.com, Nicolas Figueroa, Nicolas Stier-Moses

We study a game in which producers submit a supply function to a market, mapping production level to price, and consumers buy at lowest price. If producers' costs are proportional to each other, we give conditions for the existence of an equilibria in which producers replicate their cost structure. For monomial costs, we prove uniqueness of such equilibria, and that they are nearly efficient if competition is high, while in the linear case we provide a tight bound on the price of anarchy.

2 - The Inefficiency Ratio of Stable Equilibria in Congestion Games

Arash Asadpour, Stanford University, asadpour@stanford.edu, Amin Saberi

Price of anarchy and price of stability are the primary notions for measuring the efficiency or social welfare of the outcome of a game. Both of these notions focus on extreme cases: one is defined as the inefficiency ratio of the worst-case equilibrium and the other as the best one. Therefore, studying both these notions often results in discovering equilibria that are not necessarily the most likely outcomes of the dynamics of selfish and non-coordinating agents. The current paper studies the inefficiency of the equilibria that are most stable in the presence of noise. In particular, we study two variations of non-cooperative games: atomic congestion games and selfish load balancing. The noisy best-response dynamics in these games keeps the joint action profile around a particular set of equilibria that minimize the potential function. The inefficiency ratio in the neighborhood of these "stable" equilibria is much better than the price of anarchy. Furthermore, the dynamics reaches these equilibria in polynomial time. These observations show that in games in which a small noise is expected, the system as a whole works better than what a pessimist may predict.

3 - Bounding Inefficiency Using Efficient Game Dynamics

Aaron Roth, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, United States of America, alroth@cs.cmu.edu

We often seek to quantify the degradation in system performance due to selfish behavior by bounding the inefficiency of Nash equilibria: the price of anarchy. I will discuss an alternative: bounding the inefficiency of more general game dynamics. I will discuss several advantages of this analysis, including computational plausibility, the ability to analyze Byzantine players, as well as noise models which can actually lead to worst-case performance that is better than the price of anarchy.

4 - Intrinsic Robustness of the Price of Anarchy

Tim Roughgarden, Stanford University, Department of Computer Science, 462 Gates 353 Serra Mall, Stanford, CA, 94305, tim@cipher.Stanford.EDU

The price of anarchy (POA), the most popular measure of the inefficiency of selfish behavior, assumes that players successfully reach some Nash equilibrium. We prove that such results are often "intrinsically robust": an upper bound on the worst-case POA for pure Nash equilibria (necessarily) implies the exact same worst-case upper bound for mixed Nash equilibria, correlated equilibria, and sequences of outcomes generated by natural experimentation strategies.

■ MC16

Gleacher Center - 200

Stochastic Programming Applications

Cluster: Stochastic Optimization
Invited Session

Chair: Marina Epelman, University of Michigan, Industrial and Operations Engineering, 1205 Beal Ave., Ann Arbor, MI, 48109, United States of America, mepelman@umich.edu

1 - Optimization Models for Radiation Therapy under Uncertainty

Marina Epelman, University of Michigan, Industrial and Operations Engineering, 1205 Beal Ave., Ann Arbor, MI, 48109, United States of America, mepelman@umich.edu, Mustafa Sir, H. Edwin Romeijn, Fei Peng

In intensity-modulated radiation therapy for cancer, treatment is designed to deliver high radiation doses to tumors, while avoiding healthy tissues. Due to random shifts during treatment, significant differences between the dose derived via optimization-based treatment planning and the actual dose delivered can occur. We present optimization models that take these types of uncertainty into consideration as well as adapt the treatment in an off-line manner, and present experimental comparisons.

2 - Computational Enhancements for the Stochastic Network Interdiction Problem

Michael Nehme, The University of Texas at Austin, 2412 W 12th Street, Austin, TX, 78703, United States of America, mikenehme@yahoo.com, David Morton

We describe a stochastic network interdiction model for deploying radiation detectors at border checkpoints to detect smugglers of nuclear material. The model is stochastic because the smuggler's origin-destination pair is known only through a probability distribution when the detectors are installed. We formulate a mixed-integer program for the special case in which we can only install detectors at the checkpoints of the origin and destination countries. While this problem is NP-Complete, we can compute wait-and-see bounds in polynomial time. Utilizing these bounds, we propose an efficient branching scheme which is easily parallelized and may be useful for other stochastic integer programs with easily computable wait-and-see bounds.

3 - The Knapsack Problem with Gaussian Weights

Michael Poss, PhD Student, l'Université Libre de Bruxelles, Boulevard du Triomphe CP 210/01, Department of Computer Science, Faculty, Bruxelles, 1050, Belgium, mposs@ulb.ac.be, Bernard Fortz, Martine Labbe', François Louveaux

We study a two-stage formulation of the stochastic knapsack problem with continuous recourse. First we prove that three particular cases of the problem are weakly NP-complete. Then we use a non linear integer programming tool (NP/NLP) to efficiently solve the problem when all random variables are Gaussian.

■ MC17

Gleacher Center - 204

Near-optimal Algorithms for Stochastic Optimization Models: Inventory Management, Revenue Management and Transportation

Cluster: Logistics and Transportation
Invited Session

Chair: Retsef Levi, MIT, Sloan School of Management, 30 Wadsworth St Bldg E53-389, Cambridge, MA, 02142, United States of America, retsef@MIT.EDU

1 - Approximation Algorithms for Stochastic Lot-sizing Models

Cong Shi, Phd Candidate, MIT, 396C, 70 Pacific St, Cambridge, MA, 02139, United States of America, shicong@mit.edu, Retsef Levi

In this paper, we address the fundamental problem of finding computationally efficient and provably good inventory control policies in the presence of fixed costs and with correlated, nonstationary and evolving stochastic demands. In this paper we propose two new policies with worst-case performance guarantees that can be applied under the most general assumptions, i.e., with positive lead times and general demand structure. We show how these policies can be parameterized to create a broader class of policies. Computational experiments that the parameterized policies can perform near-optimal, significantly better than the worst-case performance guarantees.

2 - A Constant Approximation Algorithm for the a Priori TSP

David Shmoys, Professor, Cornell University, 231 Rhodes Hall, Ithaca, NY, 14853, United States of America, shmoys@cs.cornell.edu, Kunal Talwar

In the TSP, the input is a set N and distance between each {i,j} in N; the aim is to find a tour T through N that minimizes its total length c(T). In the a priori TSP, one is also given a probability distribution P over subsets of N. For each subset A, each tour T induces a tour T(A) by "shortcutting" those points not in A; its length is c(T(A)). In the a priori TSP, the "value" of a tour T is its expected length with respect to a random choice of A drawn according to P, E[c(T(A))]; we want to to find T that minimizes this expectation. Suppose that P is specified by giving an independent activation probability p(j) for each j in N. We give a simple randomized 4-approximation algorithm and a deterministic 8-approximation algorithm.

3 - Near-optimal Algorithms for Assortment Planning under Dynamic Substitution and Stochastic Demand

Vineet Goyal, Postdoctoral Associate, Massachusetts Institute of Technology, 77 Massachusetts Ave, E40-111, Cambridge, MA, 02139, United States of America, goyalv@mit.edu, Retsef Levi, Danny Segev

We consider a single-period assortment planning problem under a dynamic-substitution model with stochastic demand and give a polynomial time approximation scheme (PTAS) for the problem under fairly general assumptions that computes a near-optimal assortment with only a constant (depending only on the accuracy level) number of product types. We also present several complexity results for the problem that indicate that our assumptions are almost 'necessary' to solve it efficiently.

■ MC18

Gleacher Center - 206

MINLP Applications

Cluster: Nonlinear Mixed Integer Programming
Invited Session

Chair: Kevin Furman, ExxonMobil, 1545 Route 22 East, Annandale, NJ, 08801, United States of America, kevin.c.furman@exxonmobil.com

1 - Formulating and Solving Binary Quadratic Problems using Polynomial Programming

Bissan Ghaddar, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, bghaddar@uwaterloo.ca, Juan Vera, Miguel Anjos

We study new relaxation schemes for the unconstrained binary quadratic optimization problem based on polynomial programming. Extensive computational tests on the max-cut problem show the performance of these relaxations in terms of the bounds and the computational time compared to existing relaxations. In addition, we extend our solution methodology to target quadratic constrained binary problems. In order to gain insight into the performance of our approach to constrained quadratic binary programming problems we study the quadratic knapsack problem and present computational results.

2 - MINLP Process Control Applications and Efficient Solution Strategies using MILP Based Relaxations

Ed Gatzke, Associate Professor, University of South Carolina, Department of Chemicl Engineering, Columbia, SC, 29208, United States of America, gatzke@engr.sc.edu

This work presents results from MINLP process systems engineering applications, including process identification and modeling, feedback control using MPC, and biological yield optimization. Additionally, an efficient method is proposed which uses Piecewise Linear Relaxations to generate convex relaxations of the original nonconvex functions. Using McCormick's reformulation method with propositional logic 'Big M' constraints, the original nonlinear problem is converted into a MILP, solution of which gives a tighter lowerbound on the original problem. The complexity of the MILP relaxation can be adjusted by the user. A a local solution may be used to tighten the bounds on any variable by solving two MILP problems with an upperbound cut.

3 - A Global Optimization Approach to Distillation Column Design Feasibility

Andreas Linninger, Professor, University of Illinois- Chicago, 851 S. Morgan St., 218 SEO, Chicago, IL, 60607, United States of America, linninge@uic.edu, Gerardo Ruiz, Angelo Lucia, Seon Kim

The terrain methodology of global optimization is used to determine the feasibility of distillation column designs. A reduced space formulation using the minimum bubble point distance function as the metric provides both reliable computations and allows visualization regardless of the number of components in the mixture.

■ MC19

Gleacher Center - 208

Stochastic Optimization C

Contributed Session

Chair: Alvaro Veiga, Associated Professor, PUC-Rio, Departamento de Engenharia Elétrica, Rio de Janeiro, 22453-900, Brazil, alvf@ele.puc-rio.br

1 - Primal and Dual Linear Decision Rules in Stochastic and Robust Optimization

Daniel Kuhn, Imperial College London, 180 Queen's Gate, London, United Kingdom, dkuhn@imperial.ac.uk, Wolfram Wiesemann, Angelos Georghiou

Linear stochastic programs can be solved efficiently by requiring the recourse decisions to exhibit a linear data dependence. We propose to apply this linear decision rule restriction to the primal as well as a dual version of the stochastic program. We then demonstrate that both arising approximate problems are equivalent to tractable conic programs of moderate sizes. The gap between their optimal values estimates the loss of optimality incurred by the linear decision rule approximation.

2 - Airline Network Revenue Management Under Uncertainty by Lagrangian Relaxation.

Konstantin Emich, Humboldt-University zu Berlin, Unter den Linden 6, Berlin, 10099, Germany, emich@math.hu-berlin.de, Werner Roemisch, Andris Moeller

A multistage stochastic programming approach to airline network revenue management under uncertain passenger demand and cancellation rates is presented. Lagrangian relaxation of capacity constraints yields a decomposition of the problem into one subproblem for each combination of ODI, fare class, and point of sale. They are solved by dynamic programming, while the dual is solved by a proximal bundle method. A feasible solution is found by a Lagrangian heuristic. Numerical results are presented.

3 - Risk Assessment in Stochastic Programming: An Application to Asset-liability Management for Pension

Alvaro Veiga, Associated Professor, PUC-Rio, Departamento de Engenharia Elétrica, Rio de Janeiro, 22453-900, Brazil, alvf@ele.puc-rio.br, Davi Valladão

ALM is the practice of managing a business so that decisions taken with respect to assets and liabilities are coordinated, in order to achieve financial objectives, given a tolerance to risk. The objective of a pension fund is the payment of benefits. To do this, the allocation policy must assure two conditions: equilibrium and liquidity. This paper proposes a new method for measuring and controlling the equilibrium risk that considers the uncertainty of returns beyond the planning horizon.

■ MC20

Gleacher Center - 300

Nonlinear Programming: Large-scale Methods

Cluster: Nonlinear Programming
Invited Session

Chair: Sven Leyffer, Argonne National Laboratory, MCS Division 9700 South Cass Avenue, Argonne, IL, 60439, United States of America, leyffer@mcs.anl.gov

Co-Chair: Annick Sartenaer, Professor, University of Namur (FUNDP), Rempart de la Vierge, 8, Namur, B-5000, Belgium, annick.sartenaer@fundp.ac.be

1 - Solving Nonlinear Optimization Problems on Large-scale Parallel Computers

Andreas Waechter, IBM TJ Watson Research Center, 1101 Kitchawan Road, Yorktown Heights, NY, 10598, United States of America, andreasw@us.ibm.com, Sanjeeb Dash

We present a distributed-memory implementation of an interior-point method for large-scale nonlinear continuous optimization problems, based on the Ipopt open-source software package. The algorithm uses a line search procedure to ensure global convergence. The arising linear systems are solved with a direct or iterative linear solver. Computational results on large-scale problems are reported.

2 - S2QP: A Second Derivative SQP Method for Nonlinear Nonconvex Constrained Optimization

Daniel Robinson, Oxford University, Wolfson Building, Parks Road, Oxford, OX1 3QD, United Kingdom, daniel.robinson@comlab.ox.ac.uk, Nick Gould

S2QP is a second derivative SQP algorithm designed for solving nonlinear constrained optimization problems. Trial steps are computed by combining the solutions (steps) of at most two quadratic programs. The predictor step is the solution of a convex quadratic program and thus may be solved efficiency, while the SQP step may be computed from a variety of (potentially) indefinite quadratic programs and need not be solved globally. During this talk we give an overview of the method, present computational results on a variety of test problems, and provide a numerical comparison of two particular instances of the SQP subproblem.

3 - An Interior-point Filter Solver for Large-scale Nonlinear Programming

Michael Ulbrich, Technische Universitaet Muenchen, Department of Mathematics, Boltzmannstr. 3, Garching, 85748, Germany, mulbrich@ma.tum.de, Renata Silva, Stefan Ulbrich, Luis N. Vicente

We will describe the development of an optimization solver (ipfilter) for large-scale nonlinear programming problems based on the application of the primal-dual interior-point filter method developed by the authors. Extensive numerical testing has shown that ipfilter is competitive with state of the art solvers in both efficiency and robustness. This talk will also cover some recent extensions of the original algorithm and analysis of global convergence which, in particular, address new definitions for the filter optimality entry better suited for minimization.

■ MC21

Gleacher Center - 304

Optimization in Sensor Networks

Cluster: Telecommunications and Networks
Invited Session

Chair: Sergiy Butenko, Texas A & M University, Dept. of Industrial Engineering, College Station, TX, 77843, United States of America, butenko@tamu.edu

1 - Mathematical Programming Techniques for Robust Multi-sensor Scheduling for Multi-site Surveillance

Nikita Boyko, PhD Student, University of Florida, Industrial and Systems Engineering Depar, Gainesville, FL, nikita@ufl.edu, Panos Pardalos, Stan Uryasev, Timofey Turko, Vladimir Boginski, David Jeffcoat, Greg Zrazhevsky

We consider the exact and heuristic approaches for multi-sensor scheduling in both deterministic and stochastic settings. The considered mathematical programming formulations incorporate the constraints on fixed and variable information losses associated the surveillance process. Moreover, uncertain parameters of the models are taken into account via using quantitative risk measures in the formulations.

2 - Bottleneck Connected Dominating Set Problem in Wireless Ad Hoc Networks

Sera Kahruman, Texas A&M University, Dept. of Industrial Engineering, College Station, TX, 77843, United States of America, sera@neo.tamu.edu, Sergiy Butenko

Wireless networks are typically modeled as unit-disk graphs. The unit distance, which determines the adjacency of two nodes, is the transmission range of a wireless node. Determining the transmission range is an important decision problem since for some networks energy usage strongly depends on the transmission range. In this work, we introduce the bottleneck connected dominating set problem as a viable approach for selecting the transmission range and propose a distributed algorithm.

3 - Sensor Network Optimization for Threat Detection

Michael Zabarankin, Assistant Professor, Stevens Institute of Technology, Castle Point on Hudson, Hoboken, NJ, 07030, United States of America, mzabaran@stevens.edu, Anton Molyboha

An optimal coverage problem for networks formed by radars or active acoustic arrays directing electro-magnetic impulses or sound beams has been formulated. A surveillance strategy uses a Markov chain to control switching between predefined network coverage states and to adapt to moving noise sources. Finding optimal transition probabilities of the Markov chain has been reduced to a linear programming problem, and the suggested approach has been illustrated in several numerical examples.

■ MC22

Gleacher Center - 306

Modeling Languages and Systems

Cluster: Implementations, Software
Invited Session

Chair: Robert Fourer, Professor, Northwestern University, Dept of Industrial Eng & Mgmnt Sciences, 2145 Sheridan Road, Evanston, IL, 60208-3119, United States of America, 4er@iems.northwestern.edu

1 - Modeling Language Features in LINGO for Special Purpose Solvers

Linus Schrage, University of Chicago, Chicago, IL, 60637, United States of America, linus.schrage@chicagogsb.edu, Kevin Cunningham

Many solvers have special capabilities, e.g. global solvers for nonconvex constraints, complementarity constraints, multi-stage stochastic programming, linearization of nonlinear constraints, multi-criteria and K-best solutions, infeasibility analysis, and others. We describe the various features in LINGO not only for model formulation to exploit the above capabilities, but also in solution reporting to match these capabilities.

2 - Extending an Algebraic Modelling Language for Chance Constrained and Robust Optimization Problems

Gautam Mitra, Professor, CARISMA, Brunel University, Uxbridge (Middlesex), UB8 3PH, United Kingdom, Gautam.Mitra@brunel.ac.uk, Viktar Zviarovich, Christian Valente

We propose extensions to the AMPL modelling language that allow to express certain classes of problems with chance constraints and integrated chance constraints as well as robust optimization problems. This proposal is based on the earlier work on Stochastic AMPL (SAMPL) that provided constructs for representing scenario-based stochastic programming problems. We discuss the motivation, design issues and advantages of adding these extensions both from modelling and solution perspective. We describe the implementation of new language features in the SAMPL translator and give examples of problems using them.

3 - Robust Optimization and Uncertainty Modeling in YALMIP

Johan Löfberg, Research Associate, Linköpings Universitet, Division of Automatic Control, Department of Electrical Engineering, Linköping, SE-581 83, Sweden, johanl@isy.liu.se

A considerable amount of optimization problems arising in engineering, and control in particular, can be seen as special instances of robust optimization. Much of the modeling effort in these cases is spent on converting an uncertain problem to a robust counterpart without uncertainty. Since many of these conversions follow standard procedures, it is amenable to software support. This talk presents the robust optimization framework in the modeling language YALMIP, which carries out the uncertainty elimination automatically, and allows the user to concentrate on the model instead. We will particularly discuss some recent additions to the framework.

■ MC24

Gleacher Center - 400

Network Design

Cluster: Telecommunications and Networks
Invited Session

Chair: Fabrizio Grandoni, University of Rome Tor Vergata, via del Politecnico 1, 00133, Rome, Italy, grandoni@disp.uniroma2.it

1 - Computing Flow-inducing Network Tolls

Guido Schaefer, Centrum Wiskunde & Informatica, Science Park 123, Amsterdam, 1098 XG, Netherlands, Guido.Schaefer@cwi.nl, Tobias Harks, Martin Sieg

We consider the problem of computing tolls in non-atomic network routing games that induce a predetermined flow as Nash flow and additionally optimize a toll-dependent objective function. We show that such tolls can be computed in polynomial time for a broad class of objective functions. We also prove that the problem of computing tolls such that the number of tolled arcs is minimized is APX-hard, even for very restricted single-commodity networks, and give first approximation results.

2 - On the Complexity of the Asymmetric VPN Problem

Thomas Rothvoss, Research Assistant, EPFL, EPFL SB IMA MA C1 553 Station 8 CH-1015, Lausanne, Switzerland, thomas.rothvoss@epfl.ch, Laura Sanitá

We give the first constant factor approximation algorithm for the asymmetric Virtual Private Network (VPN) problem with arbitrary concave costs. We even show the stronger result, that there is always a tree solution of cost at most 2 OPT and that a tree solution of (expected) cost at most 49.84 OPT can be determined in polynomial time. Furthermore, we answer an outstanding open question about the complexity status of the so called balanced VPN problem by proving its NP-hardness.

3 - Consistent Routing under the Spanning Tree Protocol

Laura Sanitá, PostDoc, EPFL, EPFL SB IMA MA B1 527 Station 8 CH-1015, Lausanne, Switzerland, laura.sanita@epfl.ch, Fabrizio Grandoni, Gaia Nicosia, Gianpaolo Oriolo

A crucial issue for network design is the capability of a network to restore traffic when some components fail. Since restoring may be expensive or cause transmissions delays, a key property is requiring that traffic not affected by a failure is not re-routed in failure situations. We investigate how to implement this property in networks, such as Ethernet networks, where traffic is commonly routed on the edges of a shortest path tree, obeying to protocols of the Spanning Tree Protocol family.

■ MC25

Gleacher Center - 404

Monotonicity and Generalized Monotonicity in Variational Analysis

Cluster: Variational Analysis
Invited Session

Chair: Didier Aussel, University de Perpignan, 52 Avenue Paul Alduy, Perpignan, F-66860, France, aussel@univ-perp.fr

1 - SSDB Spaces and Maximal Monotonicity

Stephen Simons, Professor Emeritus, University of California, Santa Barbara, Santa Barbara, Ca, 93106, United States of America, simons@math.ucsb.edu

We introduce "SSDB spaces", which include Hilbert spaces, negative Hilbert spaces and spaces of the form E x E, where E is a reflexive real Banach space. We introduce "q-positive" subsets of a SSDB space, which include monotone subsets of E x E, and "BC-functions" on a SSDB spaces, which include Fitzpatrick functions of monotone multifunctions. We show how Attouch-Brezis theory can be combined with SSDB space theory to obtain and generalize various results on maximally monotone multifunctions on a reflexive Banach space, such as the significant direction of Rockafellar's surjectivity theorem, sufficient conditions for the sum of maximally monotone multifunctions to be maximal monotone, and an abstract Hammerstein theorem.

2 - New Properties of the Variational Sum of Monotone Operators

Yboon Garcia Ramos, Centro de modeliamiento, Av. Blanco Encalada 2120 Piso 7, Santiago de Chile, Chile, ygarcia@dim.uchile.cl

We study the Variational Sum of monotone operators, in particular its relationship with the Extended Sum of monotone operators. First, we establish some new properties of the Variational Sum, among them that this sum has closed graph and convex values. Then, we show that the graph of the Variational Sum always contains the graph of the Extended Sum, and hence, it contains also the graph of the usual sum. An example is given showing that the latter inclusions are proper in general.

3 - Some New Approximation Results for the Construction of Utilities in Revealed Preference Theory

Andrew Eberhard, Professor, RMIT University, GPO Box 2476V, Melbourne, Victoria, 3001, Australia, andy.eb@rmit.edu.au, Jean-Pierre Crouzeix, Daniel Ralph

When dealing with consumer demand in economic modeling, researchers often solve the optimization problem which maximises utility for a given budget constraint. The present work suggests an approach to the fitting of utility functions that allows the raw data to determine the functional form of the utility. The Afriat utility provides a well defined family of polyhedral indifference. With more data we may refine our approximation of these level curves and hence the question arises as to wether one can validly discuss some notion of convergence to an underlying utility that rationalises the preference structure? It is this question we discuss and provide some concise theory for a positive answer.

■ MC26

Gleacher Center - 406

Portfolio and Option Problems C

Contributed Session

Chair: Leticia Velazquez, University of Texas at El Paso, 500 W. University Avenue, El Paso, TX, 79968-0518, United States of America, leti@utep.edu

1 - A General Optimization Procedure for Parameter Estimation

Claudio Antonini, Director, UBS, 677 Washington Blvd., Stamford, CT, 06901, United States of America, cda@alum.mit.edu

The combination of a global and quasi-Newton optimization procedures allow us to find solutions that cover the whole parameter space and converge extremely fast. Examples of parameter identification of various financial products will be presented, along with the typical problems that can be found, and the solutions applied. Particularly, we will investigate sensitivity analysis around optimal and suboptimal solutions.

2 - On the Role of Norm Constraints in Portfolio Selection

Jun-ya Gotoh, Department of Industrial and Systems Engineering, Chuo University, 2-13-27 Kasuga, Bunkyo-ku, Tokyo, 112-8551, Japan, jgoto@indsys.chuo-u.ac.jp, Akiko Takeda

We examine the role of norm constraints in portfolio optimization from several directions. First, it is equal to a robust constraint associated with return uncertainty. Secondly, combined with the VaR/CVaR minimization, a nonparametric theoretical validation is posed based on the generalization error bound for the nu-SVM. Through experiments, the norm-constrained tracking error minimization with a parameter tuning strategy outperforms the traditional models in terms of the out-of-sample error.

3 - Comparison of Global Parameterization Schemes for Parameter Estimation Problems

Leticia Velazquez, University of Texas at El Paso, 500 W. University Avenue, El Paso, TX, 79968-0518, United States of America, leti@utep.edu, Carlos Quintero, Carlos Ramirez, Reinaldo Sanchez, Miguel Argaez

We present the numerical performance of two parameterization schemes, Singular Value Decomposition and Wavelets , for solving automated parameter estimation problems using the Simultaneous Perturbation Stochastic Approximation algorithmm, Global Levenberg-Marquardt and Simulated Annealing. The schemes are tested on a suit of two large scale parameter estimation problems using high-performance computing.

■ MC27

Gleacher Center - 408

Metric Regularity and Fixed Points of Firmly Nonexpansive Mappings

Cluster: Variational Analysis

Invited Session

Chair: Yoshiyuki Sekiguchi, Assistant Professor, Tokyo University of Marine Science & Technology, 2-1-6, Etchujima, Koto, Tokyo, 135-8533, Japan, yoshi-s@kaiyodai.ac.jp

1 - Metric Regularity and Convexity

Yoshiyuki Sekiguchi, Assistant Professor, Tokyo University of Marine Science & Technology, 2-1-6, Etchujima, Koto, Tokyo, 135-8533, Japan, yoshi-s@kaiyodai.ac.jp

Inverse and implicit function theorems play a crucial role in continuous optimization theory. Metric regularity is one of their modern form. We investigate fundamental properties of modulus of metric regularity, which expresses a quantitative nature of local behavior of inverse set-valued mappings.

2 - On the Proximal Point Method for Metrically Regular Mappings

Shin-ya Matsushita, Assistant Professor, Akita Prefectural University, 84-4 Aza Ebinokuchi Tsuchiya, Yurihonjo, 015-0055, Japan, matsushita@akita-pu.ac.jp, Li Xu

In this talk we investigate the proximal point algorithm for finding zero points of set-valued mapping without monotonicity, by employing recent development on regularity properties of set-valued operators. We first deal with the well-definedness of the sequence generated by our algorithm. Then we show that the sequence converges strongly to a zero point.

Tuesday, 10:30am - 12:00pm

■ TA01

Marriott - Chicago A

Geometric Methods for Approximation Algorithms

Cluster: Approximation Algorithms
Invited Session

Chair: Cliff Stein, Columbia University, 326 S W Mudd Building, 500 W. 120th Street, New York, NY, 10027, cliff@ieor.columbia.edu

1 - Geometric Rounding: Theory and Application

Dongdong Ge, Stanford University, Terman 328, Stanford, 94305, United States of America, dongdong@stanford.edu, Jiawei Zhang, Yinyu Ye

We develop a new dependent randomized rounding method for approximation of optimization problems with integral assignment constraints. The core of the method is a simple, intuitive, and computationally efficient geometric rounding that simultaneously rounds multiple points in a multi-dimensional simplex to its vertices. Using this method we obtain in a systematic way known as well as new results for a series of combinatorial optimization problems.

2 - Understanding the Limits of Semidefinite Programming through Unique Games

Prasad Raghavendra, University of Washington, #4, 5856 Alderson Street, Pittsburgh, PA, 15217, United States of America, prasad@cs.washington.edu, David Steurer

Assuming the Unique games conjecture (UGC), recent work has demonstrated that a simple semidefinite programming relaxation yields the best approximation for large classes of combinatorial optimization problems like constraint satisfaction problems. In this work, we show that irrespective of the truth of UGC, introducing additional constraints to the simple SDP relaxation, does not improve the approximation ratio, for any of these problems.

■ TA02

Marriott - Chicago B

Complementarity Systems, Dynamic Equilibrium, and Multi-body Contact Problems II

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Lanshan Han, University of Illinois at Urbana Champaign, 117 Transportation Building, 104 South Mathews Avenue, Urbana, IL, 61801, United States of America, hanlsh@illinois.edu

1 - Linear Complementarity Systems: Zeno Behavior

Kanat Camlibel, Doctor, University of Groningen, Dept. of Mathematics, Groningen, Netherlands, M.K.Camlibel@rug.nl

A complementarity system consists of a dynamical system and complementarity relations. This talk is devoted to the so-called Zeno behavior of linear complementarity systems. Zeno behavior refers to the possibility of infinitely many changes of active constraints in a finite time interval. In this talk, we first formalize a solution concept. Later, a definition of Zeno behavior is given together with illustrating examples. Finally, we look at conditions that guarantee absence of Zeno behavior.

2 - Network Problems, Dynamic Games and Hybrid Dynamical Systems

Monica Cojocaru, University of Guelph, Dept. of Mathematics & Statistics, 50 Stone Road East, Guelph, ON, N1G 2 W1, Canada, mcojocar@uoguelph.ca, Scott Greenhalgh

We present a computational method for describing the time evolution of a class of network equilibrium problems and dynamic Nash games. Our method is based on an approach from hybrid dynamical systems and blends in with previous approaches for studying equilibrium problems, coming from optimization and variational inequalities. In particular, we present applications of our method to computation of solutions for dynamic pricing games in markets of environmental products.

3 - Positive Invariance of Constrained Affine Dynamics and its Applications

Jinglai Shen, Assistant Professor, University of Maryland Baltimore County, Dept. of Math and Statistics, Baltimore, MD, 21250, United States of America, shenj@umbc.edu

This talk addresses long-time dynamics of piecewise affine systems (PASs), motivated by recent work on complemetnarity systems. We will review local/finite-time switchings of PASs, such as simple switching behavior, and discuss their applications to complementarity systems. We show that positively invariant sets associated with affine dynamics play an important role in long-time dynamics analysis. Necessary and sufficient conditions are obtained for the

existence of such a set. Moreover, we give necessary and sufficient conditions that characterize the interior of a positively invariant cone of a linear dynamics on a polyhedral cone. We show its applications in finite-time and long-time observability analysis of conewise linear systems.

■ TA03

Marriott - Chicago C

Cone Complementarity Problems

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Masao Fukushima, Professor, Kyoto University, Graduate School of Informatics, Dept. of Applied Math & Physics, Kyoto, 606-8501, Japan, fuku@i.kyoto-u.ac.jp

1 - The Strict Semimonotonicity Property of Linear Transformations on Euclidean Jordan Algebras

Jiyuan Tao, Assistant Professor, Loyola College in Maryland, 4501 North Charles Street, Baltimore, MD, 21210, United States of America, jtao@loyola.edu

Motivated by the equivalence of the strict semimonotonicity property of matrix A and the uniqueness of the solution to the linear complementarity problem LCP(A, q) for q in the nonnegative orthant of R^n, in this talk, we describe the strict semimonotonicity (SSM) property of linear transformations on Euclidean Jordan algebras. Specifically, we describe that under the copositive condition, the SSM property is equivalent to the uniqueness of the solution to LCP(L, q) for all q in the symmetric cone K. Also, we present a characterization of the uniqueness of the solution to LCP(L, q) for a Z transformation on the Lorentz cone.

2 - Semismooth Newton Methods for Nonlinear Second-Order Cone Programs Without Strict Complementarity

Masao Fukushima, Professor, Kyoto University, Graduate School of Informatics, Dept. of Applied Math & Physics, Kyoto, 606-8501, Japan, fuku@i.kyoto-u.ac.jp, Izabella Ferenczi, Christian Kanzow

The optimality conditions of a nonlinear second-order cone program can be reformulated as a nonsmooth system of equations using a projection mapping. This allows the application of nonsmooth Newton methods for the solution of the nonlinear second-order cone program. Conditions for the local quadratic convergence of these nonsmooth Newton methods are investigated. An interesting and important feature of these conditions is that they do not require strict complementarity of the solution.

3 - Semidefinite Complementarity Reformulation for Robust Nash Equilibrium Problems

Shunsuke Hayashi, Assistant Professor, Kyoto University, Graduate School of Informatics, Dept. of Appl Math & Physics, Kyoto, 606-8501, Japan, shunhaya@amp.i.kyoto-u.ac.jp, Ryoichi Nishimura, Masao Fukushima

In the realm of game theory, there have been a number of studies on games with uncertain data. Among them, the distribution-free model with robust Nash equilibrium (also called robust optimization equilibrium) attracts much attention recently. In the model, each player's cost function and/or the opponents' strategies are supposed to belong to some uncertainty sets, and each player chooses his/her strategy according to the robust optimization policy. In this paper, we apply the idea of strong duality in nonconvex quadratic programs, and show that the robust Nash equilibrium problem in which uncertainty is contained in both opponents' strategies and each player's cost parameters reduces to a semidefinite complementarity problem (SDCP).

■ TA04

Marriott - Denver

Submodularity in Combinatorial Optimization

Cluster: Combinatorial Optimization
Invited Session

Chair: Andreas Schulz, Massachusetts Institute of Technology, E53-357, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States of America, schulz@mit.edu

1 - Submodular Function Minimization under Covering Constraints

Satoru Iwata, Kyoto University, RIMS, Kyoto, 606-8502, Japan, iwata@kurims.kyoto-u.ac.jp, Kiyohito Nagano

We address the problems of minimizing nonnegative submodular functions under covering constraints, as generalizations of the vertex cover, edge cover, and set cover problems. We give both rounding and primal-dual approximation algorithms for the submodular cost set cover problem exploiting the discrete convexity of submodular functions. In addition, we give an essentially tight lower bound on the approximability of the edge cover problem with submodular cost functions.

2 - A Flow Model Based on Polylinking Systems

Rico Zenklusen, ETH Zurich, Raemistrasse 101, Zurich, 8092, Switzerland, rico.zenklusen@ifor.math.ethz.ch, Michel Goemans, Satoru Iwata

We introduce a flow model based on polylinking systems that generalizes several other flow models, including an information flow model for which an efficient maximum flow algorithm was recently found (Amaudruz and Fragouli, SODA'09). Exploiting underlying submodularity properties of polylinking systems we derive a max-flow min-cut theorem, submodularity of cut values, and an integrality property. Furthermore, we show how to determine a maximum flow and a minimum cut in polynomial time.

3 - A Decomposition Algorithm for Linear Optimization Over Polymatroids with Applications

Akiyoshi Shioura, Tohoku University, Aramaki aza Aoba 6-3-09, Aoba-ku, Sendai, 9808579, Japan, shioura@dais.is.tohoku.ac.jp, Vitaly Strusevich, Natalia Shakhlevich

We consider the problem of maximizing a linear function over a polymatroid intersected with a box. It is well known that a greedy algorithm finds an optimal solution of this problem. In this talk, we propose a novel decomposition approach for computing a greedy solution of the polymatroid optimization problem. We then show that how this approach can be applied to developing fast algorithms for preemptive scheduling problems with controllable processing times. This decomposition approach provides faster algorithms for most of the scheduling problems.

■ TA05

Marriott - Houston

Combinatorial Optimization O

Contributed Session

Chair: David Hartvigsen, Professor, University of Notre Dame, Mendoza College of Business, Notre Dame, IN, 46556-5646, United States of America, Hartvigsen.1@nd.edu

1 - Measure & Conquer Analysis of Exact Algorithms in the Bounded-Degree Case

Andreas Tillmann, PhD Student, TU Braunschweig, Pockelsstr. 14, Braunschweig, 38106, Germany, a.tillmann@tu-bs.de

We analyze exact algorithms using the Measure & Conquer approach in the bounded-degree case, e.g., for Max. Stable Set problems and Max. 2-SAT. This leads to better theoretical (exponential) running time bounds in comparison to the standard analysis of the algorithms. The optimization problems laying at the core of the analysis can be reduced to certain quasiconvex programs, which can be efficiently solved using a random local search strategy or Eppstein's smooth quasiconvex programming method.

2 - On the Induced Matching Polytope

Kathie Cameron, Professor, Equipe Combinatoire, University Paris VI, 175 rue du Chevaleret (1E17), Paris, 75013, France, kathiecameron@gmail.com

An induced matching in a graph G is a matching, no two edges of which are joined by an edge of G. I will discuss the induced matching polytope. The maximum induced matching problem is NP-hard for bipartite planar graphs, and thus we can not expect a nice description of the induced matching polytope like the matching polytope. But in some cases, such as for chordal graphs, there is a nice description of the induced matching polytope.

3 - Restricted Simple 2-matchings in Subcubic Graphs

David Hartvigsen, Professor, University of Notre Dame, Mendoza College of Business, Notre Dame, IN, 46556-5646, United States of America, Hartvigsen.1@nd.edu, Yanjun Li

A simple 2-matching in an edge-weighted graph is a subgraph whose connected components are non-trivial paths and cycles. We consider the problems, denoted S(k), of finding maximum weight simple 2-matchings containing no cycles of length k or less, which are closely related to the travelling salesman problem. We present a polynomial-time algorithm and polyhedral description for S(3) in subcubic graphs (i.e., graphs with maximum degree 3). We also present min-max and Edmonds-Gallai-type theorems and specialized polynomial-time algorithms for S(3) and S(4) for the case of all weights equal to 1 in subcubic graphs. We also show that S(k) with all weights equal to 1 is NP-hard for k greater than or equal to 5 in subcubic graphs.

■ TA06

Marriott - Kansas City

Topics in IPMs for Conic Optimization

Cluster: Conic Programming
Invited Session

Chair: Goran Lesaja, Georgia Southern University, Department of Mathematical Sciences, 203 Georgia Ave., Statesboro, GA, 30460-8093, United States of America, goran@georgiasouthern.edu

1 - A Large-update Infeasible Interior-point Algorithm for Linear Optimization

Alireza Asadi, Delft University of Technology, Mekelweg 4, Room HB 07.160, Delft, 2628CD, Netherlands, a.asadi@tudelft.nl, Kees Roos

A large-update $O(n^2)$ infeasible interior-point algorithm for linear optimization problem is presented. The algorithm stems from C. Roos's full-Newton step variant. To use full-Newton steps, requires his algorithm to make too small amount of reduction, i.e., $O(\frac{1}{n})$, on the infeasibility and the duality gap which imposes $O(n)$ convergence rate to his algorithm. We design a variant that allows larger amount of improvement on both the optimality and the feasibility, but, unfortunately, it is on the same boat with the feasible case, in the sense that regardless of its higher practical performance, its theoretical convergence rate is worse, namely $O(n^2)$.

2 - A New Redundant Klee-Minty Model Whose Central Path Visits at Least Half of the All Vertices

Bib Paruhum Silalahi, PhD Student, Delft University of Technology, Mekelweg 4 (Room: HB 07.140), Delft, 2628 CD, Netherlands, B.P.Silalahi@tudelft.nl, Kees Roos

It is known that the central path of a redundant Klee-Minty model can be forced to go closely to the simplex path of the Klee-Minty n-cube. In this paper we provide a redundant Klee-Minty model with redundant constraints of the form x_k + \tau x_{k-1}+ d_k great or equivalent than zero. We show that this model needs less redundant constraints than when using redundant constraints of the form x_k + d_k great or equivalent than zero as has been considered before.

3 - Full Nesterov-todd Step Interior-point Methods for Symmetric Optimization

Guoyong Gu, Delft University of Technology, Mekelweg 4, Delft, 2628 CD, Netherlands, g.gu@tudelft.nl, Kees Roos, Maryam Zangiabadi

Some Jordan algebras were proved more than a decade ago to be an indispensable tool in the unified study of interior-point methods. By using it, we generalize the full-Newton step infeasible interior-point method for linear optimization of Roos [{\em SIAM J. Optim.}, 16(4):1110—1136 (electronic), 2006] to symmetric optimization. This unifies the analysis for linear, second-order cone and semidefinite optimizations. We also report on numerical tests with adaptive steps.

4 - Interior-point Method for Conic Linear Complementarity Problem

Goran Lesaja, Georgia Southern University, Department of Mathematical Sciences, 203 Georgia Ave., Statesboro, GA, 30460-8093, United States of America, goran@georgiasouthern.edu, Kees Roos

We present primal-dual interior-point method for monotone linear commplementarity problem on symmetric cones that is based on Nesterov-Todd direction. It is shown that if the problem has strictly feasible interior point, then the method is globally convergent with polynomial iteration bound that matches the currently best known iteration bound obtained for these problems and these methods.

■ TA07

Marriott - Chicago D

Integer and Mixed Integer Programming A

Contributed Session

Chair: Stefan Ropke, Associate Professor, Technical University of Denmark, Bygningstorvet 115, Kgs. Lyngby, 2800, Denmark, sr@transport.dtu.dk

1 - A Branch-and-cut Algorithm Using Strong Formulation for an Inventory-routing Problem

Haldun Sural, Associate Professor- Doctor, METU, Industrial Engineering Department, Ankara, 06531, Turkey, sural@ie.metu.edu.tr, Oguz Solyali

We address an inventory-routing problem where a supplier receives an amount of a product and distributes to multiple retailers with dynamic demands. The problem is to decide on when and in what sequence to visit retailers such that total cost is minimized over a horizon. We propose a branch-and-cut algorithm using strong formulation. Computational results reveal that the algorithm performs better than its competitors in the literature.

2 - A Bundle Approach for Path Coupling Problems

Thomas Schlechte, ZIB, Takustrasse 7, Berlin, 14195, Germany, schlechte@zib.de, Ralf Borndoerfer, Steffen Weider

This talk focuses on solving path coupling models for the train timetabling problem (TTP), which consists in finding a conflict free set of train routes of maximum value in a given railway network. We solve these large scale integer programs by a Branch and Bound and Price approach. Furthermore we present computational results for using the bundle method to solve a Langrangean Relaxation instead of a LP Relaxation.

3 - Computer Aided Discovery of Families of Valid Inequalities

Stefan Ropke, Associate Professor, Technical University of Denmark, Bygningstorvet 115, Kgs. Lyngby, 2800, Denmark, sr@transport.dtu.dk, Jean-Francois Cordeau, Gilbert Laporte

We present a computer program that helps the user discovering new families of valid inequalities for any integer program. It does so by finding simple valid inequalities that are violated by a fractional solution supplied by the user. It is up to the user to generalize these inequalities further. We present new families of inequalities for the capacitated vehicle routing problem and the traveling salesman problem with pickup and deliveries found using the program.

■ TA08

Marriott - Chicago E

Trends in Mixed Integer Programming III

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Andrea Lodi, DEIS, University of Bologna, Viale Risorgimento, 2, Bologna, 40136, Italy, andrea.lodi@unibo.it

Co-Chair: Robert Weismantel, Professor, Otto-von-Guericke University Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, weismant@mail.math.uni-magdeburg.de

1 - Pivot-and-Fix; A New Primal Heuristic for Mixed Integer Programming

Mahdi Namazifar, University of Wisconsin, ISyE, Madison, United States of America, namazifar@wisc.edu, Robin Lougee-Heimer, John Forrest

In this talk, we introduce a new primal heuristic for mixed integer programs called "Pivot-and-Fix". The Pivot-and-Fix Heuristic explores extreme points of the MIP's linear programming relaxation, and attempts to construct a MIP-feasible solution by fixing a set of variables at integer values. Preliminary computational results for the heuristic are presented and discussed.

2 - Using Branch and Price to Find Good Solutions to MIPs Quickly

Mike Hewitt, Georgia Institute of Technology, 765 Ferst Dr, Atlanta, GA, 30332, United States of America, mhewitt@isye.gatech.edu, Martin Savelsbergh, George Nemhauser

We present a branch-and-price framework where the extended formulation is chosen so as to facilitate creating restrictions of the compact formulation that are small enough to be solved quickly. We next present an application of the framework and computational results that indicate the approach produces good solutions quickly.

3 - ParaSCIP: A Parallel Extension to SCIP

Yuji Shinano, Tokyo University of Agriculture and Technology, Naka-cho 2-24-16, Koganei, Tokyo, Japan, shinano@zib.de, Thorsten Koch, Tobias Achterberg, Stefan Heinz

SCIP (Solving Constraint Integer Programs) is currently one of the fastest non-commercial mixed integer programming solver. In this talk, we introduce ParaSCIP which realizes parallelization specialized for the solver on distributed memory computing environments. To fully utilize the power of SCIP, the implementation exploits almost all functionality available on it. ParaSCIP is designed to run over 10,000 SCIP solvers in parallel to solve hard problem instances. We will present some results from preliminary computational experiments.

■ TA09

Marriott - Chicago F

Integer Programming Driving Systems Biology

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Utz-Uwe Haus, Junior Research Group Leader, Otto-von-Guericke University Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, haus@mail.math.uni-magdeburg.de

1 - Two Pairs of Boolean Functions in Computational Biology

Tamon Stephen, Simon Fraser University, 14th Floor Central City Tower, 250-13450 102nd Ave., Surrey, BC, V3T 0A3, Canada, tamon@sfu.ca

We describe two quite different biological contexts where key properties can be encoded as monotone boolean functions. The first is describing the minimal knock out strategies in a metabolic network, the second is identifying minimal conflicting sets in ancestral genome reconstruction. Oracle-based versions of an algorithm of Fredman and Khachiyan are used to generate representations of these boolean functions. In the process of generation, a dual boolean function is identified. These dual functions have interesting interpretations in terms of the systems we are studying. We briefly mention computational results. This is joint work with Cedric Chauve, Utz-Uwe Haus and Steffen Klamt.

2 - Discrete System Identification of Biological Networks

Brandilyn Stigler, Assistant Professor, Southern Methodist University, Department of Mathematics, Dallas, TX, 75275, United States of America, bstigler@smu.edu

Boolean networks have been used successfully in modeling various biological systems. Often the available biological information may not be sufficient to construct a function that describes network interactions. We present a software package for system identification of Boolean networks. It integrates several algebraic inference methods with extensive simulation capabilities, including parallel and sequential updating, as well as deterministic and stochastic simulation of dynamics.

3 - Static and Dynamic Biologic Signaling Networks

Utz-Uwe Haus, Junior Research Group Leader, Otto-von-Guericke University Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, haus@mail.math.uni-magdeburg.de, Robert Weismantel, Kathrin Niermann, Klaus Truemper

We propose a static and a dynamic boolean approach to model biological signaling networks, and show how each can be used to answer relevant biological questions. The problems arising are NP-complete, but an interesting subclass is linear-time solvable, generalizing Tarjan's SAT algorithm. For infeasible instances, structured relaxation and computation of all maximally feasible subsystems is discussed.

■ TA10

Marriott - Chicago G

Reformulation Techniques in Global Optimization

Cluster: Global Optimization
Invited Session

Chair: Leo Liberti, Doctor, Ecole Polytechnique, LIX, Ecole Polytechnique, Palaiseau, 91128, France, leoliberti@gmail.com

1 - Column Generation Algorithms for Modularity Maximization

Pierre Hansen, Professor, Gerad, HEC Montreal and Ecole Polytechnique, 3000, Chemin de la Cote-Sainte-Catherine, LIX, Ecole Polytechnique, Montreal, Canada, pierre.hansen@gerad.ca, Sonia Cafieri, Leo Liberti

According to M. Newman, the modularity measure of a cluster in a graph is the number of edges within that subgraph minus the expected number of edges of a random graph with the same degree distribution. The problem of modularity maximization is to partition the set of vertices in such a way that the sum of modularities of each cluster is maximum. This problem and its variants have been studied extensively, mostly by physicists, in the last five years. We present column generation algorithms for modularity maximization in a general and in a bipartite graph and compare them with the most efficient ones proposed to date.

2 - An Automatic Linear Reformulation Technique Based on Affine Arithmetic

Jordan Ninin, PhD Student, ENSEEIHT-IRIT, 2 rue Camichel BP 7122, Cedex 7, Toulouse, F-31071, France, Jordan.Ninin@n7.fr, Frederic Messine, Pierre Hansen

A new automatic method for constructing linear relaxations of a continuous constrained optimization problem is proposed. Such a construction is based on affine and interval arithmetics and uses overloading techniques. The linear programs so-generated has exactly the same numbers of variables and of inequality constraints; each of the equality constraints is replace by two inequality ones. Therefore, this new procedure, for computing reliable bounds and certificates of infeasibility, is inserted inside a classical interval Branch and Bound algorithm. Its efficiency is shown by solving, in reliable way, several difficult numerical examples of continuous constrained global optimization problems from the COCONUT website.

3 - On Convex Relaxations in Non-convex Optimization

Tapio Westerlund, Professor, Abo Akademi University, Biskopsgatan 8, Abo, 20500, Finland, tapio.westerlund@abo.fi, Joakim Westerlund, Andreas Lundell

Many global optimization methods are based on the principle of relaxing a non-convex problem into convex sub-problems. The optimal solution is then found by solving a sequence of such sub-problems to optimality. Independently of the type of procedure chosen, it is important that the relaxations used when solving the sub-problems are made as tight as possible. We will consider convex relaxations for optimization problems including non-convex inequality constraints. In such problems, the constraint functions can be replaced by their convex envelopes. Often it is mentioned, that by doing so, one will obtain the tightest convex relaxation for the problem at hand. We will, however, show that even tighter convex relaxations can be obtained.

■ TA11

Marriott - Chicago H

Duality and Algorithms in Global Optimization - I

Cluster: Global Optimization
Invited Session

Chair: David Gao, Professor, Virginia Tech, Mathematics, 524 McBryde Hall, Blackburg, VA, 24061, United States of America, gao@vt.edu

1 - P2P Streaming Capacity: Optimizing Tree Embedding

Mung Chiang, Professor, Princeton University, chiangm@princeton.edu

We develop a combination of primal-dual algorithm and smallest price tree construction to compute, in polynomial time, the capacity of P2P streaming over the Internet under various topology constraints. Combinatorial algorithms work together with Lagrange duality to solve several of the open problems in this area. This is joint work with Minghua Chen, Phil Chou, Jin Li, Shao Liu, and Sudipta Sengupta.

2 - Maximizing Sum Rates in Multiuser Communication Systems: Theory and Algorithms

Chee Wei Tan, California Institute of Technology, 1200 E California Blvd MC 256-80, Pasadena, CA, 91125, United States of America, cheetan@caltech.edu

Dynamic spectrum management (DSM) technique is used to mitigate interference and maximize the throughput in a multiuser communication system, e.g., a DSL or cognitive radio network, by solving the nonconvex sum Shannon rate maximization problem. Using nonnegative matrix theory, we cast this problem as a convex maximization problem over an unbounded convex set determined by spectral radius constraints and then propose a fast cutting plane algorithm to accelerate computing the optimal solution.

3 - Analytic Solutions to Mixed-integer Programming with Fixed Charge

Ning Ruan, Virginia Tech, Department of Math, Blacksburg, United States of America, ruan@vt.edu, David Gao, Hanif D. Sherali

This talk presents a canonical dual approach for solving a mixed-integer quadratic minimization problem with fixed cost terms. We show that this well-known NP-hard problem in $R^{(2n)}$ can be transformed into a continuous concave maximization dual problem over a convex feasible subset of R^n with zero duality gap, which can be solved easily, under certain conditions, by traditional convex programming methods. Analytic solutions for both global minimizer and global maximizer are obtained.

■ TA12

Marriott - Los Angeles

Derivative-free Algorithms: Pattern Search Methods

Cluster: Derivative-free and Simulation-based Optimization
Invited Session

Chair: Charles Audet, Charles.Audet@gerad.ca

1 - Globalization Strategies for Mesh Adaptive Direct Search

Charles Audet, Charles.Audet@gerad.ca, John Dennis, Sebastien Le Digabel

The class of Mesh Adaptive Direct Search (Mads) algorithms is designed for the optimization of constrained black-box problems. In this talk, we discuss and compare three instantiations of Mads under different strategies to handle constraints. The three instantiations are Gps, LTMads and OrthoMads. Numerical tests are conducted from feasible and/or infeasible starting points on three real engineering applications. Constraints are handled by the extreme barrier, the progressive barrier, or by a mixture of both. The applications are the optimization of a styrene production process, a MDO mechanical engineering problem, and a well positioning problem. The codes of these problems are publicly available.

2 - Black-box Optimization with the NOMAD Software

Sebastien Le Digabel, Ecole Polytechnique de Montreal, C.P. 6079, Succ. Centre-ville, Montreal, Qc, H3C 3A7, Canada, Sebastien.Le.DigabeL@gerad.ca, Charles Audet, John E. Dennis, Jr

NOMAD is a black-box optimization software package based on the Mesh Adaptive Direct Search (MADS) algorithm. Black-box optimization occurs when the functions representing the objective and constraints have no exploitable structure, including available derivatives. Such functions are typically evaluated by computer codes. MADS is a directional direct search method specifically designed for such problems, supported by a rigorous hierarchical convergence analysis based on the Clarke calculus for nonsmooth functions. The presentation gives an overview of MADS and describes the NOMAD implementation and its use.

3 - Exploiting Simulation Time Reductions in Expensive Optimization Problems

Mark Abramson, The Boeing Company, Mark.A.Abramson@boeing.com, Thomas Asaki, John E. Dennis, Jr, Matthew Sottile, Raymond Magallanez, Jr., David Bethea

We continue our investigation of optimization problems whose function evaluations typically require an engineering simulation, and we explore unconventional approaches for solving these expensive problems. We first look at problems in which functions are less computationally expense at the solution than elsewhere in the domain. We then explore ideas for optimizing over computational parameters, such as the grid size used in numerically solving an underlying system of differential equations. Some promising numerical results are presented.

■ TA13

Marriott - Miami

Some Optimization Problems in Generation Management and Power Markets

Cluster: Optimization in Energy Systems
Invited Session

Chair: Rene Aid, FiME Lab Director, Electricity de France, 1 Av. du General de Gaulle, Clamart, 92141, France, Rene.Aid@edf.fr

1 - Heuristic and Exact Methods for Solving the Market Coupling Problem

Rouquia Djabali, Analyst, EPEX Spot, 5, Boulevard Montmartre, Paris, 75002, France, r.djabali@epexspot.com

Market Coupling is both a mechanism for matching orders on the power exchanges and an implicit cross border capacity allocation mechanism. It improves the economic surplus of the coupled markets: the highest purchase orders and the lowest sale orders of the coupled power exchanges are matched, regardless of the market where they have been submitted and within the limit of the Available Transfer Capacity. The Market Coupling problem can be modeled as a mixed integer quadratic problem. Qualitative and quantitative comparisons between a heuristic method (currently implemented for the Tri Lateral Coupling between Belgian, Dutch and French markets) and an exact approach, for solving the Market Coupling problem, are presented and discussed.

2 - On a Decomposition Algorithm for a Stochastic Power Management Problem

Kengy Barty, Research Engineer, EDF R&D, 1, Avenue du General de Gaulle, Clamart, 92141, France, kengy.barty@edf.fr, Basma Kharrat, Pierre Girardeau

The mid-term power management problem of EDF consists in finding optimal strategies, over a two year horizon, for all production units, that minimize the overall production cost, while supplying to power demand and satisfying some physical constraints. We propose a new approach based on combining the strengths of Lagrangian relaxation and regression techniques, in order to compute the optimal strategy.

3 - ROADEF & EURO 2010 Optimization Challenge: EDF Group Nuclear Plants Outage Scheduling

Guillaume Dereu, Engineer, EDF R&D, 1 Avenue du General de Gaulle, Clamart, 92141, France, guillaume.dereu@edf.fr

Every year, the French Operational Research Society (ROADEF) and the Assocation of European Operational Research Societies (EURO) request industrial companies with challenging optimization problem and the corresponding reward for the winners. ROADEF and EURO, in association with EDF R&D, have chosen the 2010 challenge to be the EDF group nuclear plant outage scheduling problem. In this talk, we will present the details of this large scale energy management problem with diversified constraints, together with the contest procedure. The total amount of the price is 10,000 euros.

■ TA14

Marriott - Scottsdale

Optimization in Mechanism Design

Cluster: Game Theory
Invited Session

Chair: Evdokia Nikolova, Massachusetts Institute of Technology, 32 Vassar Street, Building 32-G596, Cambridge, MA, 02139, United States of America, enikolova@csail.mit.edu

1 - Self-correcting Sampling-based Dynamic Multi-unit Auctions

Florin Constantin, Harvard University, 33 Oxford St, Cambridge, MA, 02138, United States of America, florin@eecs.harvard.edu, David Parkes

We achieve strategyproofness in dynamic multi-unit auctions via a self-correcting procedure (introduced by Parkes and Duong), applied to an online sample-based stochastic optimization algorithm. In our domain, this approach requires, however, modifying the underlying optimization algorithm. We prove the successful interfacing of a novel heuristic method with sensitivity analysis and demonstrate its good empirical performance. Our method is quite general, requiring a technical property of uncertainty independence, and that values are not too positively correlated with agent patience. We also show how to incorporate “virtual valuations” in order to increase the seller’s revenue.

2 - Equilibria of Atomic Flow Games are not Unique

Chien-Chung Huang, Max-Planck-Institut fur Informatik, Campus E1 4, Saarbrucken, 66123, Germany, villars@mpi-inf.mpg.de, Darrell Hoy, Umang Bhaskar, Lisa Fleischer

We study routing games in networks where the delay of an edge depends on the flow volume on the edge. Players control large amounts of flow and route their flow fractionally to minimize the average delay of their flow. Equilibria of such games exist, but it is not known if the equilibrium is unique. We show that there may be multiple equilibria, and give a complete characterization of the class of network topologies for which unique equilibria exist.

3 - Mechanism Design for Stochastic Optimization Problems

Samuel Ieong, Researcher, Microsoft, 1288 Pear Avenue, Rm 1039, Mountain View, CA, 94303, United States of America, sieong@cs.stanford.edu, Mukund Sundararajan, Anthony So

We identify and address algorithmic and game-theoretic issues arising from welfare maximization in the two-stage stochastic optimization framework. We show the existence of a mechanism that implements the social welfare maximizer in sequential ex post equilibrium, and the impossibility of dominant-strategy implementation. We also investigate algorithmic issues in implementing the mechanism by studying a novel combinatorial optimization problem that generalizes the Fixed-tree Multicast problem.

4 - A Truthful Mechanism for Offline Ad Slot Scheduling

Evdokia Nikolova, Massachusetts Institute of Technology, 32 Vassar Street, Building 32-G596, Cambridge, MA, 02139, United States of America, enikolova@csail.mit.edu, Jon Feldman, S. Muthukrishnan, Martin Pal

In sponsored search, advertisers must be scheduled to slots during a given period of time. We give a truthful mechanism under the utility model where bidders maximize their clicks, subject to their budget and maximum cost per click constraints. In addition, we show that the revenue-maximizing mechanism is not truthful, but has a Nash equilibrium whose outcome is identical to our mechanism. As far as we can tell, this is the first treatment of sponsored search that directly incorporates both multiple slots and budget constraints into an analysis of incentives. We use a mix of economic analysis and combinatorial optimization to prove our results.

■ TA15

Gleacher Center - 100

Stochastic Optimization and Markov Decision Processes

Cluster: Stochastic Optimization
Invited Session

Chair: Constatine Caramanis, University of Texas, Mail Code, C0806, Austin, TX, 78712, cmcaram@ece.utexas.edu

1 - Q-learning and Pontryagin's Minimum Principle

Sean Meyn, Professor, UIUC, Coordinated Science Laboratory, 1308 W. Main St., Urbana, IL, 61801, United States of America, meyn@control.csl.uiuc.edu, Prashant Mehta

Q-learning is a technique used to compute an optimal policy for a controlled Markov chain based on observations of the system controlled using a non-optimal policy. It has proven to be effective for models with finite state and action space. In this talk we demonstrate how the construction of the algorithm is identical to concepts more classical nonlinear control theory - in particular, Jacobson & Mayne's differential dynamic programming introduced in the 1960's. We show how Q-learning can be extended to deterministic and Markovian systems in continuous time, with general state and action space. Examples are presented to illustrate the application of these techniques, including application to distributed control of multi-agent systems.

2 - Optimization of Reversible Markov Decision Processes

Randy Cogill, Assistant Professor, University of Virginia, 151 Engineer's Way, Charlottesville, VA, United States of America, rcogill@virginia.edu, Cheng Peng

Reversible Markov chains have been well studied, and the simplifications reversibility brings to their analysis are well known. Here we show that reversibility provides similar simplifications in control problems. The simplifications emerge after establishing conditions that are dual to the detailed balance conditions used in analysis of reversible Markov chains. These conditions lead to a simple optimality equation and a simple simulation-based optimization procedure for reversible MDPs.

3 - Fast Algorithms for MDPs with Expected Budget Constraints

Nedialko Dimitrov, University of Texas at Austin, 1 University Station C2200, Austin, TX, 78712, United States of America, ned.dimitrov@gmail.com, David Morton, Constatine Caramanis

An MDP with n states can be solved using the value iteration algorithm in $O(n^2)$ time, as opposed to the $Omega(n^3)$ time required if one uses a linear program. Expected budget constraints on the MDP policy can be easily captured in linear program formulation, but break the basic value iteration algorithm. We show two new algorithms for solving MDPs with k budget constraints giving the exact solution in $O(poly(k)\ n^2)$ time or an approximately feasible solution in $O(log(k)\ n^2)$ time.

■ TA16

Gleacher Center - 200

Computational Stochastic Programming

Cluster: Stochastic Optimization
Invited Session

Chair: Jonathan Eckstein, Professor, Rutgers University, 640 Bartholomew Road, Piscataway, NJ, 08854, United States of America, jeckstei@rci.rutgers.edu

1 - An Integer Programming Decomposition Approach for Optimization with Probabilistic Constraints

James Luedtke, University of Wisconsin, 3236 Mechanical Engineering Building, 1513 University Avenue, Madison, WI, 53706, United States of America, jrluedt1@wisc.edu

We discuss how the integer programming approach which has been successfully applied for probabilistic (or chance) constraints with random right-hand side can be extended for general probabilistic constraints. This approach also has the advantage that it allows decomposition into single scenario subproblems. Preliminary computational results will be presented.

2 - Risk-averse Two Stage Stochastic Optimization

Naomi Miller, Rutcor, 640 Bartholomew Road, Piscataway, NJ, 08854, United States of America, naomi_miller2003@yahoo.ca, Andrzej Ruszczynski

We extend Benders' decomposition algorithm for solving linear two-stage stochastic problems with recourse to the two-stage risk-averse model, with coherent mean-risk objective functions in each stage. The risk-averse model is also formulated as one large linear program. We provide an illustrative example, where a two-stage portfolio problem with recourse is solved, with risk functions semideviation and weighted deviation from quantile, using these two methods and the simplex method.

3 - Projective Splitting and Projective Hedging

Jonathan Eckstein, Professor, Rutgers University, 640 Bartholomew Road, Piscataway, NJ, 08854, United States of America, jeckstei@rci.rutgers.edu, Benar Svaiter

Projective operator splitting is a general decomposition method using a closed-form projection instead of a classical master problem. Applied to stochastic programs, this technique produces "projective hedging" algorithms significantly generalizing Rockafellar-Wets progressive hedging, with each iteration solving an independent quadratically-perturbed subproblem for each scenario block. We examine how one might exploit the greater generality of this approach to accelerate convergence.

■ TA17

Gleacher Center - 204

Transportation and Routing

Cluster: Logistics and Transportation
Invited Session

Chair: Yanfeng Ouyang, Assistant Professor, University of Illinois, Civil & Envir Eng, 205 N Mathews Ave, Urbana, IL, 61801, United States of America, yfouyang@illinois.edu

1 - Incorporating Operational Complexity in the Period Vehicle Routing Problem

Tingting Jiang, Northwestern University, 2145 Sheridan Road, Evanston, IL, 60201, United States of America, tingting-jiang@northwestern.edu, Maciek Nowak, Karen Smilowitz

This paper explores the addition of operational complexity to the Period Vehicle Routing Problem (PVRP). The PVRP extends the vehicle routing problem by serving customers according to set visit frequencies over a time period. When routes operate over multiple days, issues of operational complexity arise. Operational complexity captures the difficulty of implementing a solution for service providers and customers. We add complexity to the PVRP and evaluate the impact of complexity on solutions.

2 - Ship Traffic Optimization for the World's Busiest Artificial Waterway

Marco Luebbecke, TU Berlin, Institute of mathematics, Strasse des 17. Juni 136, Berlin, 10623, Germany, m.luebbecke@math.tu-berlin.de, Felix Koenig, Elisabeth Guenther, Rolf Moehring

The Kiel Canal connects the North and Baltic seas and is ranked among the world's three major canals. There is bi-directional ship traffic, passing and overtaking is constrained, depending on the size category of the respective ships and the meeting point. If a conflict occurs, ships have to wait at designated, capacitated places. The objective is to minimize the total waiting time. The scheduling is currently done by experienced planners. We discuss heuristic graph algorithms and lower bounds from an integer program.

3 - The Traveling Purchaser Problem with Stochastic Prices

Seungmo Kang, Postdoctoral Research Associate, Energy Biosciences Institute, 1206 West Gregory Drive, Urbana, IL, 61801, United States of America, skang2@illinois.edu, Yanfeng Ouyang

The paper formulates an extension of the traveling purchaser problem where multiple commodities are sold at stochastic prices by spatially distributed sellers. The purchaser needs to find the optimal routing and purchasing strategies that minimize the expected total travel and purchasing costs. We propose an exact algorithm based on dynamic programming, an approximate algorithm that yields tight cost bounds, and a greedy heuristic for large-scale instances.

■ TA18

Gleacher Center - 206

Recent Progress in the Solution of Quadratic Assignment Problems I

Cluster: Nonlinear Mixed Integer Programming
Invited Session

Chair: Hans Mittelmann, Professor, Arizona State University, School of Math and Stat Sciences, P.O. Box 871804, Tempe, AZ, 85287-1804, United States of America, MITTELMANN@asu.edu

1 - Improved Bounds for General QAPs via Semidefinite Relaxations

Hans Mittelmann, Professor, Arizona State University, School of Math and Stat Sciences, P.O. Box 871804, Tempe, AZ, 85287-1804, United States of America, MITTELMANN@asu.edu

We report on our method to compute lower bounds for general quadratic assignment problems using matrix-splitting techniques and SDP relaxations. This is a generalization of the approach presented earlier for Hamming and Manhattan distance cases. These bounds are relatively cheap to compute and can

be applied to problems of dimension 200 and more. We present results for instances from QAPLIB and compare to other cheap bounds such as GLB, PB , and QPB. This is joint wotk with Jiming Peng.

2 - Group Symmetry and Branching for QAP

Renata Sotirov, Tilburg University, P.O. Box 90153, 5037 AB Tilburg, Tilburg, NL-5000 LE, Netherlands, R.Sotirov@uvt.nl, Etienne de Klerk

In this talk we consider a semidefinite programming relaxation of the QAP, and show how to exploit group symmetry of the data matrices in order to significantly reduce the size of the relaxation. Further, we show how to use the symmetries when making branching decisions. This approach, when applicable, leads to significantly reduced size of the B$\&$B tree.

3 - A Smoothing Algorithm for Solving QAPs

Kien Ming Ng, National University of Singapore, Dept of Industrial & Systems Engineering, 10 Kent Ridge Crescent, Singapore, 119260, Singapore, kienming@nus.edu.sg, Walter Murray

A smoothing algorithm is proposed to solve the QAP. The QAP is first transformed to that of finding a global optimum of a problem in continuous variables. The proposed algorithm then involves convexifying the transformed problem with an appropriate smoothing function, and solving a sequence of subproblems whose solutions form a trajectory that leads to a solution of the QAP. Computational results of applying the proposed smoothing algorithm to instances from the QAPLIB are shown.

■ TA19

Gleacher Center - 208

Nonlinear Programming E

Contributed Session

Chair: Victor Zavala, Postdoctoral Researcher, Argonne National Laboratory, 9700 S Cass Ave, Argonne, IL, 60439, United States of America, vzavala@mcs.anl.gov

1 - Exact Penalty Functions for Nonlinear Integer Programming Problems

Francesco Rinaldi, Dipartimento Informatica e Sistemistica, via Ariosto 25, Rome, 00185, Italy, francesco.rinaldi@iasi.cnr.it, Stefano Lucidi

In this work, we study exact continuous reformulations of nonlinear integer programming problems. To this aim, we preliminarily state conditions to guarantee the equivalence between pairs of general nonlinear problems. Then, we prove that optimal solutions of a nonlinear integer programming problem can be obtained by using various exact penalty formulations of the original problem in a continuous space.

2 - Using Improved Directions of Negative Curvature Within Optimization Algorithms

Javier Cano, PhD, Universidad Rey Juan Carlos, Camino Del Molino s/n, Fuenlabrada (Madrid), 28943, Spain, javier.cano@urjc.es, Javier M. Moguerza, Francisco J. Prieto

In this work, an interior-point algorithm using improved directions of negative curvature is described. The method makes use of low cost procedures to improve directions of negative curvature obtained from a direct factorization of a modified Hessian matrix. These directions improve the computational efficiency of the procedure and ensure convergence to second-order KKT points. Some numerical experiments showing the successful performance of the algorithm are presented.

3 - On-line Nonlinear Programming as a Parametric Generalized Equation

Victor Zavala, Postdoctoral Researcher, Argonne National Laboratory, 9700 S Cass Ave, Argonne, IL, 60439, United States of America, vzavala@mcs.anl.gov, Mihai Anitescu

We establish results for the problem of tracking a time-moving manifold arising in on-line nonlinear programming by casting this as a parametric generalized equation. We demonstrate that if points along the manifold are consistently strongly regular, it is possible to track the manifold approximately by solving a single linear complementarity problem per time step. Applications include on-line dynamic optimization and data assimilation.

■ TA20

Gleacher Center - 300

Nonlinear Programming: Cubic Regularisation and Subspace Methods

Cluster: Nonlinear Programming

Invited Session

Chair: Annick Sartenaer, Professor, University of Namur (FUNDP), Rempart de la Vierge, 8, Namur, B-5000, Belgium, annick.sartenaer@fundp.ac.be

Co-Chair: Sven Leyffer, Argonne National Laboratory, MCS Division 9700 South Cass Avenue, Argonne, IL, 60439, United States of America, leyffer@mcs.anl.gov

1 - Function-evaluation Efficiency of Adaptive Cubic Regularisation for Unconstrained Optimization

Coralia Cartis, Lecturer, University of Edinburgh, James Clerk Maxwell Building, The King's Buildings, Mayfield Road, Edinburgh, EH9 3JZ, United Kingdom, Coralia.Cartis@ed.ac.uk, Nick Gould, Philippe Toint

Our Adaptive Regularisation algorithm with Cubics (ARC) is shown to have improved efficiency on convex problems in terms of function- and gradient-evaluations. The bound's order matches Nesterov (2008), without using in ARC the Hessian's Lipschitz constant and exact subproblem solution. An example of slow ARC performance is given, indicating the bound may be sharp. A more refined analysis of ARC's efficiency on nonconvex problems is then derived. We also discuss trust-regions' efficiency.

2 - Cubic Regularization for Bound-constrained Optimization and Function-evaluation Complexity

Philippe Toint, University of Namur, rue de Bruxelles 61, Namur, B-5000, Belgium, philippe.toint@fundp.ac.be, Nick Gould, Coralia Cartis

The adaptive cubic overestimation algorithm described in Cartis, Gould and Toint (2007) is adapted to the problem of minimizing a nonlinear, possibly nonconvex, smooth objective function over a convex domain. Convergence to first-order critical points is shown under standard assumptions, but without any Lipschitz continuity requirement on the objective's Hessian. A worst-case complexity analysis in terms of evaluations of the problem's function and derivatives is also presented for the Lipschitz continuous case and for a variant of the resulting algorithm. This analysis extends the best known bound for general unconstrained problems to nonlinear problems with convex constraints.

3 - A Subspace Method for Large Scale Optimization Over a Sphere

Ya-xiang Yuan, Professor, Chinese Academy of Sciences (CAS), Institute of Computational Mathematics, Zhong Guan Cun Donglu 55, Beijing, 100190, China, yyx@lsec.cc.ac.cn

A subspace method for large scale optimization over a sphere is proposed. At every iteration, the new iterate point is computed by minimizing a quadratical model in the intersection of the feasible sphere and a lower dimensional subspace. The subspace and the quadratical model are updated by using the information given in the previous iterations. The method does not use line search nor use an explicit trust region. The new iterate is accepted as long as it gives a reduction in the objective function. Convergence of the method is studied and preliminary numerical results are reported.

■ TA21

Gleacher Center - 304

Network Design Under Uncertainty

Cluster: Telecommunications and Networks

Invited Session

Chair: Abdel Lisser, Professor, Universite de Paris Sud, Universite de Paris Sud, LRI, Batim. 490, Orsay, 91405, France, Abdel.Lisser@lri.fr

1 - A Robust Semidefinite Relaxation Approach for Downlink Resource Allocation using Adaptive Modulation

Pablo Adasme, PhD Student, Universite Paris sud 11, Batiment 490, 91405 Orsay, Paris, France, pablo.adasme@lri.fr, Abdel Lisser, Ismael Soto

This paper proposes two robust binary quadratic formulations for wireless downlink (DL) Orthogonal Frequency Division Multiple Access (OFDMA) networks when using adaptive modulation. The first one is based on a scenario uncertainty approach and the second is based on an interval uncertainty approach. Thus, we derive for each, two semidefinite relaxations and by numerical results, we get a near optimal average tightness of 4.12 % under the scenario approach and 1.15 % under the interval uncertainty approach when compared to the optimal solution of the problem derived by linearizing the two quadratic models with Fortet linearization method.

2 - Optimal Pricing in Markets that are Formed as Social Networks: A Stochastic Quasi-gradient Approach

Denis Becker, PhD Student, NTNU, Alfred Getz vei 2, Trondheim, Norway, Denis.Becker@iot.ntnu.no, Alexei Gaivoronski

A stochastic quasi-gradient (SQG) method is applied to support optimal pricing for telecommunication services offered over multiple periods. Instead of using an aggregated price-demand curve that casts complex market behavior into an average reaction of one market-representative the individuals are interconnected within a social network. By applying a SQG method we can solve the complex decision problem of the service provider and analyze optimal pricing for a range of different networks.

3 - Upper Bounds for the 0-1 Stochastic Knapsack Problem

Abdel Lisser, Professor, University of Paris Sud, LRI, Batiment 490, Orsay, 91405, France, lisser@lri.fr, Stefanie Kosuch

In this talk, we present two different variants of static knapsack problems with random weights. Special interest is given to the corresponding continuous problems and three different solution methods are presented. The resolution of the continuous problems allows to provide upper bounds in a branch-and-bound framework in order to solve the original problems. Numerical results on a dataset from the literature as well as a set of randomly generated instances are given.

■ TA22

Gleacher Center - 306

Interior Point Implementations I

Cluster: Implementations, Software

Invited Session

Chair: Christian Bliek, IBM, 1681 HB2 Route des Dolines, Valbonne, 06560, France, bliek@fr.ibm.com

1 - Implementation Techniques and Recent Developments in the BPMPD Interior Point Solver

Csaba Meszaros, MTA SZTAKI, Lagymanyosi u. 11, Budapest, Hungary, meszaros@sztaki.hu

In the talk we describe the design of BPMPD which is an implementation of the primal-dual interior point algorithm to solve large-scale linear, quadratic and quadratically constrained quadratic problems. We outline the details of the implemented algorithm and the further discussion includes topics related to the most important parts of the implementation, including scaling, starting point strategies and the numerical kernels. A special attention is given for sparsity and numerical stability issues. The typical practical behavior of the presented techniques are demonstrated by computational experiments.

2 - CPLEX Interior Point: Where Are We and Where Do We Go From Here?

Christian Bliek, IBM, 1681 HB2 Route des Dolines, Valbonne, 06560, France, bliek@fr.ibm.com, Robert Luce

Interior point algorithms are slowly becoming the standard to solve large scale continuous problems. We present an overview of CPLEX current Cholesky based interior point implementation and give an update on the relative performance between CPLEX interior point and simplex algorithms on LP and QP benchmarks. Will future interior point implementations be based on new efficient indefinite factorization codes like Pardiso? We present initial computational results to try to answer this question.

3 - On Interior-point Warmstarts for Linear and Combinatorial Optimization

Anthony Vannelli, Professor, University of Guelph, 50 Stone Road East, Guelph, ON, N1G 2W1, Canada, vannelli@uoguelph.ca, Miguel Anjos, Alexander Engau

The solution of combinatorial optimization problems often depends on the ability to efficient solve series of related relaxations arising in branch-and-bound or cutting-plane methods. In this talk, we present a new interior-point approach to quickly re-optimize the associated LP/SDP relaxations after data perturbations or the addition of cutting planes. We demonstrate our technique on test instances including Netlib LPs and successive LP relaxations of max-cut and the traveling-salesman problem.

■ TA23

Gleacher Center - 308

Sparse Recovery: Algorithms and Applications

Cluster: Sparse Optimization

Invited Session

Chair: Michael Friedlander, University of British Columbia, 2366 Main Mail, Vancouver, BC, V6T 1Z4, Canada, mpf@cs.ubc.ca

1 - The Power of Convex Relaxation: Near-optimal Matrix Completion

Emmanuel Candes, Ronald and Maxine Linde Professor, Caltech, Applied and Computational Mathematics, MC 217-50, Pasadena, CA, 91125, United States of America, emmanuel@acm.caltech.edu, Terence Tao

This talk considers the problem of recovering a data matrix from a sampling of its entries (this is an instance of the famous Netflix problem). Suppose we observe a few matrix entries selected uniformly at random. Can we complete the matrix and recover the entries we have not seen? Surprisingly, we show that we can recover low-rank matrices exactly from very few sampled entries; that is, from a minimally sampled set of entries. Further, perfect recovery is possible by solving a convex optimization program–a convenient SDP. Our methods are optimal and succeed as soon as recovery is possible by any method whatsoever, no matter how intractable; this result hinges on powerful techniques in probability theory, and is robust vis a vis noise.

2 - Design in Inverse Problems

Eldad Haber, Emory University, 400 Dowman Drive, E414, 30322, United States of America, haber@mathcs.emory.edu

In this talk we discuss optimization problems that arise from design in inverse problems. Such problems involve with bilevel optimization and stochastic optimization of large scale problems. We will present the field, show how we compute some useful approximations and discuss further challenges.

3 - Computing Generalized Sparse Solutions: A Root-finding Approach

Ewout van den Berg, University of British Columbia, 201-2366 Main Mall, Vancouver, BC, V6T 1Z4, Canada, ewout78@cs.ubc.ca, Michael Friedlander

Motivated by theoretical results in compressed sensing, there has been an enormous growth in the use of l1-regularization in optimization problems to obtain sparse solutions. In this talk we present an algorithm that can efficiently solve a range of large-scale sparse recovery/approximation problems, including sign-constrained and jointly sparse problems. We explore possible generalizations and compare the performance to existing solvers.

■ TA25

Gleacher Center - 404

Metric and Variational Inequalities

Cluster: Variational Analysis

Invited Session

Chair: Abderrahim Jourani, Universite de Bourgogne, Institut de Mathamatiques de Bourgogne, 21078 Dijon Cedex, France, Abderrahim.Jourani@u-bourgogne.fr

1 - Subsmooth Sets in Banach Space

Lionel Thibault, Professor, Universita Montpellier 2, Place Eugene Bataillon, Montpellier, 34095, France, thibault@math.univ-montp2.fr

I will present in this talk some recent results concerning subsmooth sets obtained recently by Aussel, Daniilidis and myself. Applications to several areas of variational analysis will be also given.

2 - Variational Convergence of Bivariate Functions and Applications to Optimization, Variational Inequalities and Economic Equilibrium

Alejandro Jofre, Universidad de Chile, Center Math. Modeling & Dept. Ing. Mat., Santiago, Chile, ajofre@dim.uchile.cl, Roger J.-B. Wets

In this talk we show first that a number of equilibrium problems and related variational inequalities can be cast as in finding MaxInf-points (or MinSup-points) of bivariate functions. The main characteristic of these maximization-minimization problems is that although the minimization is usually applied to a convex function the maximization is not. One can then appeal to theory of lopsided convergence for bivariate functions to derive stability results for the solutions with respect to parameters of the problem. This lays the foundations for the study of the existence and stability of solutions to variational inequalities, the solutions of inclusions, of Nash equilibrium points of non-cooperative games and Walras economic equilibrium points. We also give some consequences for algorithms computing these MaxInf or equilibrium points.

3 - Weak Regularity and Sufficient Conditions for Error Bound

Abderrahim Jourani, Universite de Bourgogne, Institut de Mathamatiques de Bourgogne, 21078 Dijon Cedex, France, Abderrahim.Jourani@u-bourgogne.fr, Tijani Amahroq

In the paper published in Nonlinear Analysis Theory Methods and Applications, 65 (2006), 660-676, the second author introduced the notion of weak regularity of functions and sets in Asplund spaces. In this talk, we are concerned with a similar concept but only in terms of Frachet subdifferential possibly outside of Asplund spaces and its use in the study of error bound under a proper intersection condition. Weak regularity of the difference of approximately starshaped functions is also considered.

■ TA27

Gleacher Center - 408

Current Trends of Variational Analysis

Cluster: Variational Analysis
Invited Session

Chair: Michel Thera, Professor, University of Limoges and XLIM (UMR-CNRS 6172), 123, Avenue A. Thomas, Limoges, 87060, France, michel.thera@unilim.fr

1 - Robust Stability and Optimality Conditions for Parametric Infinite and Semi-infinite Programs

Boris Mordukhovich, Wayne State University, Dept of Mathematics, 1150 Faculty Admin Bldg, Detroit, MI, 48202, United States of America, boris@math.wayne.edu

This talk concerns parametric problems of infinite and semi-infinite programming, where functional constraints are given by systems of infinitely many linear inequalities indexed by an arbitrary set, where decision variables run over Banach (infinite programming) or finite-dimensional (semi-infinite case) spaces, and where objectives are generally described by nonsmooth and nonconvex cost functions. We establish complete characterizations of robust Lipschitzian stability for parametric maps of feasible solutions and optimality conditions in terms of the initial data. The results obtained are new in both frameworks of infinite and semi-infinite programming. Based on the joint work with M. J. Canovas, M. A. Lopez and J. Parra

2 - Bregman Distance, Approximate Compactness and Chebyshev Sets in Banach Spaces

Wen Song, Professor, Harbin Normal University, School of Mathematical Sciences, Harbin, China, wsong218@yahoo.com.cn

In this paper, we give some sufficient conditions for the (norm-weak) upper semicontinuity and the (norm-weak) continuity of the Bregman projection operator on a nonempty closed subset C of a Banach space X in terms of the notion of D-approximate (weak) compactness of C; We also present certain characterizations of the convexity of a Chebyshev (in the sense of Bregman distance) subset of a Banach space X.

3 - Nonsmooth Dynamical Systems: An Overview

Samir Adly, Professor, University of Limoges, 123, Avenue A. Thomas, 87060 Limoges, France, samir.adly@unilim.fr

The stability of stationary solutions of dynamical systems constitutes a very important topic in Applied Mathematics and Engineering. Our aim in this talk is to present some recent results in this field. More precisely, we will discuss a mathematical approach that can be used to state sufficient conditions of stability and asymptotic stability of stationary solutions, necessary conditions of asymptotic stability of isolated stationary solutions and invariance results applicable to a large class of unilateral dynamical systems. The theoretical results will be discussed on some models in unilateral mechanics and non-regular electrical circuits theory.

■ TA28

Gleacher Center - 600

First-order Methods and Applications

Cluster: Nonsmooth and Convex Optimization
Invited Session

Chair: Asu Ozdaglar, Associate Professor, Massachusetts Institute of Technology, 77 Massachusetts Ave, 32-D630, Cambridge, MA, 02139, United States of America, asuman@mit.edu

1 - Fast Gradient-based Schemes for Total Variation Minimization

Amir Beck, Israel Institute of Technology, William Davidson Faculty of Industrial E, Technion City, Haifa, 32000, Israel, becka@ie.technion.ac.il, Marc Teboulle

We present fast gradient-based schemes for image denoising and deblurring problems based on the discretized total variation (TV) minimization model with constraints. Our approach relies on combining a novel monotone version of the fast iterative shrinkage/thresholding algorithm (FISTA) with the well known dual approach to the denoising problem. We derive a fast algorithm for the constrained TV-based image deblurring problem. The proposed scheme is remarkably simple and is proven to exhibit a global rate of convergence which is significantly better than currently known gradient based methods. Initial numerical results confirm the predicted underlying theoretical convergence rate results.

2 - An Elementary Algorithm for Smooth Constrained Minimization

Marc Teboulle, Professor, Tel Aviv University, School of Mathematical Sciences, Tel Aviv, 69978, Israel, teboulle@post.tau.ac.il, Ron Shefi, Alfred Auslender

We introduce a new algorithm for smooth constrained minimization. It relies on a simple geometric idea and duality. We prove that the algorithm enjoys interesting convergence properties including iteration complexity bounds, for both nonconvex and convex problems. The algorithm is suitable for large scale problems, and numerical results will demonstrate its viability and efficiency when compared to some existing state-of -the-art optimization methods/software such as SQP and others.

3 - Distributed Optimization in Stochastic Networks

Asu Ozdaglar, Associate Professor, Massachusetts Institute of Technology, 77 Massachusetts Ave, 32-D630, Cambridge, MA, 02139, United States of America, asuman@mit.edu, Ilan Lobel

We consider the problem of cooperatively minimizing a sum of convex functions, where the functions represent local objective functions of the agents. We assume that agents communicate over a stochastic time-varying network topology. We present a distributed subgradient method that uses averaging algorithms for locally sharing information among the agents, and provide convergence results and convergence rate estimates.

Tuesday, 1:15pm - 2:45pm

■ TB01

Marriott - Chicago A

Approximation Algorithms II

Cluster: Approximation Algorithms
Invited Session

Chair: Cliff Stein, Columbia University, 326 S W Mudd Building, 500 W. 120th Street, New York, NY, 10027, cliff@ieor.columbia.edu

1 - Approximating Nonlinear Newsvendor Made Easy

Nir Halman, M.I.T., 77 Mass. Ave., E40-149, Cambridge, MA, 02139, United States of America, halman@mit.edu, David Simchi-Levi, James Orlin

We show that the nonlinear newsvendor problem (i.e., where the revenue, procurement and salvage are all arbitrary nondecreasing oracle functions) requires an exponential number of queries, and prove that it is APX-hard in general. We design fully polynomial time approximation schemes for the special case where the profit margin of any optimal solution is guaranteed to exceed some given constant.

2 - On Finding Dense Subgraphs

Samir Khuller, Professor, University of Maryland, Dept. of Computer Science, AV Williams Bldg., College Park, MD, 20742, United States of America, samir@cs.umd.edu, Barna Saha

The density of a subgraph is defined as the ratio of edges to vertices. Without any size constraints, a subgraph of maximum density can be found in polynomial time. When we require the subgraph to have a specified size, the problem of finding a maximum density subgraph becomes NP-hard. We focus on developing fast algorithms for several variations of dense subgraph problem for both directed and undirected graphs, both with and without size constraints.

3 - Approximation Algorithms for a Minimization Variant of the Order Preserving Submatrices Problem

Dorit Hochbaum, Professor, UC Berkeley, Haas School of Business and, IEOR Department, Etcheverry Hall, Berkeley, Ca, 94720, United States of America, hochbaum@ieor.berkeley.edu

Finding a largest Order preserving submatrix, OPSM, arises in the discovery of patterns in gene expression. Ben-Dor et al. formulated the problem. The complement of the OPSM problem is to delete the least number of entries in the matrix so that the remaining submatrix is order preserving. We give a 5-approximation for the complement of the problem via the quadratic, nonseparable set cover problem. We further improve this to a 3-approximation. We also discuss the related biclustering problem.

■ TB02

Marriott - Chicago B

MPECs and Conic Programming

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Michal Kocvara, The University of Birmingham, School of Mathematics, Watson Building, Edgbaston, Birmingham, B15 2TT, United Kingdom, kocvara@maths.bham.ac.uk

1 - MPECs with Semidefinite Programming Constraints: On the Numerical Solution

Michal Kocvara, The University of Birmingham, School of Mathematics, Watson Building, Edgbaston, Birmingham, B15 2TT, United Kingdom, kocvara@maths.bham.ac.uk

We will solve a mathematical program with semidefinite complementarity constraints. Analogously to standard MPCCs, the complementarity constraint will be treated by a penalty to the objective function. The resulting problem is a nonlinear nonconvex optimization problem with vector and matrix variables and constraints. We will solve this by the code PENNON. Numerical example from structural optimization will illustrate the behavior of this approach.

2 - Thoughts on MPCCCs - Mathematical Programs with Cone Complementarity Constraints

Daniel Ralph, University of Cambridge, Judge Business School, Trumpington Street, Cambridge, CB2 1AG, United Kingdom, d.ralph@jbs.cam.ac.uk

We look at optimality conditions for MPCCCs - mathematical programs with cone complementarity constraints. This class of optimization problems extends the well known class of mathematical programs with complementarity constraints, MPCCs, which are somewhat tractable in terms of using standard nonlinear programming ideas to understand constraint qualifications and stationarity conditions.

3 - Solving a Class of Matrix Minimization Problems by Linear Variational Inequality Approaches

Ming-Hua Xu, Professor, Jiansu Polytechnic University, School of Mathematics and Physics, Changzhou, 213164, China, xuminghua@jpu.edu.cn, Bingsheng He, Xiao-Ming Yuan

A class of matrix optimization problems is equivalent to linear variational inequalities with special structures. For solving such problems, the alternating directions methods and the projection and contraction methods are extended. The main costly computational load in such methods is to make a projection of a real symmetric matrix on the semi-definite cone. Numerical tests up to a matrices of order 1000 indicate the Levenberg-Marquardt type projection and contraction method is very promising.

■ TB03

Marriott - Chicago C

Extensions of Optimization and Equilibrium Problems: Addressing Shared Constraints, Risk-aversion and Uncertainty

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Uday Shanbhag, University of Illinois-Urbana-Champaign, 117 Transportation Building, 104 S. Mathews Avenue, Urbana, IL, 61801, United States of America, udaybag@uiuc.edu

1 - New Insights on Generalized Nash Games with Shared Constraints

Ankur Kulkarni, University of Illinois, Urbana-Champaign, 117 Transportation Bldg, Urbana, 61801, United States of America, akulkar3@illinois.edu, Uday Shanbhag

We consider generalized noncooperative Nash games with ``shared constraints” in which there is a common constraint that players’ strategies are required to satisfy. We address a shortcoming that the associated generalized Nash equilibrium (GNE) is known to have: shared constraint games usually have a large number (often a manifold) of GNEs. We seek a refinement of the GNE and study the variational equilibrium (VE), defined by Facchinei et al as a candidate. It is shown that the VE and GNE are equivalent in a certain degree theoretic sense. For a class of games the VE is shown to be a refinement of the GNE and under certain conditions the VE and GNE are observed to coincide.

2 - Distributed Optimization in a Sensor Network

Alireza Razavi, University of Minnesota, Department of Electrical & Computer Eng, 200 Union Street SE, Minneapolis, MN, 55455, United States of America, raza0007@umn.edu, Tom Luo

Consider a distributed optimization problem in sensor networks where nodes wish to minimize a strongly convex function, under the constraint that each node controls its local variables only, and communicates over noisy channels. We analyze the communication energy required to obtain an epsilon approximate solution using both analog and digital communication. For former, we prove that energy grows at the rate of Omega(1/epsilon) while this rate is reduced to O(log^3 1/epsilon) if latter is used.

3 - Extensions of Nash Equilibrium Problems

Uday Shanbhag, University of Illinois-Urbana-Champaign, 117 Transportation Building, 104 S. Mathews Avenue, Urbana, IL, 61801, United States of America, udaybag@uiuc.edu

We consider existence and uniqueness properties of two extensions of Nash equilibrium problems with unbounded strategy sets. The first extension focuses on generalized Nash games over networks in the presence of congestion costs. We study such games when the congestion cost functions are neither smooth nor lead to strongly monotone maps. The second extension addressed the question of risk-averse Nash equilibrium problems.

■ TB04

Marriott - Denver

Submodular Function Maximization I

Cluster: Combinatorial Optimization
Invited Session

Chair: Andreas Schulz, Massachusetts Institute of Technology, E53-357, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States of America, schulz@mit.edu

1 - Maximizing a Monotone Submodular Function Subject to a Matroid Constraint

Gruia Calinescu, Illinois Institute of Technology, 10 West 31st Street, Stuart Building, Room 236, Chicago, IL, 60616, United States of America, calinescu@iit.edu, Chandra Chekuri, Martin Pal, Jan Vondrak

Let f be a non-negative monotone submodular set function on ground set X, and assume we have a matroid on X: we are given an oracle which computes f(S) for any subset S of X, and decides if S is independent or not in the matroid. We consider the problem of maximizing f(S) subject to S being independent in the matroid. We provide a randomized (1-1/e)-approximation, improving on the previous 1/2-approximation obtained by the greedy algorithm. Our approximation is optimal unless P=NP.

2 - Maximizing Non-monotone Submodular Functions

Vahab Mirrokni, Senior Research Scientist, Google Research, 76 9th Ave, 4th floor, New York, United States of America, mirrokni@gmail.com, Uriel Feige, Jan Vondrak

Submodular maximization is a central problem in combinatorial optimization, generalizing Max-cut problems. Unlike submodular minimization, submodular maximization is NP-hard. We design the first constant-factor approximation algorithms for maximizing nonnegative submodular functions: We give a deterministic local search 1/3-approximation and a randomized 2/5-approximation algorithm for maximizing nonnegative submodular functions. We show that these algorithms give a 1/2-approximation for maximizing symmetric submdular functions. Furthermore, we prove that our 1/2-approximation for symmetric submodular functions is the best one can achieve with a subexponential number of value queries.

3 - Symmetry and Approximability of Submodular Maximization Problems

Jan Vondrak, Researcher, IBM Almaden, 650 Harry Road, San Jose, CA, 95120, United States of America, jvondrak@gmail.com

We show a general approach to deriving inapproximability results for submodular maximization problems, based on the notion of “symmetry gap”. Apart from unifying some previously known hardness results, this implies new results for the problem of maximizing a non-monotone submodular function over the bases of a matroid: We show a (1-1/P)/2-approximation for any matroid with fractional base packing number P, and our general hardness result implies that this is optimal within a factor of 2.

■ TB05

Marriott - Houston

Combinatorial Optimization P

Contributed Session

Chair: Yuichi Takano, University of Tsukuba, 1-1-1 Tennoudai, Tsukuba, Ibaraki, Japan, takano10@sk.tsukuba.ac.jp

1 - Multicriteria Optimization in Public Transportation

Ralf Borndoerfer, Zuse Institute Berlin, Takustrasse 7, Berlin, Germany, borndoerfer@zib.de

Costs, operational stability, and employee satisfaction are typical objectives in optimization problems in public transportation. These criteria are traditionally simply merged into a single objective. In order to study the tradeoffs between competing goals, however, one needs to compute the entire Pareto curve. The talk discusses extensions of Lagrangean relaxation and column generation approaches to compute such Pareto curves for vehicle and crew scheduling problems in public transit.

2 - A Hybrid Approach Combining Column Generation and Approximation Heuristic for Large-size CIP

Jalila Sadki, PhD Student, Laboratoire d'Informatique de Paris Nord, 99 Av. Jean Baptiste Clament, Villetaneuse, 93430, France, jalila.sadki@lipn.univ-paris13.fr, Agnès Plateau, Laurent Alfandari, Anass Nagih

Our study is devoted to solve Covering Integer Programming (CIP) with a huge number of variables. The greedy heuristic of Dobson for (CIP) is considered as a generator of diversified columns, and is integrated into a classical column generation scheme. Several hybrid approaches are proposed and evaluated on a transportation problem. We show that they improve the column generation scheme accelerating its convegence in terms of number of iterations while reducing the total number of generated columns. Moreover the MIP resolution of the master problem is also improved in most cases.

3 - Metric-preserving Reduction of Earth Mover's Distance

Yuichi Takano, University of Tsukuba, 1-1-1 Tennoudai, Tsukuba, Ibaraki, Japan, takano10@sk.tsukuba.ac.jp, Yoshitsugu Yamamoto

Earth mover's distance (EMD) is a perceptually meaningful dissimilarity measure between histograms, however, the computation of EMD lays a heavy burden. We prove that the EMD problem reduces to a problem with half the number of constraints regardless of the ground distance. Then we propose a further reduced formulation, the number of variables of which reduces from $O(m^2)$ to $O(m)$ for histograms with m locations when the ground distance is derived from a graph with a homogeneous neighborhood structure.

■ TB06

Marriott - Kansas City

Semidefinite Programming

Cluster: Conic Programming
Invited Session

Chair: Donald Goldfarb, Professor, Columbia University, 500 W. 120TH ST, Mudd, Department of IEOR, New York, NY, 10027, United States of America, goldfarb@columbia.edu

1 - Row by Row Methods for Semidefinite Programmming: Part I

Donald Goldfarb, Professor, Columbia University, 500 W. 120TH ST, Mudd, Department of IEOR, New York, NY, 10027, United States of America, goldfarb@columbia.edu, Katya Scheinberg, Zaiwen Wen, Shiqian Ma

We present a row-by-row method for solving SDP problem based on solving a sequence of second-order cone programming (SOCP) problems obtained by fixing any (n-1)-dimensional principal submatrix of the matrix X and using its Schur complement. After introducing the prototype algorithms for generic SDPs,we present specialized versions for the maxcut SDP relaxation and the minimum nuclear norm matrix completion problem since closed-form solutions for the SOCP subproblems are available.

2 - Row by Row Methods for Semidefinite Programmming: Part 2

Zaiwen Wen, Columbia University, IEOR Department, New York, NY, 10027, United States of America, zw2109@columbia.edu, Donald Goldfarb, Shiqian Ma, Katya Scheinberg

We present efficient algorithms for solving the second-order cone programming (SOCP) subproblems that arise in the row-by-row methods introduced in part I for solving SDPs with generic linear constraints. Numerical results are presented to demonstrate the robustness and efficiency of the row-by-row approach. A generalization of this approach is also presented.

3 - On Factorization of Non-commutative Polynomials by Semidefinite Programming

Janez Povh, Institute of Mathematics, Physics and Mechanics Ljubljana, Jadranska 19, Ljubljana, Slovenia, janez.povh@fis.unm.si, Kristjan Cafuta, Igor Klep

Factorization of non-commutative (NC) polynomials as sum of hermitian squares (SOHS) attracted a big interest recently due to new results about non-negativity and convexity of NC polynomials (Helton 2002). SOHS factorizations are obtained by the Gram matrix method (GMM), which relies on semidefinite programming. We present efficient implementations of the GMM together with a new Matlab package NCSOStools which can do symbolic computation with NC polynomials and solves SOHS problems.

■ TB07

Marriott - Chicago D

Integer and Mixed Integer Programming B

Contributed Session

Chair: Leonardo R Costa, Institute Federal do Esp. Santo (IFES), Av. Vitaria, 1729, Jucutuquara, Vitaria, 29040-780, Brazil, lrcosta@ifes.edu.br

1 - A Dispatching Rule-based Approach for Total Tardiness Minimization in a Flexible Flowshop

Debora P. Ronconi, University of Sao Paulo, Av. Prof. Almeida Prado 128, Sao Paulo, 05508070, Brazil, dronconi@usp.br, Guilherme Mainieri

This work considers the minimization of the total tardiness in a flexible flowshop. The problem was addressed by a dispatching rule-based approach in which jobs are scheduled forward, i.e. from first to last stage. Two new dispatching rules were developed and one of them is able to consider future states of the system. It was also developed a new method in which jobs are scheduled backward, i.e. from last to first stage. These methods show better performance compared to the literature methods.

2 - Modelling the Routing of Cars in Rail Freight Service

Henning Homfeld, Technische Universitaet Darmstadt, Schlossgartenstr. 7, Darmstadt, 64289, Germany, homfeld@mathematik.tu-darmstadt.de, Armin Fuegenschuh, Alexander Martin, Hanno Schuelldorf

Reducing the number of train miles is of highest importance in rail freight service. The aim is to find routes for the cars through a network under a wide range of hard side constraints. We present three integer programming formulations (a flow, Steiner-tree, and path based model) for this car routing problem arising at the largest European railway company and discuss their pros and cons. The models are compared on a set of real world instances.

3 - Reverse Logistics: Bounds for a Two-level Problem

Leonardo R Costa, Institute Federal do Esp. Santo (IFES), Av. Vitaria, 1729, Jucutuquara, Vitaria, 29040-780, Brazil, lrcosta@ifes.edu.br, Laura Bahiense, Virgilio J. M. Ferreira Filho

The reverse logistics concepts involves the physical transport of the used product starting from the final user to refurbishing. This work has focus in models that represents the reverse distribution problem, studying a model of linear mixed mathematical programming, for two levels capacitated location. A heuristic is proposed to obtain solutions, testing it in artificially generated instances, with exact results obtained by a solver and lower bounds obtained by a lagrangean relaxation.

■ TB08

Marriott - Chicago E

Trends in Mixed Integer Programming IV

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Andrea Lodi, DEIS, University of Bologna, Viale Risorgimento, 2, Bologna, 40136, Italy, andrea.lodi@unibo.it

Co-Chair: Robert Weismantel, Professor, Otto-von-Guericke University Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, weismant@mail.math.uni-magdeburg.de

1 - Information-based Branching Schemes for Binary Mixed Integer Programs

George Nemhauser, Institute Professor, Georgia Tech / School of ISyE, 765 Ferst Drive, Atlanta, GA, 30332-0205, United States of America, george.nemhauser@isye.gatech.edu, Fatma Kilinc, Martin Savelsbergh

Branching variable selection can greatly affect the effciency of a branch- and-bound algorithm. Traditional approaches to branching variable selection rely on estimating the effect of the candidate variables on the objective function. We propose an approach empowered by exploiting the information contained in a family of fathomed subproblems, collected beforehand from a partial branch-and-bound tree. In particular, we use this information to define new branching rules that reduce the risk of incurring inappropriate branchings. We provide computational results to validate the effectiveness of the new branching rules on MIPLIB benchmark instances.

2 - Exploiting Multi-commodity Flow Structures in Mixed Integer Programs

Christian Raack, PhD Student, Zuse Institute Berlin, Takustr. 7, Berlin, 14195, Germany, raack@zib.de, Tobias Achterberg

Given a general Mixed Integer Program (MIP), we automatically detect block-structures in the constraint matrix together with the coupling by capacity constraints arising from multi-commodity flow formulations. We identify the underlying graph and generate cutting planes based on cuts in the detected network. Using the solver SCIP, we are able speed-up the computation for a large set of MIPs coming from network design problems by a factor of two on average.

3 - n-step Mingling Inequalities and Their Facet-defining Properties for Mixed Integer Knapsack Sets

Kiavash Kianfar, Assistant Professor, Texas A&M University, 239B Zachry, TAMU 3131, Collge Station, TX, 77843, United States of America, kianfar@tamu.edu, Alper Atamturk

The n-step MIR inequalities (Kianfar and Fathi, 2008) are valid inequalities for the mixed-integer knapsack set (MIKS) derived based on mixed-integer rounding. The mingling inequalities (Atamturk and Gunluk, 2007) are also derived based on mixed-integer rounding and incorporate bounds on integer variables. The mingling and 2-step mingling inequalities have been shown to define facets in many cases. We show that the ideas behind n-step MIR and mingling can be combined to generate what we call n-step mingling inequalities for MIKS. Furthermore, we show that these inequalities define facets for MIKS if certain conditions on coefficients are satisfied. This makes n-step mingling a novel method for generating (new) facets for MIKS.

■ TB09

Marriott - Chicago F

Algorithmic Aspects of Combinatorial Optimization Problems

Cluster: Integer and Mixed Integer Programming

Invited Session

Chair: Michael Juenger, University of Cologne, Pohligstr. 1, Koeln, D-50999, Germany, mjuenger@informatik.uni-koeln.de

1 - Algorithms and Combinatorics for Network Reconstruction

Annegret Wagler, Doctor, Otto-von-Guericke University, Universitaetsplatz 2, Magdeburg, 39106, Germany, wagler@imo.math.uni-magdeburg.de, Robert Weismantel, Markus Durzinsky

Models of biological systems are of high scientific interest and practical relevance, but not easy to obtain due to their inherent complexity. To solve the challenging problem of reconstructing networks from the experimentally observed behavior of a biological system, we developed a combinatorial approach to generate a complete list of all networks being conformal with the experimental data. Based on these results, we provide an algorithm to efficiently solve network reconstruction problems.

2 - Warm Starts and Hip Cuts for Interior-point Methods in Combinatorial Optimization

Alexander Engau, Assistant Professor, University of Colorado Denver, Mathematical and Statistical Sciences, Campus Box 170, P.O. Box 173364, Denver, CO, 80217-3364, United States of America, aengau@alumni.clemson.edu, Miguel Anjos, Anthony Vannelli

We present our recent progress to advance the use of interior-point methods for solving the continuous relaxations of combinatorial problems. To quickly re-optimize successive relaxations, we first describe a new warm-start technique that removes the interiority condition from previous iterates to be re-used as infeasible starting points after changes to the problem data or the addition of cutting planes. We then integrate this scheme into a hybrid interior-point cutting-plane method (HIPCUT) that adds and removes cuts at intermediate iterates using indicators of the cut violation. Computational tests for the traveling-salesman problem, max-cut, and single-row facility layout demonstrate the method's robustness and competitive performance.

3 - Partitioning Planar Graphs: A Fast Combinatorial Approach for Max-cut

Gregor Pardella, Dipl.-Inf., University of Cologne, Pohligstrasse 1, Cologne, 50969, Germany, pardella@informatik.uni-koeln.de, Frauke Liers

Graph partitioning problems have many relevant real-world applications, e.g., VIA minimization in the layout of electronic circuits or in physics of disordered systems. We present a new combinatorial approach solving the max cut problem in time O(|V|^{3/2}log|V|) on arbitrary weighted planar graphs. In contrast to previously known methods our auxiliary graph has a simpler structure and contains a considerably smaller number of both nodes and edges and can be computed fast. As the bulk of the running time is spent in a matching routine which scales with the graph size our approach is more preferable in practice. We show computational results for several types of instances.

■ TB10

Marriott - Chicago G

Recent Advances in Deterministic Global Optimization

Cluster: Global Optimization

Invited Session

Chair: Christodoulos Floudas, Stephen C. Macaleer '63 Professor in Engineering and Applied Science, Professor of Chemical Engineering, Princeton University, Dept. of Chemical Engineering, Princeton, NJ, 08544, United States of America, floudas@titan.princeton.edu

1 - Nash Equilibrium Problems via Parametrization and Applications

Panos Pardalos, Distinguished Professor of Industrial and Systems Engineering, University of Florida, 303 Weil Hall, P.O. Box 116595, Gainesville, FL, 32611, United States of America, pardalos@ufl.edu, Pando Georgiev

We consider a general Nash equilibrium problem depending on a parameter. We prove that under suitable conditions, there exists a solution of the perturbed problem, depending continuously on the parameter. We present a new proof of existence of Nash equilibrium, based on continuity properties of the minimizers of the perturbed separable minimization problems.

2 - Global Optimization of MINLPs with BARON

Nick Sahinidis, John E. Swearingen Professor, Carnegie Mellon University, Department of Chemical Engineering, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States of America, sahinidis@cmu.edu, Mohit Tawarmalani

We present extensive computational experience with a new version of BARON for the solution of MINLPs that possess convex or nonconvex relaxations when integrality requirements are relaxed. The approach incorporates MIP relaxations judiciously, in conjunction with cutting plane generation and range reduction, to significantly reduce computational requirements and expedite solution.

3 - Protein Alignment : Closer to Global LOVO - Optimization

Paulo S. da Silva Gouveia, State University of Campinas, Sao Simao, 565, Jardim Santa Catarina, Department of Applied Mathematics, Sao Jose do Rio Preto, 15080-150, Brazil, paulossg@gmail.com, Ana Friedlander, Jose Mario Martinez, Leandro Martinez, Roberto Andreani

Kolodny and Linial presented a method for global optimization of the Structal score for protein alignment problems and proved that the time required by the method is polynomial, but their method is not practical. The objective this contribution is to define and test a variation of the Kolodny-Linial method with improved practical properties. For this we used the algorithm GLOPT and as a result we have a global optimization method for solving the LOVO problem as defined in JOGO 43 (2009) 1-10.

■ TB11

Marriott - Chicago H

Rigorous Global Optimization and Interval Methods

Cluster: Global Optimization

Invited Session

Chair: Oliver Stein, University of Karlsruhe (TH), Institute of Operations Research, Karlsruhe, 76128, Germany, stein@wior.uni-karlsruhe.de

1 - Rigorous Global Optimization in High-dependency Problems in Dynamical Systems

Kyoko Makino, Michigan State University, Department of Physics and Astronomy, East Lansing, MI, 48824, United States of America, makino@msu.edu, Martin Berz

Many aspects of the rigorous analysis of the behavior of dynamical systems can be phrased in terms of global optimization of suitable merit functions. However, often the resulting objective function is highly complex involving large numbers of local minima and long code lists with the danger of cancellation problems for rigorous methods. We present a variety of such cases and discuss their solution by means of Taylor model-based global optimizers, which provide rigorous enclosures of minima.

2 - An Exact Interval Branch and Bound Algorithms to Solve Problems with Some Black-box Contraints

Frederic Messine, Doctor, ENSEEIHT, 2 rue Camichel BP 7122, Cedex 7, Toulouse, F-31071, France, Frederic.Messine@enseeiht.fr, Julien Fontchastagner, Yvan Lefevre

Interval Branch and Bound have shown their intrinsic interest to solve exactly some difficult mixed non-convex and non-linear programs. A code named IBBA was developed to solve some design problems for electromechanical actuators. In this work, we extend IBBA to solve problems when some constraints are of Black-Box type (for example: computations with a finite element method). This new exact code is validated by solving some design problems of electrical machines and magnetic couplings.

3 - Taylor Model Relaxations for Rigorous Smooth Constrained Optimization

Martin Berz, Michigan State University, Department of Physics and Astronomy, East Lansing, MI, 48824, United States of America, berz@msu.edu, Kyoko Makino

Taylor models provide rigorous enclosures of functions over a domain within a relaxation band within their Taylor expansion around a point inside the domain. The widths of the resulting band are usually much sharper than those from conventional rigorous methods like intervals and related linearizations. The resulting rigorous relaxations can be used for the local description of the objective function and the constraints, and furthermore efficiently for higher order domain reduction.

■ TB12

Marriott - Los Angeles

Derivative-free Algorithms: Applications and Constraints

Cluster: Derivative-free and Simulation-based Optimization
Invited Session

Chair: Virginia Torczon, Professor, College of William & Mary, Department of Computer Science, P.O. Box 8795, Williamsburg, VA, 23187, United States of America, va@cs.wm.edu

1 - Generating Set Search Strategies for Dealing with Nonlinear Constraints

Virginia Torczon, Professor, College of William & Mary, Department of Computer Science, P.O. Box 8795, Williamsburg, VA, 23187, United States of America, va@cs.wm.edu, Robert Michael Lewis

We report recent progress on generating set search approaches for handling general nonlinear constraints. Our emphasis is on robust techniques for which first-order stationarity results can be derived under standard assumptions. Our goal is the development of computational strategies for a variety of computational platforms and that are effective on the challenging engineering design and control problems to which direct search derivative-free methods are most often employed.

2 - The Return of Hooke-Jeeves Direct Search

David Echeverria Ciaurri, Doctor, Stanford University, 367 Panama Street, Green Earth Sciences Bldg., 137, Stanford, CA, 94305-2220, United States of America, echeverr@stanford.edu, Obiajulu Isebor, Louis Durlofsky

One may automatically rule out derivative-free algorithms that are not amenable for being implemented in a distributed-computing framework. In this talk we compare parallelized derivative-free strategies with one of those serial schemes, Hooke-Jeeves Direct Search (HJDS), on optimization problems relevant in the oil industry. We conclude that, depending on the number of cluster processors available, HJDS (introduced almost fifty years ago) may still be an alternative to consider in practice.

3 - Constrained Derivative Free Optimization for Reservoir Characterization

Hoél Langouét, PhD Student, IFP, 1-4, Avenue de Bois-Préau, Rueil Malmaison, 92852, France, hoel.langouet@ifp.fr, Delphine Sinoquet

Reservoir characterization inverse problem aims at forecasting the production of an oil field from available production data. These data (pressure, oil/water/gas rates at the wells and 4D seismic data) are compared with simulated data to determine petrophysical properties of the reservoir. The underlying optimization problem requires dedicated techniques for derivative free constrained optimization. We present results with a trust region method with quadratic interpolating models on this application and comparison with other optimization methods on benchmark of toy problems.

■ TB13

Marriott - Miami

Electricity Markets under Uncertainty and Strategic Behavior

Cluster: Optimization in Energy Systems
Invited Session

Chair: Alejandro Jofre, Universidad de Chile, Center Math. Modeling & Dept. Ing. Mat., Santiago, Chile, ajofre@dim.uchile.cl

1 - Electricity Markets for Uncertain and Intermittent Participants

Geoffrey Pritchard, University of Auckland, Department of Statistics, Auckland, New Zealand, g.pritchard@auckland.ac.nz, Golbon Zakeri, Andy Philpott

We discuss a stochastic-programming-based method for scheduling electric power generation subject to uncertainty. Such uncertainty may arise from either imperfect forecasting or moment-to-moment fluctuations,and on either the supply or the demand side. The method gives a system of locational marginal prices which reflect the uncertainty, and these may be used in a market settlement scheme in which payment is for energy only.

2 - A Model for Coordinating Uncertain Wind Power Production and Pumped Storage Hydro Production

Marida Bertocchi, University of Bergamo, Department of Mathematics, Statistics, C, via dei Caniana 2, Bergamo, 24127, Italy, marida.bertocchi@unibg.it, Maria Teresa Vespucci, Francesca Maggi, Mario Innorta

We present a stochastic model for the daily scheduling of pumped storage hydro plants and wind power plants, taking into account uncertainty on wind power production. The integration of wind and hydropower generation with pumped storage allows to efficiently manage the intermittency of wind power generation. A description of the hydro production system is included in the model taking into account uncertainty on wind power production. We present numerical results on a realistic case study.

3 - Equilibrium for Discontinuous Games and Optimal Regulation in Electricity Markets

Nicolas Figueroa, Universidad de Chile, Republica 701, Santiago, Chile, nicolasf@dii.uchile.cl, Alejandro Jofre

In this presentation an electricity market is considered involving a network, a set of producers generating electricity and a central agent. Production is organized by means of an auction. Once producers simultaneously bid cost functions, the central agent decides the quantity each generator produces and the flows through the network lines. Producers play strategically with the central agent. When bidding, each firm tries to obtain revenues as high as possible. We prove first existence of equilibrium for this discontinuous game and then by using optimal mechanism design, we derive an optimal regulation mechanism for pricing, and compare its performance with the bayesian version of the usual price equal to Lagrange multiplier.

■ TB14

Marriott - Scottsdale

New Directions in Markets

Cluster: Game Theory
Invited Session

Chair: Ramesh Johari, Stanford University, Management Science and Enginerring, Stanford, CA, 94305-4026, United States of America, ramesh.johari@stanford.edu

Co-Chair: Ciamac Moallemi, Assistant Professor, Columbia University, 3022 Broadway, New York, NY, 10025, United States of America, ciamac@gsb.columbia.edu

1 - A Comparison of Bilateral and Multilateral Models for Content Exchange

Ramesh Johari, Stanford University, Management Science and Enginerring, Stanford, CA, 94305-4026, United States of America, ramesh.johari@stanford.edu, Christina Aperjis, Michael Freedman

Peer-assisted content distribution matches user demand for content with available supply at other peers in the network. Inspired by this supply-and-demand interpretation of the nature of content sharing, we employ price theory to study peer-assisted content distribution. In this approach, the market-clearing prices are those which exactly align supply and demand, and the system is studied through the characterization of price equilibria. In this talk, we rigorously analyze the efficiency and robustness of price-based multilateral exchange. Using equilibrium models from economics, we compare and contrast multilateral content exchange with bilateral exchanges such as BitTorrent.

2 - Manipulation-resistant Collaborative Filtering Systems

Xiang Yan, Stanford University, P.O. Box 11263, Stanford, CA, United States of America, xyan@stanford.edu, Benjamin Van Roy

Collaborative filtering systems influence purchase decisions, and hence have become targets of manipulation by unscrupulous vendors. We provide theoretical and empirical results demonstrating that while common nearest neighbor algorithms, which are widely used in commercial systems, can be highly susceptible to manipulation, two classes of collaborative filtering algorithms which we refer to as linear and asymptotically linear are relatively robust.

3 - A Unified Framework for Dynamic Pari-mutuel Information Market Design

Shipra Agrawal, Stanford University, Stanford, CA, United States of America, shipra@cs.stanford.edu, Erick Delage, Mark Peters, Zizhuo Wang, Yinyu Ye

Recently, several pari-mutuel mechanisms have been introduced to organize prediction markets, such as logarithmic scoring rule, cost function based market maker, and sequential convex pari-mutuel mechanism (SCPM). We develop a unified framework that bridges these seemingly unrelated models. Our framework establishes necessary and sufficient conditions for designing mechanisms with many desirable properties such as proper scoring, truthful bidding (in a myopic sense), efficient computation, controllable risk measure and guarantees on the worst-case loss. In addition to providing a general framework that unifies and explains all the existing mechanisms, our work provides an effective and instrumental tool for designing new market mechanisms.

4 - Strategic Execution in the Presence of an Uninformed Arbitrageur

Ciamac Moallemi, Assistant Professor, Columbia University, 3022 Broadway, New York, NY, 10025, United States of America, ciamac@gsb.columbia.edu, Beomsoo Park, Benjamin Van Roy

We consider a trader who aims to liquidate a large position in the presence of an arbitrageur who hopes to profit from the trader's activity. The arbitrageur is uncertain about the trader's position and learns from observed price fluctuations. This is a dynamic game with asymmetric information. We present an algorithm for computing perfect Bayesian equilibrium behavior and conduct numerical experiments. Our results demonstrate that the trader's strategy differs significantly from one that would be optimal in the absence of the arbitrageur. In particular, the trader must balance the conflicting desires of minimizing price impact and minimizing information that is signaled through trading.

■ TB15

Gleacher Center - 100

Stochastic Integer Programming Applications in Health Care

Cluster: Stochastic Optimization
Invited Session

Chair: Osman Ozaltin, PhD Student, University of Pittsburgh, 3700 Ohara Street 1048 Benedum Hall, Pittsburgh, PA, 15261, United States of America, oyo1@pitt.edu

1 - Multiple Operating Room Scheduling under Uncertainty

Sakine Batun, PhD Student, University of Pittsburgh, Department of Industrial Engineering, 3700 Ohara Street 1048 Benedum Hall, Pittsburgh, PA, 15261, United States of America, sab79@pitt.edu, Brian T. Denton, Todd R. Huschka, Andrew J. Schaefer

We study the problem of scheduling surgeries with uncertain durations in a multiple operating room (OR) environment. We formulate the problem as a two-stage stochastic mixed integer program (SMIP) with the objective of minimizing total expected operating cost, which is composed of the fixed cost of opening ORs, the overtime cost and the surgeon idling cost. We analyze structural properties of our model and propose a way of improving the existing solution procedures (L-shaped algorithm and L-shaped based branch-and-cut algorithm) by adding valid inequalities to the formulation. We perform computational experiments based on real data provided by Thoracic Surgery Department at Mayo Clinic in Rochester, MN.

2 - Flu Shot Design and Timing under Additive Immunity Model

Osman Ozaltin, PhD Student, University of Pittsburgh, 3700 Ohara Street 1048 Benedum Hall, Pittsburgh, PA, 15261, United States of America, oyo1@pitt.edu, Andrew J. Schaefer, Mark S. Roberts, Oleg Prokopyev

Seasonal flu epidemics caused by antigenic drifts and high rate of virus transmission require annual updates in the flu shot composition. The WHO recommends which strains of influenza to include in each year's vaccine based on surveillance data and epidemiological analysis. Two critical decisions regarding the flu shot design are its timing and composition. We propose a multi-stage stochastic mixed-integer programming model addressing the trade offs between these two decisions.

3 - Optimal Liver Region Design under Uncertainty

Andrew J. Schaefer, Associate Professor and Wellington C. Carl Faculty Fellow, University of Pittsburgh, 3700 Ohara Street 1048 Benedum Hall, Department of Industrial Engineering, Pittsburgh, PA, 15261, United States of America, schaefer@ie.pitt.edu, Mehmet Demirci, Mark S. Roberts

We consider the problem of redesigning the U.S. liver allocation hierarchy. We relax the steady-state assumption of previous work, resulting in a large-scale integer program. We develop a column generation approach where the pricing problem is itself a stochastic integer program. Our computational results indicate that our proposed solutions will save hundreds of lives over the current configuration.

■ TB16

Gleacher Center - 200

Optimization with Risk Constraints

Cluster: Stochastic Optimization
Invited Session

Chair: James Luedtke, University of Wisconsin, 3236 Mechanical Engineering Building, 1513 University Avenue, Madison, WI, 53706, United States of America, jrluedt1@wisc.edu

1 - A Cutting Surface Method for Uncertain Linear Programs with Polyhedral Stochastic Dominance

Sanjay Mehrotra, Professor, Northwestern University, IEMS Department, 2145 Sheridan Road, Evanston, IL, 60208, United States of America, mehrotra@iems.northwestern.edu, Tito Homem-de-Mello

We present a cutting-surface algorithm for linear optimization problems with a newly introduced concept of multi-dimensional polyhedral linear second-order stochastic dominance constraints. We show its finite convergence. The cut generation problem is a difference of convex functions (DC) optimization problem. Numerical examples are presented showing the nature of solutions of our model.

2 - Chance-constrained Optimization via Randomization: Feasibility and Optimality

Marco C. Campi, Professor, University of Brescia, via Branze 38, Brescia, 25123, Italy, marco.campi@ing.unibs.it, Simone Garatti

We study the link between a semi-infinite chance-constrained optimization problem and its randomized version, i.e. the problem obtained by sampling a finite number of its constraints. Extending previous results on the feasibility of randomized convex programs, we establish the feasibility of the solution obtained after the elimination of a portion of the sampled constraints. Constraints removal allows one to improve the cost function at the price of a decreased feasibility. The cost improvement can be inspected directly from the optimization result, while the theory we present here permits to keep control on the other side of the coin, the feasibility of the obtained solution.

3 - Disjunctive Normal Form Representation of Probabilistic Constraints

Miguel Lejeune, Assistant Professor, George Washington University, 2201 G Street, NW, Washington, DC, 20052, United States of America, mlejeune@gwu.edu

A combinatorial pattern framework is proposed for the modeling and solution of probabilistically constrained optimization problems. The method involves the binarization of the probability distribution and the construction of a prime and minimal disjunctive normal form. This latter represents the sufficient conditions for the satisfiability of the stochastic constraint and is a collection of patterns which are obtained through a mathematical programming approach.

■ TB17

Gleacher Center - 204

Bilevel and Multiobjective Optimization

Cluster: Logistics and Transportation
Invited Session

Chair: Christopher T. Ryan, University of British Columbia, Sauder School of Business, Vancouver, BC, Canada, chris.ryan@sauder.ubc.ca

1 - A Column Generation Approach for a Bilevel Product Pricing Problem

Aurelie Casier, Department of Computer Science, Faculty des Sciences, Université Libre de Bruxelles, Boulevard du Triomphe CP 210/01, Brussels, 1050, Belgium, acasier@ulb.ac.be, Martine Labbe', Bernard Fortz

Consider the product pricing problem (PPP) in which a company sets prices for products in order to maximize its revenue and reacting to these prices the customers buy, among all products on the market, the one providing them the biggest utility. Initially modeled as a bilevel program, PPP can be reformulated as a single level nonlinear model. From this nonlinear formulation, we derive a new IP formulation containing an exponential number of variables and propose a column generation solution approach.

2 - Bilevel Combinatorial Optimization Problems

Elisabeth Gassner, Graz University of Technology, Steyrergasse 30, Department of Optimization, Graz, 8010, Austria, gassner@opt.math.tugraz.at, Bettina Klinz

This talk deals with two bilevel approaches for combinatorial optimization problems, the discrete-discrete problem (DDP) and the continuous-discrete problem (CDP). In both cases the follower has to solve a combinatorial optimization problem. In DDP the leader chooses a partial solution of the follower's reaction problem while in CDP the leader is allowed to change parameter values of the follower's instance. The computational complexity as well as polynomially solvable special cases for DDP and CDP applied to basic problems like the shortest path, the assignment or the MST problem are presented.

3 - An Algebraic Approach to Fuzzy Integer Programming

Victor Blanco, Universidad de Sevilla, Dpto. Estadistica e IO, Facultad de Matematicas, Sevilla, 41012, Spain, vblanco@us.es, Justo Puerto

Fuzzy optimization deals with the problem of determining optimal solutions of an optimization problem when some of the elements in the problem are not precise. Zadeh(1965) analyzed a logic (fuzzy) that permits truth values between zero and one instead of the classical binary logic. Then, imprecision can be considered as a fuzzy environment. In LP some or all the elements may be considered fuzzy: coefficients, right-hand side, level of satisfaction of constraints, etc. Here, we present a methodology for solving integer LP where some of its elements are considered fuzzy. Previous results on short generating functions for solving single and multi-objective integer LP allow us to give a method to obtain optimal solutions in this framework.

4 - A Parametric Integer Programming Algorithm for Bilevel Mixed Integer Programs

Christopher T. Ryan, University of British Columbia, Sauder School of Business, Vancouver, BC, Canada, chris.ryan@sauder.ubc.ca, Matthias Koeppe, Maurice Queyranne

We consider discrete bilevel programs where the follower solves an integer program with a fixed number of variables. Using results in parametric integer programming, we present a polynomial time algorithms for mixed integer bilevel programs. Our algorithm also detects whether the infimum cost is attained, a difficulty that has been identified but not directly addressed in the literature. It yields an approximation scheme with running time polynomial in the logarithm of the relative precision.

■ TB18

Gleacher Center - 206

MINLP Theory & Algorithms

Cluster: Nonlinear Mixed Integer Programming
Invited Session

Chair: Kevin Furman, ExxonMobil, 1545 Route 22 East, Annandale, NJ, 08801, United States of America, kevin.c.furman@exxonmobil.com

1 - Solving Nonlinear Integer Programs with Nonconvex Quadratic Constraints

Youdong Lin, Lindo Systems, Inc, 1415 N Dayton St, Chicago, IL, 60642, United States of America, ylin@lindo.com, Linus Schrage

We described a software implementation for finding global optima to nonlinear programs that contain integer variables as well as one or more constraints that contain nonconvex quadratic terms. We discuss and analyze the effectiveness of various methods for constructing convex relaxations and for doing branching.

2 - Interior-point Methods for Mixed-integer Nonlinear and Cone Programming Problems

Hande Benson, Drexel University, LeBow College of Business, 3141 Chestnut St, Philadelphia, PA, 19104, United States of America, hvb22@drexel.edu

In this talk, we will present details of an interior-point method for solving the nonlinear, second-order cone, and semidefinite programming subproblems that arise in the solution of mixed-integer optimization problems. Of particular concern will be warmstart strategies and infeasibility identification. Numerical results will be presented.

3 - An Exact MINLP Formulation for Nonlinear Disjunctive Programs Based on the Convex Hull

Nicolas Sawaya, ExxonMobil, 1545 Route 22 East, Annandale, NJ, 08801, United States of America, nicolas.sawaya@exxonmobil.com, Ignacio Grossmann, Kevin Furman

Nonlinear disjunctive programming provides a powerful framework for modeling applications that can be posed as discrete continuous optimization problems with nonlinear constraints. For cases with convex functions, an attractive approach to solve such problems uses the convex hull of nonlinear disjunctions. However, direct implementation using general purpose solvers leads to computational difficulties. We propose an exact reformulation of nonlinear disjunctive programs that avoids this issue.

■ TB19

Gleacher Center - 208

Nonlinear Programming G

Contributed Session

Chair: Vladimir Kazakov, Reseach Fellow, University of Technology, Sydney, P.O. Box 123, Broadway, NSW, 2007, Australia, vladimir.kazakov@uts.edu.au

1 - Bilevel Programming: Reformulation using KKT Conditions

Francisco N. C. Sobral, IMECC - State University of Campinas (UNICAMP), Rua Carmelito Leme, 63, Frente, Campinas, 13084-609, Brazil, fsobral@ime.unicamp.br, Ernesto G. Birgin

In this work we study a resolution technique which consists in replacing the lower level problem by its necessary first order conditions, which can be formulated in various ways, as complementarity constraints occur and are modified. The new reformulated problem is a nonlinear programming problem which can be solved by classical optimization methods. We apply the described technique to solve with ALGENCAN a set of bilevel problems taken from the literature and analyze their behavior.

2 - Decomposition and Stochastic Subgradient Algorithms for Support Vector Machines

Sangkyun Lee, University of Wisconsin-Madison, Computer Sciences, Madison, United States of America, sklee@cs.wisc.edu, Stephen Wright

Support Vector Machines (SVMs) are widely used in machine learning to perform classification and regression. We describe optimization algorithms for solving various SVM formulations on large data sets. In particular, we discuss a decomposition method for a convex quadratic programming formulation of semiparametric SVMs, and stochastic-gradient approaches for linear SVMs.

3 - Conditions of Optimality for Averaged Nonlinear Programming Problem

Vladimir Kazakov, Reseach Fellow, University of Technology, Sydney, P.O. Box 123, Broadway, NSW, 2007, Australia, vladimir.kazakov@uts.edu.au, Anatoly Tsirlin, Alexandr Tsirlin

We consider extension of nonlinear programming problem where the maximum of the average value of objective function subject to given constraints on the average value of the fixed number of constraints is sought. We derive its conditions of optimality and illustrate its importance with a number of applications.

■ TB20

Gleacher Center - 300

Nonlinear Programming: Applications

Cluster: Nonlinear Programming
Invited Session

Chair: Sven Leyffer, Argonne National Laboratory, MCS Division 9700 South Cass Avenue, Argonne, IL, 60439, United States of America, leyffer@mcs.anl.gov

Co-Chair: Annick Sartenaer, Professor, University of Namur (FUNDP), Rempart de la Vierge, 8, Namur, B-5000, Belgium, annick.sartenaer@fundp.ac.be

1 - Direct Transcription for a Class of Dynamic Hybrid Systems

Lorenz Biegler, Bayer Professor, Carnegie Mellon University, Chemical Engineering Department, Pittsburgh, PA, 15213, United States of America, lb01@andrew.cmu.edu, Brian Baumrucker

Optimization of differential-algebraic systems can be handled efficiently through direct transcription methods; these require discretization of state and control profiles and lead to large, sparse NLPs. In this talk we extend this approach to a class of hybrid systems with switches in state equations, but with continuous state profiles over time; this class includes handling of sliding modes present in Filippov systems. For these systems we derive MPEC formulations that also include moving finite elements and specialized complementarity constraints. The resulting MPEC formulation is demonstrated on examples drawn from process control and vehicle dynamics, including the celebrated “Michael Schumacher” problem.

2 - Optimization in Data Assimilation for Weather Forecasts

Patrick Laloyaux, University of Namur, 8, Rempart de la Vierge, Namur, Belgium, patrick.laloyaux@fundp.ac.be, Serge Gratton, Annick Sartenaer, Jean Tshimanga

To estimate the state of the ocean and of the atmosphere, very large nonlinear least-squares problems with highly expensive objective function evaluations have to be solved. The Gauss-Newton algorithm is commonly applied, which solves a sequence of linear systems using a conjugate-gradient-like method. To improve the rate of convergence of the method, a preconditioner and an improved starting point for the conjugate-gradient-like method have been developed and will be presented in this talk.

3 - The Manipulation of Carbon Emission Programs

Todd Munson, Argonne National Laboratory, 9700 S Cass Ave, Argonne, IL, 60439, United States of America, tmunson@mcs.anl.gov

Carbon emission programs are designed to reduce greenhouse gas emissions by implementing either a carbon tax or a cap-and-trade program. In this talk, we discuss the extent to which foreign entities can manipulate cap-and-trade programs by cutting production, resulting in a collapse of some carbon emission markets. We analyze a leader-follower computable general equilibrium model to understand this issue that results in mathematical programs with equilibrium constraints that need to be solved. Numerical results providing insights into the possible manipulation of carbon emission programs by foreign producers are provided.

■ TB21

Gleacher Center - 304

Routing and Scheduling in Wireless Networks

Cluster: Telecommunications and Networks
Invited Session

Chair: Leen Stougie, Professor Doctor, Vrije Universiteit & CWI Amsterdam, De Boelelaan 1105, Amsterdam, 1085HV, Netherlands, lstougie@feweb.vu.nl

1 - Efficient and Fair Routing for Mesh Networks

Enrico Malaguti, DEIS, University of Bologna, Viale Risorgimento, 2, Bologna, 40136, Italy, enrico.malaguti@unibo.it, Andrea Lodi, Nicolas Stier-Moses

We study how a mesh network should use the energy stored in its nodes. The solution that minimizes the total energy spent by the whole network may be very unfair to some nodes because they bear a disproportionate burden of the traffic. We explicitly aim at the solution that minimizes the total energy but we add a fairness constraint, thus optimizing social welfare and keeping user needs as constraints. We look both at centralized and decentralized algorithms to solve this problem, and show how fairness can be obtained with a limited increase of total energy.

2 - Flow Minimization in Wireless Gathering

Alberto Marchetti Spaccamela, Professor, Sapienza University of Rome, via Ariosto 25, Roma, 00184, Italy, alberto@dis.uniroma1.it, Peter Korteweg, Vincenzo Bonifaci, Leen Stougie

We consider the problem of efficient data gathering in a wireless network through multi-hop communication. We focus on minimizing the maximum flow time of a data packet (Fmax-Wgp) and minimizing the average flow time of the data packets (Fsum-Wgp). We first show that no polynomial time algorithm can have approximation ratio less than a polynomial in the number of messages unless P = NP. These negative results motivate the use of resource augmentation analysis; namely we allow the algorithms to transmit data at a higher speed than that of the optimal solutions to which we compare them. We show that both a FIFO-like strategy for Fmax-Wgp and a SRPT-like strategy for Fsum-Wgp, are 5-speed optimal.

3 - Shortest Path Routing - Handling Infeasible Routing Patterns

Mikael Call, Linköping University, Linköping University, Matematiska Institutionen, Linköping, 58183, Sweden, mikael.call@liu.se, Kaj Holmberg

Several network design problems comes with the additional constraint that traffic must be routed in accordance with some shortest path routing protocol, e.g. OSPF or IS-IS. This implies that some routing patterns are not eligible. We describe the most common combinatorial structures formed by routing patterns that yield infeasibility by analysing a special inverse shortest path problem. We examine families of valid inequalities for the design problem obtained from these structures.

■ TB22

Gleacher Center - 306

Interior Point Implementations II

Cluster: Implementations, Software
Invited Session

Chair: Christian Bliek, IBM, 1681 HB2 Route des Dolines, Valbonne, 06560, France, bliek@fr.ibm.com

1 - On Recent Improvements in the Conic Optimizer in MOSEK

Erling Andersen, CEO, Mosek ApS, Fruebjergvej 3, Box 16, Copenhagen, 2100, Denmark, e.d.andersen@mosek.com

The software package MOSEK is capable of solving large-scale sparse conic quadratic optimization problems using an interior-point method. In this talk we will present our recent improvements in the implementation. Moreover, we will present numerical results demonstrating the performance of the implementation.

2 - Fast Preconditioner for Linear Systems Arising in Interior Point Methods

Jacek Gondzio, University of Edinburgh, School of Mathematics, Edinburgh, United Kingdom, J.Gondzio@ed.ac.uk

A use of iterative methods and a choice of suitable preconditioner to solve reduced Newton systems arising in optimization with interior point methods will be addressed. A new fast preconditioner will be presented. Its numerical properties will be anlysed and its use will be illustrated by computational results obtained for a collection of small optimization problems (with matrices of not more than 10 million of nonzero elements).

3 - Interior Point Methods in Microsoft Solver Foundation

Nathan Brixius, Microsoft Corporation, One Redmond Way, Redmond, WA, 98052, United States of America, nathan.brixius@microsoft.com

Microsoft Solver Foundation is a .Net runtime for modeling and optimization. The core is a set of solvers for LP, QP, constraint, MIP, and unconstrained NLP problems. These solvers are integrated with services for model validation, parallel solving, model interchange, and declarative data binding. We will focus on the algorithms underlying Solver Foundation's interior point LP and QP solvers, and show how these algorithms can be extended to a wide range of convex optimization problems.

■ TB23

Gleacher Center - 308

Algorithms for Rank Minimization

Cluster: Sparse Optimization
Invited Session

Chair: Benjamin Recht, California Institute of Technology, 1200 E California Blvd, MC 136-93, Pasadena, CA, 91125, United States of America, brecht@caltech.edu

1 - Semidefinite Programming Methods for Rank Minimization and Applications in System Theory

Lieven Vandenberghe, UCLA, 66-147L Engineering IV, Los Angeles, CA, 90095, United States of America, vandenbe@ee.ucla.edu, Zhang Liu

We discuss the implementation of interior-point methods for linear nuclear norm approximation problems. This problem can be formulated as a semidefinite program that includes large auxiliary matrix variables and is difficult to solve by general-purpose solvers. By exploiting problem structure, we reduce the cost per iteration of an interior-point method to roughly the cost of solving the approximation problem in Frobenius norm. We also discuss applications in system identification.

2 - Testing the Nullspace Property using Semidefinite Programming

Alexandre d'Aspremont, Princeton University, School of Engineering and Applied Scienc, Room 207, ORFE buidling,, Princeton, NJ, 08544, aspremon@princeton.edu, Laurent El Ghaoui

Given a matrix A, we use semidefinite relaxation techniques to test the nullspace property on A and show on some numerical examples that these relaxation bounds can prove perfect recovery of sparse solutions to underdetermined linear systems with relatively high cardinality.

3 - Rank Minimization via Online Learning

Constatine Caramanis, University of Texas, Mail Code, C0806, Austin, TX, 78712, cmcaram@ece.utexas.edu, Raghu Meka, Prateek Jain, Inderjit Dhillon

Minimum rank problems arise frequently in machine learning and are notoriously difficult to solve. We present the first online learning approach for rank minimization of matrices over polyhedral sets. Our first algorithm is a multiplicative update method based on a generalized experts framework, while our second algorithm is a novel application of the online convex programming framework (Zinkevich, 2003). We give provable approximation guarantees.

■ TB25

Gleacher Center - 404

Stability of Error Bounds and Maximal Monotonicity of the Sum

Cluster: Variational Analysis
Invited Session

Chair: Andrew Eberhard, Professor, RMIT University, GPO Box 2476V, Melbourne, Victoria, 3001, Australia, andy.eb@rmit.edu.au

1 - Stability of Error Bounds for Semi-infinite Constraint Systems

Michel Thera, Professor, University of Limoges and XLIM (UMR-CNRS 6172), 123, Avenue A. Thomas, Limoges, 87060, France, michel.thera@unilim.fr, Van Ngai Huynh, Alexander Kruger

In this presentation, we will be concerned with the stability of the error bounds for semi-infinite convex constraint systems. Roughly speaking, the error bound of a system of inequalities is said to be stable if its "small" perturbations admit a (local or global) error bound. We first establish subdifferential characterizations of the stability of local/global for semi-infinte systems of convex inequalities. Then we will show that these characterizations allow to extend some results established by Luo & Tseng and by Azé Corvellec on the sensitivity analysis of Hoffman constants to semi-infinite linear constraint systems.

2 - An Answer to S. Simons' Question on the Maximal Monotonicity of the Sum

Xianfu Wang, Associate Professor, University of British Columbia | Okanagan, Department of Mathematics, Kelowna, BC, V1V 1V7, Canada, Shawn.Wang@ubc.ca

In his 2008 monograph "From Hahn-Banach to Monotonicity"Stephen Simons asked whether or not the sum theorem holds for the special case of a maximal monotone linear operator and a normal cone operator of a closed convex set provided that the interior of the set makes a nonempty intersection with the domain of the linear operator. In this note, we provide an affirmative answer to Simons' question. In fact, we show that the sum theorem is true for a maximal monotone linear relation and a normal cone operator. The proof relies on Rockafellar's formula for the Fenchel conjugate of the sum as well as some results featuring the Fitzpatrick function. This is a joint work with Heinz Bauschke and Liangjin Yao.

3 - On Stability of the MPCC Feasible Set

Vladimir Shikhman, RWTH Aachen University, Templergraben 55, Aachen, Germany, shikhman@mathc.rwth-aachen.de, Hubertus Th. Jongen, Jan-J. Ruckmann

The feasible set of mathematical programs with complementarity constraints (MPCC) is considered. We discuss local stability of the feasible set (up to homeomorphy). For stability we propose a new Mangasarian-Fromovitz Condition (MFC). We reformulate MFC in analytic and geometric terms using the tools of modern nonsmooth and variational analysis. We elaborate links to metric regularity, Mordukhovich's extremal principle, subdiff. qualification condition.

■ TB27

Gleacher Center - 408

Symmetric Cones, Hyperbolic Polynomials, and Matrix Majorizations

Cluster: Variational Analysis

Invited Session

Chair: Hristo Sendov, University of Western Ontario, Dept of Statistical & Actuarial Sciences, 1151 Richmond Street North, London, ON, N6A 5B7, Canada, hssendov@stats.uwo.ca

1 - Clarke Generalized Jacobian of the Projection onto Symmetric Cones

Levent Tuncel, Professor, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, ltuncel@math.uwaterloo.ca, Naihua Xiu, Lingchen Kong

We give an exact expression for Clarke generalized Jacobian of the projection onto symmetric cones, which generalizes and unifies the existing related results on second-order cones and the cones of symmetric positive semi-definite matrices over the reals. Our characterization of the Clarke generalized Jacobian exposes a connection to rank-one matrices.

2 - Hyperbolic Polynomials as a Magical Tool for Proofs of Lower Bounds in Combinatorics

Leonid Gurvits, Los Alamos National Laboratory, United States of America, gurvits@lanl.gov

I will present one general inequality on the mixed derivative of a H-Stable polynomial(i.e. a homogeneous hyperbolic polynomial with the hyperbolic cone containing the positive orthant), will sketch the key steps of my proof, describe some uniqueness results and open problems.This inequality is a vast (and unifying) generalization of the van der Waerden conjecture on the permanents of doubly stochastic matrices as well as the Schrijver-Valiant conjecture on the number of perfect matchings in regular bipartite graphs. These two famous results correspond to the H-Stable polynomials which are products of linear forms. I will explain how my original proof can be tuned to handle important non-hyperbolic cases, including the mixed volume.

3 - On Malamud Majorization and the Extreme Points of its Level Sets

Hristo Sendov, Professor, University of Western Ontario, Western Science Centre - Room 262, 1151 Richmond Street, London, ON, N6A 5B7, Canada, hssendov@hotmail.com, Pal Fischer

X and Y are sequences of vectors. X is Malamud majorized by Y if the sum of any k vectors in X is in the convex hull of all possible sums of k vectors in Y. X is majorized by Y if X=YM for a doubly stochastic matrix M. [1] asks for geometric conditions on Y s.t. the level sets of the majorizations are the same. We answer when vectors Y are extreme points of their convex hull. [1] Malamud: Inverse spectral problems for normal matrices and the Gauss-Lucas theorem, Trans. Amer. Math. Soc. (2004).

■ TB28

Gleacher Center - 600

Applications of Cone Optimization

Cluster: Nonsmooth and Convex Optimization

Invited Session

Chair: Henry Wolkowicz, Professor of Math., University of Waterloo, Dept of Combinatorics & Optimization, University of Waterloo, Waterloo, ON, N2L 3G1, Canada, hwolkowicz@uwaterloo.ca

1 - Explicit Sensor Network Localization using Semidefinite Representations and Clique Reductions

Nathan Krislock, University of Waterloo, Dept. of Combinatorics & Optimization, University of Waterloo, Waterloo, ON, N2L 3G1, Canada, ngbkrisl@math.uwaterloo.ca, Henry Wolkowicz

The sensor network localization, SNL, problem consists of locating the positions of sensors, given only the distances between sensors that are within radio range and the positions of some fixed sensors (called anchors). Using the theory of Euclidean Distance Matrices, we relax SNL to a semidefinite programming, SDP, problem. By finding explicit representations of the faces of the SDP cone corresponding to intersections of cliques, we derive a technique that solves SNL, with exact data.

2 - SDP Representation of Rational and Singular Convex Sets

Jiawang Nie, Assistant Professor, University of California at San Diego, UCSD, Mathematics Department, 9500 Gilman Drive, La Jolla, CA, 92093, United States of America, njw@math.ucsd.edu, J. William Helton

A set is called SDP representable if it is expressible by some linear matrix inequality via lifting variables. First, we will present a general result: A set S defined by polynomial inequalities is SDP representable if its boundary pieces are nonsingular and positively curved. Second, we will present conditions for SDP representability when S is defined by multivariate rational polynomial functions or its boundary pieces have singularities. Specific examples will also be shown.

3 - Graph Realizations Corresponding to Optimized Extremal Eigenvalues of the Laplacian

Christoph Helmberg, Technische Universität Chemnitz, Fakultät für Mathematik, Chemnitz, D-09107, Germany, helmberg@mathematik.tu-chemnitz.de, Frank Goering, Markus Wappler, Susanna Reiss

We study graph realizations in Euclidean space obtained from optimal solutions of semidefinite programs for optimizing the maximal and minimal eigenvalue of the Laplace matrix of a graph by redistributing the mass on the edges of the graph. We show that the geometric structure of optimal graph realizations is tightly linked to the separator structure of the graph and that in both cases there exist optimal realizations whose dimension is bounded by the tree width of the graph plus one.

Tuesday, 3:15pm - 4:45pm

■ TC01

Marriott - Chicago A

Approximation Algorithms using Iterated Rounding

Cluster: Approximation Algorithms

Invited Session

Chair: Cliff Stein, Columbia University, 326 S W Mudd Building, 500 W. 120th Street, New York, NY, 10027, cliff@ieor.columbia.edu

1 - On Linear and Semidefinite Programming Relaxations for Hypergraph Matching

Lap Chi Lau, The Chinese University of Hong Kong, Department of Computer Science, Shatin N.T., Hong Kong - ROC, chi@cse.cuhk.edu.hk, Yuk Hei Chan

We analyze different LP/SDP relaxations for the hypergraph matching problem. For the standard LP relaxation, we use a new iterative technique to determine the exact integrality gap for k-uniform hypergraphs and k-partite hypergraphs. Then we analyze different strengthening of the standard LP, including the Sherali-Adams hierarchy, the "clique" LP and the Lovasz theta-function. Our results show a new connection between analysis of local search algorithms and analysis of LP/SDP relaxations.

2 - Additive Approximations for Bounded Degree Survivable Network Design

Mohit Singh, Post-Doctoral Researcher, Microsoft Research, 1 Memorial Drive, Cambridge, MA, 02142, United States of America, mohsingh@microsoft.com, Lap Chi Lau

We study the survivable network design problem with degree constraints on vertices. We present a polynomial time algorithm which returns a solution with cost at most twice the optimal and the degree bounds are violated by a small additive constant depending on the connectivity requirement. As a corollary, this result implies the first additive approximation algorithm for degree constrained Steiner forest problem, degree constrained k-edge connected subgraph problem for bounded k.

3 - Unified Analysis of LP Extreme Points for Steiner Network and Traveling Salesman

R. Ravi, Carnegie Bosch Professor, Carnegie Mellon University, Tepper School of Business, 5000 Forbes Ave, Pittsburgh, PA, 15213, United States of America, ravi@cmu.edu, Mohit Singh, Viswanath Nagarajan

We consider two well-studied combinatorial optimization problems: the Survivable Network Design problem (SNDP) and the Symmetric Traveling Salesman problem (STSP). We give new proofs of existence of a 1/2-edge and 1-edge in any extreme point of the natural LP relaxations for SNDP and STSP respectively. Our proofs give a unifying framework for the results of Jain (1998) on Survivable Network Design and Boyd and Pulleyblank (1990) on Symmetric Traveling Salesman.

■ TC02

Marriott - Chicago B

New Approaches for Complementarity Problems and MPECs

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Michael Ulbrich, Technische Universitaet Muenchen, Department of Mathematics, Boltzmannstr. 3, Garching, 85748, Germany, mulbrich@ma.tum.de

1 - A Large-scale Affine Variational Inequality Solver Based on a PATH-Following Method

Qian Li, University of Wisconsin, 1210 West Dayton Street, Madison, WI, 53706, United States of America, qli@math.wisc.edu, Michael Ferris

PathAVI is an implementation of a path-following method for solving affine variational inequalities (AVIs). It exploits the special structure of the underlying polyhedral set and employs a pivotal scheme to solve a class of models (formulated as AVIs), whose equivalent linear complementarity reformulations cannot be processed by existing complementarity solvers. PathAVI is capable of processing large-scale AVIs by incorporating sparse linear system packages and updating schemes.

2 - A New Relaxation Scheme for MPECs

Sonja Veelken, RWTH Aachen, Templergraben 55, Aachen, 52062, Germany, veelken@mathc.rwth-aachen.de, Michael Ulbrich

We present a new relaxation scheme for MPECs, where the complementarity constraints are replaced by a reformulation that is exact for sufficiently nondegenerate components and relaxes only the remaining conditions. A positive parameter determines to what extend the complementarity conditions are relaxed. We discuss the properties of the resulting parametrized nonlinear programs, compare stationary points and solutions and present convergence to C-/M-stationary points under MPEC-CRCQ/LICQ. Numerical results show that a resulting numerical solution approach combines good efficiency with high robustness.

3 - Nonlinear Equilibrium vs. Linear Programming

Roman Polyak, Professor, George Mason University, 4400 University drive, Fairfax, 22030, United States of America, rpolyak@gmu.edu

We consider the Nonlinear Equilibrium (NE) as an alternative to Linear Programming (LP) approach for optimal recourse allocation. It was shown that under natural economic assumptions the NE exists and unique. Finding the NE is equivalent to solving a variation inequality. For solving the variation inequality a projected pseudo-gradient method was introduced, his global convergence with Q-linear rate was proven and its computational complexity was estimated. The method can be viewed as a natural pricing mechanism for establishing an Economic Equilibrium.

■ TC03

Marriott - Chicago C

Algorithms and Tools of Complementarity and Variational Problems

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Mikhail Solodov, Institute for Pure and Applied Mathematics, IMPA, Estrada Dona Castorina 110, Jardim Botanico, Rio de Janeiro, CEP 22460-, Brazil, solodov@impa.br

1 - A Semismooth Newton Method for the Continuous Quadratic Knapsack Problem

Paulo J. S. Silva, Professor, IME-USP, Rua do Matão, 1010, São Paulo, 05508-090, Brazil, pjssilva@ime.usp.br, Roberto Cominetti, Walter F. Mascarenhas

We present a semismooth Newton method for the continuous quadratic knapsack problem, that is, the projection onto the intersection of a box and a hyperplane. Our algorithm is derived from the minimum reformulation of the linear complementarity system associated to the KKT conditions of the original problem. We show conditions that ensure that the Newton method does not need a globalization strategy, discuss its connection with other algorithms, and present encouraging numerical results.

2 - Inexact Josephy-Newton Framework for Variational Problems and its Applications to Optimization

Alexey Izmailov, Professor, Moscow State University, MSU, VMK, Department of OR, Leninskiye Gory, GSP-2, Moscow, 119992, Russian Federation, izmaf@rambler.ru, Mikhail Solodov

We analyze a perturbed version of the Josephy-Newton method for generalized equations. This framework is convenient to treat in a unified way standard sequential quadratic programming, its stabilized version, quasi-Newton sequential quadratic programming, sequential quadratically constrained quadratic programming, linearly constrained Lagrangian methods, etc. Another possible application is concerned with the development of truncated versions of sequential quadratic programming.

3 - Decomposition via Variable Metric Inexact Proximal Point Framework

Mikhail Solodov, Institute for Pure and Applied Mathematics, IMPA, Estrada Dona Castorina 110, Jardim Botanico, Rio de Janeiro, CEP 22460-, Brazil, solodov@impa.br, Pablo Lotito, Lisandro Parente

We introduce a general decomposition scheme based on the hybrid inexact proximal point method and on the use of variable metric in subproblems. We show that the new general scheme includes as special cases the splitting method for composite mappings, the proximal alternating directions methods, and and alternating projection-proximal methods, among others. Apart from giving a unified insight into the decomposition methods in question and openning the possibility of using variable metric, which is a computationally important issue, this development also provides rate of convergence results not previously available for most of the techniques in question.

■ TC04

Marriott - Denver

Combinatorial Optimization C

Contributed Session

Chair: Dan Stratila, RUTCOR, Rutgers University, 640 Bartholomew Rd, Rm 107, Piscataway, NJ, 08854, United States of America, dstrat@rci.rutgers.edu

1 - Makespan-minimal Collision-free Scheduling of Arc Welding Robots in Car Body Shops

Cornelius Schwarz, Universität Bayreuth, Universitätsstr. 30, Bayreuth, 95440, Germany, cornelius.schwarz@uni-bayreuth.de, Joerg Rambau

The equipment in a welding cell consists of a number of welding robots and one or more laser sources, each of which can supply more than one robot, but only one at a time! We present the first exact algorithm which finds a makespan-minimal assignment of welding task to robots and a scheduled tour for every robot, such that robots sharing a common laser source do not weld simultaneously and the schedule is collision free. We give some computational results on data obtained by KuKa SimPro.

2 - Fast Algorithms for Parameterized Linear Programs with Applications to Cyclic Scheduling

Eugene Levner, Professor, Holon Institute of Technology, 52 Golomb.St., Holon, Israel, levner@hit.ac.il, Vladimir Kats

A special class of linear programming problems with two variables per constraint parameterized with one, two or three parameters are considered. These problems are solved to optimality with new strongly polynomial time algorithms which are much faster than earlier known related polynomial algorithms. The linear programming models and algorithms are applied for solving cyclic scheduling problems arising in automated production lines served by robots.

3 - Faster Primal-dual Algorithms for the Economic Lot-sizing Problem

Dan Stratila, RUTCOR, Rutgers University, 640 Bartholomew Rd, Rm 107, Piscataway, NJ, 08854, United States of America, dstrat@rci.rutgers.edu, Mihai Patrascu

Consider the classical lot-sizing problem, introduced by Manne (1958), and Wagner and Whitin (1958). Since its introduction, researchers have worked on faster algorithms for it. Federgruen and Tzur (1991), Wagelmans et al (1992), and Aggarwal and Park (1993) independently obtained O(n log n) algorithms. Recently, Levi et al (2006) developed a primal-dual algorithm. Building on the work of Levi et al, we obtain a fast primal-dual algorithm for the lot-sizing problem and analyze its running time.

■ TC05

Marriott - Houston

Combinatorial Optimization Q

Contributed Session

Chair: Cédric Joncour, University Bordeaux 1 & Inria, 351, cours de la Libération, Talence, France, cedric.joncour@math.u-bordeaux1.fr

1 - On the Vehicle Routing Problem with Lower Bound Capacities

Luis Gouveia, DEIO-CIO, Faculdade de Ciencias da Universidade de Lisboa, Campo Grande, Bloco C6- Piso 4, Lisbon, Portugal, legouveia@fc.ul.pt, Jorge Riera, Juan Jose' Salazar

In this paper we show and discuss a family of inequalities for solving a variant of the classical vehicle routing problem where also a lower bound is considered. The inequalities are related to the projected inequalities from a single commodity flow formulation. Other inequalities are based on rounding procedures. We also show computational experiments proving the utility of the new inequalities.

2 - k-Hyperplane Clustering: An Adaptive Point-reassignment Algorithm

Stefano Coniglio, PhD Student, Politecnico di Milano, P.zza L. da Vinci 32, Milano, 20133, Italy, coniglio@elet.polimi.it, Edoardo Amaldi

In the k-Hyperplane Clustering problem, given a set of points, we are asked to determine k hyperplanes and assign each point to one of them so as to minimize the sum-of-squared 2-norm point-to-hyperplane orthogonal distances. We propose a metaheuristic based on the adaptive identification and reassignment of likely to be ill-assigned points and including two Tabu Search features. The solutions of the best available algorithm are worse than those of our method by more than 34% on average.

3 - Consecutive Ones Matrices for the 2d-orthogonal Packing Problem

Cédric Joncour, University Bordeaux 1 & Inria, 351, Cours de la Libération, Talence, France, cedric.joncour@math.u-bordeaux1.fr, Arnaud Pécher

The two-dimensional orthogonal packing problem (2d-OPP) is a well-known optimization problem. Given a set of items with rectangular shapes, the problem is to decide whether the set of items is feasible, that is whether there is a non-overlapping packing in a given rectangular bin. Rotation of items is not allowed. Fekete and Schepers introduced a couple of interval graphs as data structure to store a feasible packing, and gave a fast algorithm. In this work, we propose a new algorithm using consecutive ones matrices as data structures, due to Fulkerson and Gross's characterization of interval graphs.

■ TC06

Marriott - Kansas City

Semismooth Newton Methods for Linear and Convex Quadratic SDP

Cluster: Conic Programming

Invited Session

Chair: Kim-Chuan Toh, National University of Singapore, 2 Science Drive 2, Department of Mathematics, Singapore, SG, 117543, Singapore, mattohkc@nus.edu.sg

1 - An Implementable Proximal Point Algorithmic Framework for Nuclear Norm Minimization

Yongjin Liu, Singapore-MIT Alliance and NUS, 2 Science Drive 2, Singapore, 117543, Singapore, smaly@nus.edu.sg, Kim-Chuan Toh, Defeng Sun

This paper proposes the inexact proximal point algorithms in the primal, dual and primal-dual forms for the nuclear norm minimization. We design efficient implementations of these algorithms and present comprehensive convergence results. In particular, we investigate the performance of our proposed algorithms for which the inner sub-problems are solved by the gradient projection or accelerated proximal gradient method. Our numerical results show the efficiency of our algorithms.

2 - Calibrating Least Squares Semidefinite Programming with Equality and Inequality Constraints

Yan Gao, National University of Singapore, 2 Science Drive 2, Singapore, 117543, Singapore, yangao@nus.edu.sg, Defeng Sun

In many applications in finance, insurance, and reinsurance, one seeks a solution of finding a covariance matrix satisfying a large number of given linear equality and inequality constraints in a way that it deviates the least from a given symmetric matrix. One difficulty in finding an efficient method for solving this problem is due to the presence of the inequality constraints. In this paper, we propose to overcome this difficulty by reformulating the problem as a system of semismooth equations with two level metric projection operators. We then design an inexact smoothing Newton method to solve the resulted semismooth system. Our numerical experiments confirm the high efficiency of the proposed method.

■ TC07

Marriott - Chicago D

Integer and Mixed Integer Programming C

Contributed Session

Chair: Filipa Duarte de Carvalho, Assistant Professor, Instituto Superior de Economia e Gestão - Technical University of Lisbon, Rua do Quelhas 6, Lisboa, 1200-781, Portugal, filipadc@iseg.utl.pt

1 - Postoptimality Analysis using Multivalued Decision Diagrams

Tarik Hadzic, University College Cork, Cork Constraint Computation Centre, 14 Washington St West, Cork, Ireland, hadzic@gmail.com, John Hooker

This talks shows how multivalued decision diagrams (MDDs) can be used to solve and obtain postoptimality analysis for optimization problems with binary or general integer variables. The constraint set corresponds to a unique reduced MDD that represents all feasible or near-optimal solutions, and in which optimal solutions correspond to certain shortest paths. The MDD can be queried in real time for in-depth postoptimality reasoning. We illustrate the analysis on network reliability and other problems. This is joint work with John Hooker.

2 - Steiner Tree Packing Problems Arising in Printing Electronics on Sheet Metal

Lars Schewe, TU Darmstadt, Schlossgartenstrasse 7, Darmstadt, 64289, Germany, schewe@mathematik.tu-darmstadt.de

We present variants of the Steiner tree packing problem that arise in the manufacturing of adaptronic components: A circuit is printed on sheet metal which in turn is processed further. The goal of the optimization is to minimize the possible damage that these further processing steps might inflict. The main problem is to incorporate restrictions from later forming steps. This leads to variants of the Steiner tree packing problem which we tackle using a branch-and-cut approach.

3 - Strong Valid Inequalities for the 2-club Problem

Filipa Duarte de Carvalho, Assistant Professor, Instituto Superior de Economia e Gestão - Technical University of Lisbon, Rua do Quelhas 6, Lisboa, 1200-781, Portugal, filipadc@iseg.utl.pt, Maria Teresa Chaves de Almeida

Given a graph, a k-club is a subset of nodes that induces a subgraph of diameter k. Finding a maximum cardinality k-club is NP-hard for any integer k. For small values of k, large k-clubs may represent, for instance, cohesive groups in social networks or protein interactions in biological networks. We present new families of valid inequalities for the 2-club polytope as well as conditions for them to define facets. Computational experience is reported on a set of medium size instances.

■ TC08

Marriott - Chicago E

Trends in Mixed Integer Programming V

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Andrea Lodi, DEIS, University of Bologna, Viale Risorgimento, 2, Bologna, 40136, Italy, andrea.lodi@unibo.it

Co-Chair: Robert Weismantel, Professor, Otto-von-Guericke University Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, weismant@mail.math.uni-magdeburg.de

1 - A Generalization to Accelerate Convergence of Column Generation

Wilbert Wilhelm, Barnes Professor, Texas A&M University, Industrial and Systems Engineering, TAMUS 3131, College Station, Te, 77843-3131, United States of America, wilhelm@tamu.edu, Dong Liang

This paper describes a generalization of column generation that reformulates the master problem with fewer variables but more constraints; sub-problem structure does not change. It shows both analytically and computationally that the reformulation promotes faster convergence in application to a linear program and to the relaxation of an integer program at each node in the branch-and-bound tree. It also shows that this reformulation subsumes and generalizes prior special-case approaches that have been shown to improve the rate of convergence.

2 - Decomposition of Multi-Period MIPs with Approximate Value Functions

Alejandro Toriello, Georgia Tech School of Industrial and Systems Engineering, 765 Ferst Drive NW, Atlanta, GA, 30332, United States of America, atoriello@gatech.edu, George Nemhauser, Martin Savelsbergh

We investigate the possibility of generating good solutions to multi-period MIPs by solving single- or few-period subproblems linked by state variables. The tailing-off effect of shorter planning horizons is mitigated by a piecewise-linear concave approximate value function obtained via sampling and data fitting.

3 - A Branch-and-price Algorithm for the Bin Packing Problem with Conflicts

Ruslan Sadykov, INRIA Bordeaux - Sud-Ouest, 351, Cours de la Liberation, Talence, 33405, France, Ruslan.Sadykov@inria.fr, Francois Vanderbeck

In this generalization of the bin packing problem, any two items in conflict cannot be put to the same bin. We show that the instances of the literature with 120 to 1000 items can be solved to optimality with a generic Branch-and-Price algorithm, such as our prototype named BaPCod, within competitive computing time (we close 8 of the 10 open instances so far). The approach involves generic primal heuristics, generic branching, but a specific pricing procedure.

■ TC09

Marriott - Chicago F

Symmetry in Mixed Integer Programming

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Volker Kaibel, OvGU Magdeburg, Universitätsplatz 2, Magdeburg, 39106, Germany, kaibel@ovgu.de

1 - Flexible Isomorphism Pruning

James Ostrowski, Lehigh University, jao204@lehigh.edu, Jeff Linderoth, Francois Margot

Isomorphism Pruning is an effective technique for solving integer programs with many isomorphic solutions. Previous implementations of isomorphism pruning had the limitation that the algorithm must use a restricted choice of branching variables during the branch-and-bound search. We show how remove this limitation-modifying isomorphism pruning to allow for complete flexibility in the choice of branching variable. Computational results showing the benefit of this flexibility will be given.

2 - Reformulations in Mathematical Programming: Symmetry

Leo Liberti, Ecole Polytechnique, LIX, Ecole Polytechnique, Palaiseau, France, leoliberti@yahoo.com

If a mathematical program has many symmetric optima, solving it via Branch-and-Bound often yields search trees of large sizes; thus, finding and exploiting symmetries is an important task. We propose a method for finding the formulation group of any MINLP and a reformulation for reducing symmetries. The reformulated problem can then be solved via solvers such as CPLEX or Couenne. We present detailed computational results and a study of the Kissing Number Problem's symmetries.

3 - Tractable and Intractable Orbitopes

Volker Kaibel, OvGU Magdeburg, Universitätsplatz 2, Magdeburg, 39106, Germany, kaibel@ovgu.de

Orbitopes are the convex hulls of the lexicographically maximal elements in orbits that arise from a group operating on 0/1-matrices by permutating the columns. Results on these polytopes can be useful in order to exploit symmetries in certain integer programing models. In this talk, we present the current knowledge on different types of orbitopes, depending on the group acting on the columns as well as on possible restrictions to matrices with, e.g., at most, exactly, or at least one 1-entry per row. It turned out over the last few years that some of these orbitopes admit nice linear decriptions (in the original space or via extended formulations), while others most likely do not, because optimizing over them can be shown to be NP-hard.

■ TC10

Marriott - Chicago G

Optimization in Data Mining

Cluster: Global Optimization
Invited Session

Chair: Art Chaovalitwongse, Rutgers University, Industrial Engineering, 96 Frelinghuysen Road, Piscataway, NJ, 08854, United States of America, wchaoval@rci.rutgers.edu

1 - Relaxing Support Vectors with Linear and Quadratic Programming Models

Onur Seref, Assitant Professor, Virginia Tech, 1007 Pamplin Hall 0235, Blacksburg, VA, 24061, United States of America, seref@vt.edu

In this talk, we introduce linear and quadratic programming models to relax vectors that are usually misclassified by maximal margin classifiers using a restricted amount of free (unpenalized) total slack. We introduce kernelized versions and emphasize important properties of these models. We also introduce a simple 2-phase method based on these models for multiple instance classification and present competitive computational results on public benchmark datasets and neurological data.

2 - New Computational Framework for Optimizing Feature Selection

Art Chaovalitwongse, Rutgers University, Industrial Engineering, 96 Frelinghuysen Road, Piscataway, NJ, 08854, United States of America, wchaoval@rci.rutgers.edu

We will present a new optimization framework, support feature machine (SFM), for improving feature selection and feature weighting to improve classification results. SFM is used to find the optimal feature group that shows strong class-separability, measured in terms of inter-class and intra-class distances. In addition, relaxed support feature machine, a variation of SFM, is also developed to optimize the feature weights (prioritization).

3 - Community Identification in Dynamic Social Networks

Chanyant Tantipathananandh, University of Illionis at Chicago, 851 S. Morgan (M/C 152), Room 1120 SEO, Chicago, IL, 60607-7053, United States of America, ctanti2@uic.edu, Tanya Berger-Wolf

Communities are characterized as "densely knit" subsets of a social network. This notion becomes more problematic if the social interactions change over time. Aggregating social networks over time can misrepresent the changing communities. We present an optimization-based framework for modeling dynamic communities and an algorithm for it which guarantees a small constant factor approximation. We demonstrate the algorithm on real data sets to confirm its efficiency and effectiveness.

■ TC11

Marriott - Chicago H

Global Optimization A

Contributed Session

Chair: Bernardetta Addis, Temporary Research Fellow, Politecnico di Milano - dei, via Ponzio 34, Milano, 20133, Italy, addis@elet.polimi.it

1 - GloptLab - A Configurable Framework for Global Optimization

Ferenc Domes, University of Vienna, Nordbergstr. 15, Wien, 1090, Austria, ferenc.domes@univie.ac.at

GloptLab is an easy-to-use testing and development platform for solving quadratic optimization problems, written in Matlab. Various new and state-of-the-art algorithms implemented in GloptLab are used to reduce the search space: scaling, constraint propagation, linear relaxations, strictly convex enclosures, conic methods, probing and branch and bound. Other techniques, such as finding and verifying feasible points, enable to find the global minimum of the objective function. All methods in GloptLab are rigorous, hence it is guaranteed that no feasible point is lost. From the method repertoire custom made strategies can be built, with a user-friendly graphical interface.

2 - Solving Global Optimization Problems with Discrete Filled Function Methods: A Survey

Siew Fang Woon, PhD Candidate, Curtin University of Technology, Kent Street, Bentley, Perth, Western Australia, 6102, Australia, woonsiewfang@yahoo.com, Volker Rehbock

Many real life scenarios can be modeled as nonlinear discrete optimization problems. Such problems often have multiple local minima, and thus require global optimization methods. The discrete filled function method is a recent global optimization tool. We review a variety of these methods from the literature. The most promising methods were tested on several benchmark problems. Computational results show this approach is robust and efficient in solving large scale discrete optimization problems.

3 - A Global Optimization Method for Space Trajectory Design

Bernardetta Addis, Temporary Research Fellow, Politecnico di Milano - dei, via Ponzio 34, Milano, 20133, Italy, addis@elet.polimi.it, Andrea Cassioli, Marco Locatelli, Fabio Schoen

Optimal space trajectory design, a complex activity, can be stated as a global optimization problem. Simplified models are often suited for preliminary analysis and used as test problems for global optimization methods. We develop a multi level global optimization technique relying on standard methods for local optimization. Our approach has been able to find many new putative optima for the ESA Advanced Concept Team test cases, which in many cases outperform those already known.

■ TC12

Marriott - Los Angeles

Derivative-free Algorithms: Model-based Methods

Cluster: Derivative-free and Simulation-based Optimization

Invited Session

Chair: Stefan Wild, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, IL, 60515, United States of America, wild@mcs.anl.gov

1 - The BOBYQA Algorithm for Bound Constrained Minimization Without Derivatives

Mike Powell, University of Cambridge, United Kingdom, M.J.D.Powell@damtp.cam.ac.uk

The author’s NEWUOA software for unconstrained minimization without derivatives often requires only O(n) values of the objective function when n is large, where n is the number of variables. It is the basis of the new BOBYQA algorithm (Bound Optimization BY Quadratic Approximation) that allows upper and lower bounds on the variables. The differences between NEWUOA and BOBYQA are addressed briefly. Also the robustness of BOBYQA is demonstrated by some numerical examples.

2 - Results on Efficient Methods for Quadratic Model-based Derivative-free Optimization

Giovanni Fasano, Assistant Professor, University Ca’Foscari of Venice, Dipartimento di Matematica Applicata, Ca’ Dolfin - Dorsoduro 3825/E, Venice, 30123, Italy, fasano@dis.uniroma1.it

We consider a general framework for iterative algorithms in Quadratic model-based Derivative Free Optimization (DFO). The essential role of maintaining a suitable geometry in the latter set has been clinched, in order to get convergence. We describe relevant connections between the geometry of the set of points and the overall efficiency of the algorithms. We propose a framework, where possibly interpolation and regression models are suitably combined, in order to improve the efficiency.

3 - Variable Numbers of Interpolation Points in Model-based Algorithms

Stefan Wild, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, IL, 60515, United States of America, wild@mcs.anl.gov, Jorge More’

Several efficient derivative-free algorithms build models of the objective function by interpolating the function on sets of scattered data points. These sets are usually allowed to differ only by a single point from one iteration to the next, the total number of points in the set being fixed. In this talk we explore the effect of allowing the number of interpolation points to vary from iteration to iteration based on the availability of nearby points at which function values are known.

■ TC13

Marriott - Miami

Mathematical Programming Methodologies for Optimizing and Aggregating the Flexibilities of Electricity Demand

Cluster: Optimization in Energy Systems

Invited Session

Chair: Francois Bouffard, University of Manchester, School of Electrical & Electronic Eng, P.O. Box 88, Sackville Street, Manchester, M60 1QD, United Kingdom, francois.bouffard@manchester.ac.uk

1 - Optimizing Electricity Systems to Meet Energy and Environmental Objectives at Least Cost

Mark Barrett, Principal Research Fellow, University College London, Gower St, London, WC1E 6BT, United Kingdom, mark.barrett@ucl.ac.uk

Two methods to optimise low carbon renewable electricity systems are described. First, a hybrid steepest descent and genetic algorithms applied to an electricity system simulation to find least total cost configurations of storage, generation and trade, within a minimum renewable fraction or carbon constraint. Second, the minimization of the operational cost of a given system of demands, storage and generation using a specific system management algorithm. Model results and relevance to policy will be discussed, as will methodological limitations and possible improvements

2 - Aggregated Electricity Load Modeling & Control for Regulation and Load Following Ancillary Services

Duncan Callaway, School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI, 48109, United States of America, dcall@umich.edu

In this talk, stochastic thermostatically controlled loads (TCLs) are modeled with coupled Fokker-Planck equations. Transient dynamics caused by centralized TCL control are explored with a new exact solution to the model. Models parameterized with system identification methods perform slightly better than a theoretical model based on known parameters. Controller performance is demonstrated by causing a population of TCLs to follow a wind plant’s output with minor impact on TCL function.

3 - Optimal Heating or Cooling of a Building Space under Continuous Time Temperature Uncertainty

Sydney Howell, Professor of Financial Management, Manchester Business School, Booth Street West, Manchester, M15 6PB, United Kingdom, s.howell@mbs.ac.uk, Paul Johnson, Peter Duck

A single PDE models the economics and dynamics, in continuous time, of how a building space responds to a stochastic external temperature cycle, and to a heating or cooling system. A quadratic function models user discomfort (during intermittent occupation) and we assume a fixed daily cycle of electricity prices (stepwise or continuous). We can rapidly compute the time-varying optimal temperature control rule (the precision of control varies optimally with variations in the cost of control). We can also rapidly compute a purely physical performance parameter (mean or variance) for any variable over any region of the problem space, plus time to first exit from that region.

■ TC14

Marriott - Scottsdale

Game Theory in Operations Management

Cluster: Game Theory

Invited Session

Chair: Georgia Perakis, MIT, 50 Memorial Drive, Cambridge, MA, United States of America, georgiap@mit.edu

1 - Coalition Stability and Allocation Rules

Mahesh Nagarajan, Assistant Professor, UBC, 2053 Main Mall, Vancouver, BC, V6T1Z2, Canada, mahesh.nagarajan@sauder.ubc.ca

We show an asymptotic duality result that gives sufficient conditions such that notions of dynamic coalitional stability generate stable outcomes that are independent of the allocation rules used to divide a coalition’s profits. We show that several supply chain games satisfy these conditions.

2 - Loss of Welfare in Deregulated Markets: Application to Electricity Markets

Jonathan Kluberg, PhD Candidate, MIT, 1 Amherst St., Cambridge, MA, 02139, United States of America, kluberg@mit.edu, Georgia Perakis

We evaluate the ability of Cournot competition to generate social welfare in an imperfect market with only a few suppliers. We compare the oligopoly case to the monopoly case and to the state-controlled case where a planner manages production and consumption in order to maximize social welfare. Our goal is to

estimate how much welfare is lost through competition compared to the state-planned production, and to provide key indicators to distinguish efficient oligopolies from inefficient ones.

3 - Efficiency and Coordination in a Supply Chain with Competing Manufacturers and Retailers

Victor DeMiguel, Associate Professor, London Business School, Regents Park, London, United Kingdom, avmiguel@london.edu, Elodie Adida

We study a supply chain where multiple manufacturers compete to supply a set of products to multiple risk-averse retailers who compete to satisfy the uncertain demand. For the symmetric case, we show equilibrium existence and uniqueness, give closed-form expressions for the equilibrium, perform comparative statics, and show that revenue-sharing contracts coordinate the decentralized chain. For the asymmetric case, we use numerical optimization to study the impact of asymmetry on the equilibrium.

■ TC15

Gleacher Center - 100

Multi-stage Stochastic Programming

Cluster: Stochastic Optimization
Invited Session

Chair: Suvrajeet Sen, The Ohio State University, 210 Baker Systems Engineering, 1971 Neil Avenue, Columbus, OH, 43210, United States of America, sen.22@osu.edu

1 - An Optimization Framework for Decision Tree Analysis

Jitamitra Desai, Visiting Assistant Professor, Lehigh University, Department of Industrial & Systems Eng., 200 W Packer Avenue, #325 Mohler, Bethlehem, PA, 18015, United States of America, jdesai@lehigh.edu

In this research, we present mathematical models and algorithms for decision tree analysis. First, a mathematical representation of decision trees as a (path-based) polynomial programming problem is presented, and then an equivalent (linear) mixed-integer 0-1 program is derived, which can be efficiently solved using a branch-and-bound method. Recognizing the exponential increase in problem size for large-scale instances, we exploit the special structure of this formulation to also design an efficient globally optimal branch-price-and-cut algorithm. Such a framework allows for the incorporation of new classes of constraints that were hitherto unsolvable in this decision-making context via traditional approaches.

2 - Convex Approximations of a Multiperiod Probabilistically-constrained Model with Random Disruptions

Tara Rengarajan, University of Texas, 1 University Station C2200, Austin, TX, United States of America, tara_rengarajan@mail.utexas.edu., Nedialko Dimitrov, David Morton

We study a convex approximation of a multiperiod probabilistically-constrained program for hedging against random disruptions. We develop an optimal stratified sampling scheme subject to a computational budget, and show this can improve over naive sampling by an order of magnitude in the number of time periods provided the number of disruptions is small. We also consider a robust variant of our model and demonstrate it can be solved by a simple water-filling algorithm.

3 - Multistage Stochastic Decomposition: A Sampling Algorithm for Multistage Stochastic Linear Programs

Zhihong Zhou, University of Arizona, 2519 Indianola Ave. Apt.A, Columbus, OH, 43202, United States of America, zhzhou@email.arizona.edu, Suvrajeet Sen

Multistage stochastic programs (MSP) pose some of the more challenging optimization problems. Usually, this class of problems is computationally intractable even when the random variables in the MSP have finite support. In this paper, we propose a sequential sampling method,the multistage stochastic decomposition algorithm, which is applicable to multistage stochastic linear programs. We present its asymptotic convergence properties as well as preliminary evidence of computational possibilities.

■ TC16

Gleacher Center - 200

Applications of Stochastic Programming

Cluster: Stochastic Optimization
Invited Session

Chair: Michel Gendreau, Universite de Montreal, Pavillon Andre-Aisenstadt, C.P. 6128, succ. Centre-ville, Montreal, QC, H3C 3J7, Canada, michel.gendreau@cirrelt.ca

1 - A Deterministic Heuristic for Stochastic Service Network Design Problems

Michal Kaut, Norwegian University of Science and Technology, Department of Industrial Economics, Trondheim, NO-7491, Norway, michal.kaut@himolde.no, Teodor G. Crainic, Stein W. Wallace

Previously, we had shown that the optimal service network designs in stochastic show qualitative differences from the deterministic designs. On the other hand, real-life stochastic cases are typically impossible to solve. In this talk, we present a heuristic that solves the problem as a deterministic one, but at the same time tries to enforce the properties we know should be present in a stochastic solution.

2 - On Solving a Rapid Transit Network Design Problem via One-stage Stochastic Programming

Laureano Escudero, Professor, Universidad Rey Juan Carlos, c/Tulipan, S/n, Mostoles, Ma, 28933, Spain, laureano.escudero@urjc.es, Susana Munoz

We deal with a modification of the extended rapid transit network design problem to allow the definition of circular lines provided that whichever two stations are linked by one line at most. Given the stochasticity of the number of users for each origin-destination pair of nodes in the network, as well as the construction costs of the stations and the links between them, a one-stage stochastic integer programming model and a scenario analysis based approach for problem solving are presented.

3 - An Exact Algorithm for the Multi-vehicle Routing Problem with Stochastic Demands

Michel Gendreau, Universite de Montreal, Pavillon Andre-Aisenstadt, C.P. 6128, succ. Centre-ville, Montreal, QC, H3C 3J7, Canada, michel.gendreau@cirrelt.ca

We describe an exact branch-and-cut algorithm that is based on the principles of the well-known 0-1 Integer L-shaped procedure to solve the general variant of the Vehicle Routing Problem with Stochastic Demands. A new separation algorithm to find partial route cuts, as well as new cuts derived from the application of the Local Branching heuristic of Fischetti and Lodi will be presented. Computational results will show the effectiveness of the new algorithm.

■ TC17

Gleacher Center - 204

Network Games and Mechanisms

Cluster: Logistics and Transportation
Invited Session

Chair: Ozlem Ergun, Associate Professor, Georgia Tech, School of Industrial & Systems Engineeri, 765 Ferst Drive, Atlanta, GA, 30332, oergun@isye.gatech.edu

Co-Chair: Luyi Gui, Georgia Tech, School of Industrial & Systems Engineeri, 765 Ferst Drive, Atlanta, GA, 30332, lgui3@isye.gatech.edu

1 - Pricing with Markups under Horizontal and Vertical Competition

Roger Lederman, Columbia Business School, Uris Hall, New York, United States of America, rlederman13@gsb.columbia.edu, Jose Correa, Nicolas Stier-Moses

We model a market for a single product that may be composed of sub-products that face horizontal and vertical competition. Each firm, offering all or some portion of the product, adopts a price function proportional to its costs by deciding on the size of a markup. Customers then choose a set of providers that offers the lowest total cost. We characterize equilibria of the two-stage game and study the efficiency resulting from the competitive structure of the market.

2 - Wardrop Equilibria versus Equilibria of Atomic Splittable Flow Games

Umang Bhaskar, Dartmouth College, Sudikoff Lab: HB 6211, Hanover, NH, 03755, United States of America, umang@cs.dartmouth.edu, Lisa Fleischer, Chien-Chung Huang

We study flow games where each player routes a fixed amount of flow in a network with delays on the edges, to minimize the average delay of his flow. If players have different sources and destinations, the total delay of an equilibrium flow could be worse than that of the corresponding Wardrop equilibrium. We show that if all players have the same source and destination, and the graph is series-parallel, the total delay of an atomic equilibrium is bounded by that of the Wardrop equilibrium.

3 - On a Collaborative Mechanism Based on Exchange Prices in Multicommodity Flow Networks

Luyi Gui, Georgia Tech, School of Industrial & Systems Engineeri, 765 Ferst Drive, Atlanta, GA, 30332, lgui3@isye.gatech.edu, Ozlem Ergun

Given a multicommodity network where edge capacities and commodities are privately owned by individuals, we design a collaborative mechanism based on capacity exchange prices so as to subtly regulate the selfish behaviours of the players. We study the stability and efficiency of such price mechanisms and the fairness of the resulting payoff allocations among players in terms of cooperative game theory. We also consider the robustness of the mechanism by characterizing the system equilibria under data uncertainties.

■ TC18

Gleacher Center - 206

Recent Progress in the Solution of Quadratic Assignment Problems II

Cluster: Nonlinear Mixed Integer Programming
Invited Session

Chair: Hans Mittelmann, Professor, Arizona State University, School of Math and Stat Sciences, P.O. Box 871804, Tempe, AZ, 85287-1804, United States of America, MITTELMANN@asu.edu

1 - An Algorithm for the Cross-dock Door Assignment Problem

Ying Liu, Graduate Student, University of Pennsylvania, Moore School, 3451 Walnut Street, Philadelphia, PA, 19104, United States of America, liuying1@seas.upenn.edu, Monique Guignard-Spielberg, Guilherme Henrique, Bum-Jin Kim, Soumya Rajamani, Peter Hahn, Artur Pessoa

In a crossdock facility, goods are moved from doors for incoming trucks to doors for outgoing trucks. Labor and energy costs may be minimized by properly assigning incoming doors to incoming trucks and outgoing doors to outgoing trucks. We present the problem as a Generalized Quadratic 3-dimensional Assignment Problem. Using artificially generated origin-destination flows of trucked goods, we then compare two exact and one approximate solution algorithm at a small and a medium size crossdock.

2 - A Comparison of Lower Bounds for the Symmetric Circulant Traveling Salesman Problem

Cristian Dobre, Tilburg University, Warandelaan 2, Tilburg, 5000 LE, Netherlands, c.dobre@uvt.nl, Etienne de Klerk

When the matrix of distances between cities is symmetric and circulant the traveling salesman problem,TSP, reduces to the so called symmetric circulant traveling salesman problem,SCTSP; whose complexity is open.We consider a new LP relaxation of the SCTSP.We show how to derive this new LP relaxation from a semidefinite programming relaxation proposed by de Klerk et al ,2008.We present theoretical and empirical comparisons between this new bound and three well known bounds from the literature.

3 - GRASP-PR for the GQAP

Ricardo Silva, Federal University of Lavras, Campus Universitario CP 3037 Lavras MG, Lavras, 07901, Brazil, ricardo.mabreu@gmail.com, Mauricio G. C. Resende, Geraldo Mateus

The generalized quadratic assignment problem (GQAP) is a generalization of the NP-hard quadratic assignment problem (QAP) that allows multiple facilities to be assigned to a single location as long as the capacity of the location allows. In this paper, we propose several GRASP with path-relinking heuristics for the GQAP using different construction, local search, and path-relinking procedures.

■ TC19

Gleacher Center - 208

Nonlinear Programming F

Contributed Session

Chair: Adilson Elias Xavier, Professor, Federal University of Rio de Janeiro, Av. Horacio Macedo, 2030, Centro de Tecnologia - PESC - Bloco H, Rio de Janeiro, 21941-914, Brazil, adilson@cos.ufrj.br

1 - Asymptotic Properties of the Method of Centers

Jean-Pierre Dussault, Sherbrooke University, Departement d'informatique, Sherbrooke, J1K 2R1, Canada, Jean-Pierre.Dussault@USherbrooke.ca

The so called center method of Pierre Huard, as well as the famous logarithmic barrier algorithm were important inspirations in the developments of the interior point methods. To complement numerous complexity results, we address in this talk some asymptotic properties of those methods, including comparisons of their parametrization of the so called central path, and asymptotic convergence results in the context of non linear (non convex) optimization.

2 - Weighted Low-rank Approximations

Nicolas Gillis, Universite Catholique de Louvain, Voie du Roman Pays, 34, Louvain-la-Neuve, 1348, Belgium, nicolas.gillis@uclouvain.be, Francois Glineur

Weighted low-rank approximation (WLRA) is a data analysis technique with applications in collaborative filtering and computer vision. We prove NP-hardness of WLRA using a reduction of the Maximum Edge Biclique Problem (MBP). PCA with missing data is a particular instance of WLRA and its NP-hardness is proved as well. As a side result, a simple biclique finding algorithm is presented. Finally, we propose a new efficient algorithm based on the alternating minimization of each rank-one factor.

3 - The Hyperbolic Smoothing Approach for Solving Clustering Problems

Adilson Elias Xavier, Professor, Federal University of Rio de Janeiro, Av. Horacio Macedo, 2030, Centro de Tecnologia - PESC - Bloco H, Rio de Janeiro, 21941-914, Brazil, adilson@cos.ufrj.br, Vinicius Layter Xavier

The minimum sum-of-squares clustering problem is considered, which in addition to its intrinsic bi-level nature, has the characteristic of being nondifferentiable. To overcome these difficulties, the resolution method proposed adopts a smoothing strategy. The final solution is obtained by solving a sequence of low dimension differentiable unconstrained optimization subproblems which gradually approach the original problem. Two algorithms with a set of computational experiments are presented.

■ TC20

Gleacher Center - 300

Nonlinear Programming: Methods

Cluster: Nonlinear Programming
Invited Session

Chair: Annick Sartenaer, Professor, University of Namur (FUNDP), Rempart de la Vierge, 8, Namur, B-5000, Belgium, annick.sartenaer@fundp.ac.be

Co-Chair: Sven Leyffer, Argonne National Laboratory, MCS Division 9700 South Cass Avenue, Argonne, IL, 60439, United States of America, leyffer@mcs.anl.gov

1 - Stopping Criteria for Bound-constrained Optimization Problems

Serge Gratton, CNES-CERFACS, 18 avenue E.Belin, Toulouse, France, Serge.Gratton@cerfacs.fr, Philippe Toint, Melodie Mouffe

Iterative algorithms for non-quadratic optimization problems often generate a sequence of iterates that converges to a point that is at least first order critical. When computing an iterate is costly, as it is often the case for large scale applications, it is crucial to stop the iterations as soon as the solution is of a reasonable quality. We apply backward error techniques to bound-constrained problems with errors in the data. This provides us with new interpretations for existing criticality measures based on the notion of projected gradient, and enable us to define a family of meaningful stopping criteria. These new concepts will be illustrated on academic problems mainly arising in the domain of calculus of variations.

2 - A Trust-region SQP-filter Algorithm for Constrained Optimization Problems with Expensive Functions

Alexander Thekale, University of Erlangen-Nuremberg, Martensstr. 3, Erlangen, 91058, Germany, thekale@am.uni-erlangen.de, Philippe Toint, Kathrin Klamroth

We present an algorithm for nonlinear constrained optimization problems which depend on the outcome of expensive functions. This general problem formulation encloses a large variety of problems including, e.g., simulation based problems. Our algorithm combines derivative-free techniques with filter trust-region methods to keep the number of expensive function evaluations low. Under adequate assumptions, we show global convergence to a feasible point. Numerical results stress the applicability of this method.

3 - Adaptive Multilevel Methods for Large Scale Nonlinear Optimization

Stefan Ulbrich, Technische Universitaet Darmstadt, Fachbereich Mathematik, Schlossgartenstr. 7, Darmstadt, 64289, Germany, ulbrich@mathematik.tu-darmstadt.de, J. Carsten Ziems

Many large scale NLPs result from discretization of an infinite-dimensional problem and admit a hierarchical approximation. This can be used to solve them efficiently. We present a framework for inexact adaptive multilevel SQP methods that generate a hierarchy of adaptively refined discretizations by using error estimators and control the accuracy of iterative solvers. We discuss the practical implementation (error estimators, etc.) for PDE-constrained problems. Numerical results are presented.

■ TC21

Gleacher Center - 304

Optimization Models for Planning and Risk Management in Telecom

Cluster: Telecommunications and Networks

Invited Session

Chair: Alexei Gaivoronski, Professor, NTNU, Alfred Getz vei 2, Trondheim, 7491, Norway, alexei.gaivoronski@iot.ntnu.no

1 - Stochastic Optimization for Risk Moderated Planning of Service Provision in Telecom

Alexei Gaivoronski, Professor, NTNU, Alfred Getz vei 2, Trondheim, 7491, Norway, alexei.gaivoronski@iot.ntnu.no

In this paper we develop optimization based quantitative tools for planning of service provision of different collaborating and competing constellations of business actors. The objective is to strike a balance between profitability and risk, acceptable for all involved parties. These methods are based on the notions of modern investment theory and risk management and use advances in decision support under uncertainty, in particular stochastic optimization.

2 - Optimization Tools for Business Model Evaluation for an Advanced Multimedia Service Portfolio

Paolo Pisciella, PhD Student, NTNU, Alfred Getz vei 2, Trondheim, Norway, Paolo.Pisciella@iot.ntnu.no, Josip Zoric, Alexei Gaivoronski

We use the optimization methodology for evaluation of business models for the collaborative provision of mobile data service portfolio composed of three services: Video on Demand, Internet Protocol Television and User Generated Content. We provide a description of the provision system considering the relation occurring between technical and business aspects for each agent. Such analysis is then projected into optimization model dealing with the problem of the definition of incentives.

3 - An Iterative Scheme for the Stochastic Bilevel Linear Problem

Pierre Le Bodic, PhD Student, Universite de Paris Sud, LRI, Bat 490, Orsay, France, lebodic@lri.fr, Stefanie Kosuch, Janny Leung, Abdel Lisser

We propose an iterative linear scheme to solve the bilevel linear problem with stochastic knapsack constraints. This kind of problem arises in particular in telecommunication markets. The problem is reformulated as a Global Linear Complementary Problem. Finally, we propose an iterative scheme between two linear problems derived from the GLCP to practically solve the original problem. We perform numerical experiments on synthetic data and compare it with state-of-the-art techniques.

■ TC22

Gleacher Center - 306

Software for Topology and Material Optimization

Cluster: Implementations, Software

Invited Session

Chair: Michael Stingl, University of Erlangen, Martensstr. 3, Erlangen, 91338, Germany, stingl@am.uni-erlangen.de

1 - A Gradient Method for Free Material Design

Yu Xia, University of Birmingham, Watson Building, Edgbaston, Birmingham, United Kingdom, xiay@maths.bham.ac.uk, Yurii Nesterov, Michal Kocvara

We give a new formulation of the free material design problem. Analysis and numerical examples show that our algorithm works on large-scale problems.

2 - PLATO-N - A Software System for Free Material and Topology Optimization Problems

Stefanie Gaile, Institute of Applied Mathematics 2, Department Mathematics, University Erlangen-Nuernberg, Martensstr. 3, Erlangen, 91058, Germany, Stefanie.Gaile@am.uni-erlangen.de, Michael Stingl, Guenter Leugering

PLATO-N is a software platform dedicated to topology optimization incorporating large-scale Free Material Optimization (FMO) and Mixed Integer programming methods. We introduce multidisciplinary FMO models which can be represented by large-scale nonlinear semidefinite programs and discuss novel optimization methods for the solution of the same. We demonstrate the capabilities of PLATO-N by means of challenging optimization problems arising from the field of aircraft component design.

3 - Interpretation of Free Material Optimization Results

Gabor Bodnar, RISC Software GmbH, Softwarepark 35, Hagenberg, A-4232, Austria, Gabor.Bodnar@risc.uni-linz.ac.at

In FMO, the resulting materials are described by their elasticity tensors and they virtually never correspond to any real material. Thus post-processing is necessary to gain insight to the properties of the optimal material, with the aim of coming up manufacturable approximates. The program “Free Material Studio” provides a palette of visualization and interpretation tools to help the engineers in the interpretation process.

■ TC23

Gleacher Center - 308

Convex Optimization in Machine Learning

Cluster: Sparse Optimization

Invited Session

Chair: Katya Scheinberg, Columbia University, Mudd Bldg, 500 W 120th Street, New York, NY, 10027, United States of America, katyascheinberg@gmail.com

1 - More Data Less Work: Optimization Runtime from a Machine Learning Perspective

Nathan Srebro, TTI-Chicago, 6045 S. Kenwood Ave., Chicago, IL, 60637, United States of America, nati@uchicago.edu

I will discuss why it is important to understand optimization runtime from a machine learning perspective. From this perspective, runtime should monotonically DECREASE, not increase, with data set size. This is not the case for standard convex optimization approaches. I will demonstrate how such decreasing behavior can be achieved, and why from a machine learning perspective, poorly converging algorithms are often empirically, and theoretically, faster.

2 - Partial Order Embedding with Multiple Kernels

Gert Lanckriet, UCSD, 9500 Gilman Drive, La Jolla, CA, 92093, United States of America, gert@ece.ucsd.edu

We embed arbitrary objects into a Euclidean space subject to a partial order over pairwise distances. Such constraints arise naturally when modeling human perception of similarity. Our partial order framework uses graph-theoretic tools to more efficiently produce the embedding and exploits global structure within the constraint set. Our algorithm is based on semidefinite programming and can be parameterized by multiple kernels to yield a unified space from heterogeneous features.

3 - SINCO: Sparse Inverse Covariance Selection Algorithm

Katya Scheinberg, Columbia University, Mudd Bldg, 500 W 120th Street, New York, NY, 10027, United States of America, katyascheinberg@gmail.com

We will present a simple block-coordinate descent algorithm for sparse inverse covariance selection problem. The algorithm exploits sparsity of the solution that we seek. Also this algorithm can be applies to other large-scale SPD problems where the solution is known or expected to be sparse. For instance to can be applies to the the dual formulation of the matrix completion problem.

■ TC25

Gleacher Center - 404

Variational and Convex Analysis Techniques for Problems Involving Dynamics

Cluster: Variational Analysis
Invited Session

Chair: Rafal Goebel, Loyola University Chicago, 6525 N. Sheridan Road, Department of Mathematics and Statistics, Chicago, IL, 60626, United States of America, rafal.k.goebel@gmail.com

1 - Best Response Dynamics for Nonconvex Continuous Games

E.N. Barron, Professor, Loyola University Chicago, Department of Mathemtics, Damen Hall 317, Chicago, IL, 60626, United States of America, enbarron@gmail.com, Rafal Goebel, Robert Jensen

We consider the continuous payoff zero sum game in which the payoff for the maximizing player may not be concave and the payoff for the minimizing player may not be convex. The Best Response Dynamics is a coupled system of differential inclusions which results in a dynamical system. We prove that under some almost necessary conditions, the long term limit of the trajectories of the Best Response Dynamics converges to a saddle point of the payoff function.

2 - Fully Convex Control

Peter Wolenski, Louisiana State University, Department of Mathematics, Baton Rouge, LA, 70803, United States of America, wolenski@math.lsu.edu

We will survey variational problems with joint convexity assumptions, and describe recent results involving systems with time-dependent data, impulses, and self-dual approximations. An application of the theory to tracking problems will also be presented.

3 - Duality and Uniqueness of Convex Solutions to Stationary Hamilton-Jacobi Equations

Rafal Goebel, Loyola University Chicago, 6525 N. Sheridan Road, Department of Mathematics and Statistics, Chicago, IL, 60626, United States of America, rafal.k.goebel@gmail.com

The talk focuses on convex optimal control and calculus of variations problems on the infinite time horizon. Characterizations of the optimal value function as the unique convex solution to a stationary Hamilton-Jacobi PDE and as a convex conjugate of the value function for the dual problem are given. Consequences for the regularity of the value function and of the optimal feedback mapping are deduced. Applications of the duality techniques to a constrained linear-quadratic regulator and to the problem of feedback stabilization of a control system with saturation nonlinearities are shown.

■ TC27

Gleacher Center - 408

Stochastic Programming and Equilibrium Systems

Cluster: Variational Analysis
Invited Session

Chair: Jane Ye, Professor, University of Victoria, Department of Math and Stats, P.O. BOX 3060 STN CSC, Victoria, BC, V8P 5C2, Canada, janeye@math.uvic.ca

1 - Existence, Stability and Error Bounds for Set-valued Variational Inequalities

Didier Aussel, University de Perpignan, 52 Avenue Paul Alduy, Perpignan, F-66860, France, aussel@univ-perp.fr

We will concentrate on Stampacchia variational inequalities defined by set-valued map. For those problems we will present new existence results, stability properties and also investigate the Aubin property and metric regularity of the solution map. Finally error bounds will be proposed thanks to adapted versions of gap function.

2 - Necessary Optimality Conditions for Stochastic Programs with Equilibrium Constraints

Jane Ye, Professor, University of Victoria, Department of Math and Stats, P.O. Box 3060 STN CSC, Victoria, BC, V8P 5C2, Canada, janeye@math.uvic.ca

We present a necessary optimality condition for a two-stage stochastic mathematical program with equilibrium constraints where the second stage problem has multiple equilibria/solutions. We obtain the result by extending a formula about the exchange of limiting subdifferential operator with Aumann's integration in a general setting and applying the result together with the existing sensitivity analysis results on value function on deterministic MPEC.

3 - Uniform Exponential Convergence of Sample Average Random Functions and Applications

Huifu Xu, Senior Lecturer, University of Southampton-Highfield, School of Mathematics, Southampton, SO17 1BJ, United Kingdom, H.Xu@soton.ac.uk

We derive the uniform exponential convergence of the sample average of a class of lower semicontinuous random functions under general sampling and apply it to analyze the convergence of the sample average approximation method for solving nonsmooth stochastic minimization problems. Exponential convergence of estimators of both optimal solutions and stationary points (characterized by the limiting subgradients) are established. We also use the unform convergence result to establish the exponential rate of convergence of statistical estimators of a stochastic Nash equilibrium problem and estimators of the solutions to a stochastic generalized equation problem.

■ TC28

Gleacher Center - 600

Proximal Algorithms and Related Topics

Cluster: Nonsmooth and Convex Optimization
Invited Session

Chair: Jerome Bolte, Universite Pierre et Marie Curie, 4, place Jussieu, 75252 Paris, Cedex 05, France, bolte@math.jussieu.fr

1 - The Geometry of the Proximal Algorithm with Bregman Distances and Related Variable-metric Methods

Felipe Alvarez, Associate Professor, University of Chile, Santiago, 8370448, Chile, falvarez@dim.uchile.cl

Following an original idea of Karmarkar in a different context, we will show how to derive a continuous-in-time model for the proximal point algorithm with Bregman distances. This turns out to be a gradient-type flow on the relative interior of the constraint set endowed with a variable metric structure. We will explain why Bregman distances are necessary for keeping some fundamental properties of the classical unconstrained gradient flow. We will show how to exploit such properties to obtain global convergence results for related iterative algorithms. Finally, we will discuss briefly some specializations to proximal methods for SDP and rescaled gradient methods for traffic equilibrium problems.

2 - Dual Convergence for Penalty Proximal Point Algorithms in Convex Programming

Thierry Champion, Assistant Professor, Universite du Sud Toulon-Var, Avenue de l'Universite - BP20132, LA GARDE cedex, 83957, France, champion@univ-tln.fr, Felipe Alvarez, Miguel Carrasco

We consider an implicit iterative method in convex programming which combines inexact variants of the proximal point algorithm with parametric penalty functions. From this iterative method we obtain a multiplier sequence which is explicitly computed in terms of the generated primal sequence. In this talk, we show the convergence of the whole multiplier sequence to a particular solution of the dual problem under fairly general hypotheses, and provide some numerical illustrations.

3 - Proximal Algorithms for Semi-algebraic Functions

Jerome Bolte, Universite Pierre et Marie Curie, 4, Place Jussieu, 75252 Paris, Cedex 05, France, bolte@math.jussieu.fr

We shall discuss the convergence properties of the proximal algorithm and similar dynamics in a semi-algebraic/tame setting. These properties are related to the Lojasiewicz inequalities and to its various reformulations. Some alternating algorithms involving nonconvex aspects will also be evoked.

Wednesday, 10:30am - 12:00pm

■ WA01

Marriott - Chicago A

On the Approximability of Scheduling and Resource Allocation Problems

Cluster: Approximation Algorithms
Invited Session

Chair: Andreas Schulz, Massachusetts Institute of Technology, E53-357, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States of America, schulz@mit.edu

1 - (Acyclic) Job Shops Are Hard to Approximate

Monaldo Mastrolilli, IDSIA, Galleria 2, Manno, Switzerland, monaldo@idsia.ch, Ola Svensson

We consider the approximability of the notorious job and flow shop scheduling problems. We close a major open problem in scheduling theory by providing stronger inapproximability results for job shops and for the general version of flow shops, where jobs are not required to be processed on each machine.

2 - (Almost Always) Near-optimal Solutions for Single-machine Precedence-constrained Scheduling

Nelson Uhan, Assistant Professor, Purdue University, 315 N. Grant Street, Grissom Hall 262, West Lafayette, IN, 47907, United States of America, nuhan@purdue.edu, Andreas Schulz

We study the classic single-machine precedence-constrained scheduling problem with the weighted sum of completion times objective. In particular, we study so-called 0-1 bipartite instances of this problem, whose approximability is virtually identical to the approximability of arbitrary instances (Woeginger 2003). We show various “almost all”-type results for these instances, including that almost always, all feasible schedules are arbitrarily close to optimal.

3 - An FPTAS for the Santa Claus Problem with a Fixed Number of Agents and Related Problems

Shashi Mittal, Massachusetts Institute of Technology, E40-131 Operations Research Center, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States of America, mshashi@MIT.EDU, Andreas Schulz

We present a novel framework for designing fully polynomial-time approximation schemes for a wide variety of resource allocation, scheduling and other combinatorial optimization problems, including the Santa Claus problem with a fixed number of agents.

■ WA02

Marriott - Chicago B

Linear Programs with Complementarity Constraints: Applications and Algorithms

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: John Mitchell, Professor, Rensselaer Polytechnic Institute, Math Sciences, 325 Amos Eaton, 110 8th St, Troy, NY, 12180, United States of America, mitchj@rpi.edu

1 - Finding a Global Optimum In Cross-validated Support Vector Machine

Yu-Ching Lee, IESE, Univ. of Illinois at Urbana-Champaign, 117 Transportation Bldg., 104 S. Mathews, Urbana, IL, 61801, United States of America, ylee77@illinois.edu, Kristin Bennett, John Mitchell, Jong-Shi Pang

Formulated as a convex quadratic program with 2 key parameters (the regularization parameter and the tube size), the cross-validated support vector machine (SVM) is a well-known statistical method for data classification and regression. We investigate the optimal choice of these 2-parameters via a bilevel programming approach applied in a set of training data and the testing data. Various approaches for finding a global minimum of this non-convex bilevel program are discussed.

2 - A Disjunctive Programming Approach to LPCC

Bin Yu, Graduate Student, Rensselaer Polytechnic Institute, CII 5015, 110 Eighth Street,, Troy, NY, 12180, United States of America, yub@rpi.edu, Jing Hu, John Mitchell, Jong-Shi Pang

A linear program with complementarity constraints (LPCC) can be modeled as a disjunctive program. By imposing one pair of disjunctive constraints at a time, we are able to use a cut generating LP to generate a disjunctive cut for the LPCC problem. We present a branch and cut algorithm to globally solve the LPCC problem, where the cutting planes are disjunctive cuts. The algorithm is able to characterize infeasible and unbounded LPCC problems as well as solve problems with finite optimal value.

3 - An LPCC Approach to Indefinite Quadratic Programs

John Mitchell, Professor, Rensselaer Polytechnic Institute, Math Sciences, 325 Amos Eaton, 110 8th St, Troy, NY, 12180, United States of America, mitchj@rpi.edu, Jing Hu, Jong-Shi Pang

The best KKT point for a quadratic program (QP) can be found by solving a linear program with complementarity constraints (LPCC). We show that determining whether a QP has a finite optimal value can also be resolved using an LPCC formulation. We describe cuts based on second order optimality conditions that can be used to tighten the LPCC formulation. We exploit the second order cuts to show that certain classes of nonconvex quadratic programs can be solved in polynomial time.

■ WA03

Marriott - Chicago C

Conic Complementarity Problems II

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Akiko Yoshise, University of Tsukuba, Graduate School of, Systems and Information Engineering, Tsukuba Ibaraki, 305-8573, Japan, yoshise@sk.tsukuba.ac.jp

1 - A Continuation Method for Nonlinear Complementarity Problems over Symmetric Cone

Chek Beng Chua, Assistant Professor, Nanyang Technological Univerity, Sch of Phy & Math Sci / Div of Math Sci, 21 Nanyang Link, Singapore, 637371, Singapore, cbchua@ntu.edu.sg, Peng Yi

We introduce a new P-type property for nonlinear functions defined over Euclidean Jordan algebras, and study a continuation method for nonlinear complementarity problems over symmetric cones. This new P-type property represents a new class of nonmonotone nonlinear complementarity problems that can be solved numerically.

2 - Homogeneous Cone Complementarity Problems and P Properties

Lingchen Kong, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, konglchen@126.com, Levent Tuncel, Naihua Xiu

This talk aims to present existence and uniqueness properties of a solution to homogeneous cone complementarity problem (HCCP). We prove that if a continuous function has either the order-P0 and R0, or the P0 and R0 properties then the associated HCCPs have solutions. If it has the trace-P property then the associated HCCP has a unique solution. A necessary condition for the GUS property is presented. We give some applications about our results.

3 - On Interior Point Trajectories for Conic Complementarity Problems

Akiko Yoshise, University of Tsukuba, Graduate School of, Systems and Information Engineering, Tsukuba Ibaraki, 305-8573, Japan, yoshise@sk.tsukuba.ac.jp

We will discuss some theoretical aspects of a class of complementarity problems over symmetric cones in terms of interior point maps, interior point trajectories and their limiting behavior. The class includes monotone complementarity problems over nonnegative orthants, second-order cones and semideinite matrix cones.

■ WA04

Marriott - Denver

Combinatorial Optimization D

Contributed Session

Chair: Yazgi Tutuncu, Doctor, IESEG School of Management, 3 Rue de la Digue, Lille, France, y.tutuncu@ieseg.fr

1 - An Exact Algorithm for the Pickup and Delivery Problem with Time Windows

Enrico Bartolini, Department of Computer Science, University of Bologna, Via Sacchi 3, Cesena, FC, 47521, Italy, ebartoli@cs.unibo.it, Aristide Mingozzi, Roberto Baldacci

We present an exact method for the Pickup and Delivery Problem with Time Windows (PDPTW) based on a set partitioning-like formulation with additional cuts. The algorithm uses column-and-cut generation to compute a dual solution that is used to generate a reduced integer problem. If it has moderate size, it is solved using CPLEX; otherwise, it is solved by branch-and-cut-and-price. Computational results on benchmark instances show that the new method outperforms the currently best known method.

2 - An Exact Method for the Double TSP with Multiple Stacks

Richard Lusby, Technical University of Denmark, Department of Management Engineering, Lyngby, 2800, Denmark, rmlu@man.dtu.dk, Jesper Larsen, Matthias Ehrgott, David Ryan

The double travelling salesman problem with multiple stacks is a pickup and delivery problem in which all pickups must be completed before any deliveries can be made. A solution consists of two tours and a stacking plan for the container (which cannot be re-packed) that is used for the delivery. We present an exact solution method based on matching k-best TSP solutions for each of the separate pickup and delivery TSP problems. Computational results confirm the efficiency of this methodology.

3 - Optimization Approaches to Bed Capacity Planning Problem in Hospital Management

Yazgi Tutuncu, Doctor, IESEG School of Management, 3 Rue de la Digue, Lille, France, y.tutuncu@ieseg.fr, Ceki Franko, Femin Yalcin, Murat Ozkut

Bed capacity planning is an important management subject for hospitals that should be considered in order to satisfy the needs of patients,organize departments and improve the service quality.In this study, an application of the bed capacity planning problem is presented and different types of solution techniques such as branch-and-bound method, M/M/s algorithm, and Genetic Algorithm are proposed.The comparison of these techniques has been given to illustrate the efficiencies of these methods.

■ WA05

Marriott - Houston

Combinatorial Optimization S

Contributed Session

Chair: Myoung-Ju Park, Seoul National University, San 56-1 Shilim-Dong, Kwanahk Gu, Seoul, 151-742, Korea, Republic of, pmj0684@snu.ac.kr

1 - Unmanned Aerial Vehicle Routing with Limited Risk

Siriwat Visoldilokpun, Kasikorn Bank, 1 Soi. Kasikornthai, Radburana Rd., Bangkok, 10140, Thailand, siriwatvi@yahoo.com, Dr. Jay Rosenberger

We study Unmanned Aerial Vehicle routing problem with limited risk (URPR) in which considered risk is a fuel burn variation. The URPR is modeled as a set-partitioning problem with a quadratic variance constraint. However the quadratic constraint is simplified to a single linear constraint. We discuss URPR with time windows (URPRTW) and URPR without time windows (URPR) and present algorithms in Branch-and-Cut-and-Price (BCP) methodology in which variables with negative reduced costs are generated and added in the pricing step, and minimum dependent set (MDS) constraints are generated in the cutting step to encourage solution‚Äôs integrality. Computational experiments show that medium-sized URPRTWs and small-sized URPRs were solved optimally.

2 - An Exact Method for the Minimum Caterpillar Spanning Problem

Luidi Simonetti, Institute of Computing (IC) - University of Campinas (UNICAMP), Caixa Postal 6176, Campinas, SP, 13083-970, Brazil, luidi@ic.unicamp.br, Cid de Souza, Yuri Frota

A spanning caterpillar in a graph is a tree which has a path such that all vertices not in the path are leaves. In the Minimum Spanning Caterpillar Problem (MSCP) each edge has two costs: a path cost when it belongs to the path and a connection cost when it is incident to a leaf. The goal is to find a spanning caterpillar minimizing the sum of all path and connection costs. Here we formulate the MSCP as a minimum Steiner arborescence problem. This reduction is the basis for the development of an efficient branch-and-cut algorithm for the MSCP. Computational experiments carried out on modified instances from TSPLib 2.1 revealed that the new method is capable to solve to optimality MSCP instances with up to 300 nodes in reasonable time.

3 - Approximation Algorithm for the Capacitated Set Cover Problem

Myoung-Ju Park, Seoul National University, San 56-1 Shilim-Dong, Kwanahk Gu, Seoul, 151-742, Korea, Republic of, pmj0684@snu.ac.kr, Yun-Hong Min, Sung-Pil Hong

The capacitated set cover problem consists of a set of items and a collection of sets of items. Each item has a demand which can be split into sets that contain it. Each set cannot receive a total demand exceeding its capacity. The goal is to find a minimum size set cover. When the maximum size of sets, k, is fixed, we suggest a (1/2+H_k)-approximation algorithm where H_k=1+1/2+...+1/k. For the case k=2, we show that the problem is Max-SNP-hard and develop a 3/2-approximation algorithm.

■ WA06

Marriott - Kansas City

Computational Game Theory

Cluster: Conic Programming

Invited Session

Chair: Javier Pena, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States of America, jfp@andrew.cmu.edu

1 - Constructing “Nice” Prox Functions for Sets Arising from a Class of Multistage Optimization Problems

Samid Hoda, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States of America, shoda@andrew.cmu.edu, Andrew Gilpin, Javier Pena

A nice prox function for a convex set is any strongly convex function over the set with an easily computable conjugate. We present a procedure for constructing nice prox functions for polytopes arising from a class of multistage optimization problems. Certain parameters in the construction directly affect the quality of the prox function for use in first-order smoothing methods. We show how to set the parameters to achieve practical iteration complexities when solving very large-scale problems.

2 - On the Computation of Nash Equilibria of Sequential Games

Javier Pena, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States of America, jfp@andrew.cmu.edu, Tuomas Sandholm, Samid Hoda, Andrew Gilpin

We describe specialized algorithms for saddle-point problems arising in the Nash equilibrium of two-person, zero-sum sequential games. For sequential games with multiple rounds, the saddle-point formulations are immense but highly structured. By taking advantage of key structural features, our algorithms achieve unmatched computational performance as well as strong theoretical complexity results.

3 - Automated Abstraction and Equilibrium-finding Algorithms for Sequential Imperfect Information Games

Andrew Gilpin, gilpin@cs.cmu.edu, Javier Pena, Samid Hoda, Tuomas Sandholm

I will discuss three abstraction classes for sequential imperfect information games: information abstraction, action abstraction, and stage abstraction. In the context of poker, I will describe how our abstraction algorithms, in conjunction with our specialized equilibrium-finding algorithms based on non-smooth convex optimization and sampling, successfully created competitive game theory-based agents.

■ WA07

Marriott - Chicago D

Integer and Mixed Integer Programming D

Contributed Session

Chair: H.Paul Williams, Professor, London School of Economics, Houghton Street, London, WC2A2AE, United Kingdom, h.p.williams@lse.ac.uk

1 - Engagement Planning in Sequence Dependant Cost Structures

Kristian Lundberg, Linkoping University, Olaus Magnus, Linkoping, Sweden, krlun@mai.liu.se

Sequence dependant cost structures(SDCS) covers a very complex combinatorial problem related to sequencing and allocation problems, such as VRP and multiple TSP. However SDCS also covers mutual and cooperative dependencies between nodes. This functionality is implemented in the cost structure. The presentation will focus on suitable solving methods such as decomposition techniques. Related applications to the SDCS problem can be found in planning of military and civil security operations.

2 - The Chvatal Dual of a Pure Integer Programme

H.Paul Williams, Professor, London School of Economics, Houghton Street, London, WC2A2AE, United Kingdom, h.p.williams@lse.ac.uk

We give a graphical way of representing Chvatal functions. Also we will show some limited ways in which they can be simplified by removing unnecessary rounding operations. A method of calculating Chvatal functions for an IP over acone will be given. Finally it will be shown that when the rounding operations are removed from a Chvatal function it may correspond to extreme or interior points of the dual LP polytope.

■ WA08

Marriott - Chicago E

Trends in Mixed Integer Programming VI

Cluster: Integer and Mixed Integer Programming

Invited Session

Chair: Robert Weismantel, Professor, Otto-von-Guericke University Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, weismant@mail.math.uni-magdeburg.de

Co-Chair: Andrea Lodi, DEIS, University of Bologna, Viale Risorgimento, 2, Bologna, 40136, Italy, andrea.lodi@unibo.it

1 - Grammar-based Integer Programing Models for Multi-activity Shift Scheduling

Louis-Martin Rousseau, Professor, Ecole Polytechnique de Montreal, CP 6079 Succ Centre-Ville, Montreal, H3C 3A7, Canada, louis-martin.rousseau@polymtl.ca, Bernard Gendron, Marie-Claude Cote

This paper presents an implicit formulation for shift scheduling problems, using context-free grammars to model restrictions in the planning of shifts. From the grammar, we generate an IP model allowing the same set of shifts as Dantzig's set covering model. While solving times on small instances are comparable to other implicit compact models in the literature, on instances where a lot of shifts is allowed, our method is more efficient and can encode a larger set of constraints. Among others, work stretch restrictions as well as multi-activity cases can easily be modeled with grammars. We present comparative experimental results on a both known and new shift scheduling problems.

2 - Core Concepts for Multidimensional Knapsack Problems

Ulrich Pferschy, Professor, University of Graz, Dept. of Statistics and Operations Research, Universitaetsstr. 15, Graz, 8010, Austria, pferschy@uni-graz.at, Jakob Puchinger, Guenther Raidl, Martin Nussbaumer

A classical approach for the 0-1 knapsack problem identifies items with high efficiency and packs them into the knapsack, while leaving items with low efficiency unpacked. A relatively small core problem remains to be solved consisting of items with intermediate efficiency and a residual knapsack capacity. We study the core concept for the multidimensional knapsack problem and discuss the choice of the efficiency measure, the influence of different core sizes and the behavior of CPLEX and an evolutionary algorithm for solving the core problem. We also present a so-called squeaky wheel heuristic which turns out to be quite effective in complementing a core constructed by classical efficiencies. Extensive experiments will be summarized.

3 - Using Lagrangean Relaxation of Resource Constraints for Open Pit Mining Production Scheduling

Ambros Gleixner, Zuse-Institute Berlin, Takustr. 7, Berlin, 14195, Germany, gleixner@zib.de

We consider a recent mixed-integer programming formulation for the Open Pit Mining Production Scheduling Problem with block processing selectivity and study its properties. We demonstrate the use of Lagrangean relaxation of the resource constraints in several ways: rapid computation of dual bounds provably as strong as given by the linear programming relaxation, determining approximate cutoff grades and effective primal heuristics.

■ WA09

Marriott - Chicago F

California Integer Programming

Cluster: Integer and Mixed Integer Programming

Invited Session

Chair: Jon Lee, IBM TJ Watson Research Center, P.O. Box 218, Yorktown Heights, NY, 10598, United States of America, jonlee@us.ibm.com

1 - Large-scale Linear Algebra Relaxations of Combinatorial Problems

Peter Malkin, Postdoctoral Researcher, UC Davis, One Shields Avenue, Davis, CA, 95616, United States of America, malkin@math.ucdavis.edu, Jesus De Loera, Pablo A. Parrilo

We discuss techniques to create large-scale linear algebra relaxations of a combinatorial problem using Border bases of systems polynomial equations that encode the combinatorial problem. By solving these relaxations we can determine the feasibility of combinatorial problems and find feasible solutions. Both computational and theoretical results can be obtained with this method. We report on theoretical and computational results of applying this approach to graph vertex colorability.

2 - The Summation Method for Integer and Continuous Optimization

Matthias Koeppe, Professor, UC Davis, One Shields Avenue, Davis, CA, 95616, United States of America, mkoeppe@math.ucdavis.edu, Velleda Baldoni, Nicole Berline, Jesus De Loera, Michele Vergne

By viewing the maximum of a function as the limit of certain sums or integrals, efficient summation / integration procedures yield approximation algorithms for optimization problems. We study exact integration procedures for polynomial functions. Via Euler-Maclaurin formulas, these are useful also in the integer setting. The methods are related to Brion's formulas, Barvinok's exponential sums, and to the polynomial Waring problem (polynomials as sums of few linear forms).

3 - Estimation of the Number of Solutions for Integer Programs via Convex Optimization

Jesus De Loera, Professor, University of California-Davis, Dept of Mathematics, One Shields Avenue, Davis, CA, 95616, United States of America, deloera@math.ucdavis.edu

Counting or estimating lattice points inside polyhedra has applications in Discrete Optimization. Recently Barvinok and Hartigan outlined theorems estimating the number of lattice points or 0-1 points inside a polyhedron. These predictions do not need to prior knowledge about integer feasibility. I report on the experimental performance of two estimation algorithms. Our test sets included Knapsacks, multiway transportation problems, Market split problems, and b-matching problems from various dimensions.

■ WA10

Marriott - Chicago G

Optimization Under Uncertainty and Applications

Cluster: Global Optimization

Invited Session

Chair: Cole Smith, The University of Florida, Industrial and Systems Engineering, P.O. Box 116595, Gainesville, FL, 32611, cole@ise.ufl.edu

1 - Connectivity and Flow Problems on Networks under Uncertainty and Robustness Considerations

Vladimir Boginski, Professor, University of Florida / REEF, boginski@reef.ufl.edu

We consider some issues of network reliability in terms of connectivity and flows. We use several characteristics of network robustness, as well as incorporate quantitative risk measures into the corresponding mathematical programming formulations.

2 - The Stochastic Lot-sizing Problems with Deterministic Demands and Wagner-Within Costs

Zhili Zhou, University of Florida, Industrial and Systems Engineering, Gainesville, FL, 32611, United States of America, zhilizhou@ou.edu, Yongpei Guan

In this paper, we consider stochastic lot-sizing problems with deterministic demands and Wagner-Within costs. We examine properties for the optimal inventory and backlogging levels and provide extended formulations. In our formulations, the integral polyhedra can be described by linear inequalities. These formulations can solve the single-item uncapacitated case (SULS) and the single-item uncapacitated case with backlogging (SULSB) respectively, regardless of the scenario tree structure.

3 - Expectation and Chance-constrained Models and Algorithms for Insuring Critical Paths

Siqian Shen, University of Florida, Industrial and Systems Engineering, 303 Weil Hall, P.O. Box 116595, Gainesville, FL, 32611, sshen@ufl.edu, Shabbir Ahmed, Cole Smith

We consider a class of two-stage stochastic optimization problems arising in the protection of vital arcs in a critical path network. We provide decomposition strategies to solve this problem with respect to either convex or nonconvex penalties, and employ RLT to remodel the problem to be amenable to solution via Benders decomposition. We also propose an algorithm for a chance-constrained formulation. We employ SAA for scenario generation and demonstrate the computational efficacy.

■ WA11

Marriott - Chicago H

Global Optimization B

Contributed Session

Chair: Oleksii Ursulenko, Texas A&M University, 241 Zachry, 3131 TAMU, College Station, TX, 77843-3131, United States of America, ursul@tamu.edu

1 - A Fast Algorithm for Solving the Minimum Maximal Problem

Sukwon Chung, Stanford, 450 Serra Mall, Stanford, CA, 94305, United States of America, sukwonchung@stanford.edu, Jianming Shi, Wenjie Chen

A flow x on a network is said to be maximal if there does not exist another y on the network such that y is elementwise equal to or greater than x, but x is not equal to y. We consider the problem of minimizing the flow value on the maximal flow set of a connected network. This problem is formulated as a minimization of a linear function over a nonconvex efficient set. We propose an algorithm using methods that differ from existing ones to find an epsilon-optimal solution.

2 - An Improved Column Generation Algorithm for Minimum Sum-of-squares Clustering

Daniel Aloise, PhD Candidate, Ecole Polytechnique de Montreal, C.P. 6079, Succ. Centre-Ville, Montreal, H3C 3A7, Canada, daniel.aloise@gerad.ca, Pierre Hansen, Leo Liberti

Given a set of entities associated with points in Euclidean space, minimum sum-of-squares clustering (MSSC) consists in partitioning this set into clusters such that the sum of squared distances from each point to the centroid of its cluster is minimized. A column generation algorithm for MSSC was given by du Merle, Hansen, Jaumard and Mladenovic in SIAM J. Sci. Comput. 21, 1485-1505, 2000. The bottleneck of that algorithm is the solution of the auxiliary problem of finding a column with negative reduced cost. We propose a new way to solve this auxiliary problem based on geometric arguments. This greatly improves the efficiency of the whole algorithm and leads to exact solution of instances 10 times larger than previously done.

3 - Solving Sum of Ratios Fractional Combinatorial Optimization Problems

Oleksii Ursulenko, Texas A&M University, 241 Zachry, 3131 TAMU, College Station, TX, 77843-3131, United States of America, ursul@tamu.edu, Sergiy Butenko, Oleg Prokopyev

We consider the sum of linear ratios versions of several classical combinatorial problems: Minimum Spanning Tree, Shortest Path and Shortest Cycle. We discuss complexity of these problems and attempt to solve them using mixed integer programming, and a global optimization approach. The computational results show that the suggested approach by far outperforms the MIP formulations, and may be used to solve large problem instances, provided that the number of ratios is small.

■ WA12

Marriott - Los Angeles

Derivative-free Algorithms: Local and Global Methods

Cluster: Derivative-free and Simulation-based Optimization
Invited Session

Chair: Ana Luisa Custodio, New University of Lisbon, Dep. Mathematics FCT-UNL Quinta da Torre, Caparica, 2829-516, Portugal, alcustodio@fct.unl.pt

1 - Incorporating Minimum Frobenius Norm Models in Direct-search

Ana Luisa Custodio, New University of Lisbon, Dep. Mathematics FCT-UNL Quinta da Torre, Caparica, 2829-516, Portugal, alcustodio@fct.unl.pt, Humberto Rocha, Luis N. Vicente

Direct-search methods of directional type exhibit interesting convergence properties for nonsmooth functions and are relatively easy to implement, but can be very slow when compared to model-based methods. The goal of this talk is to show that the use of minimum Frobenius norm quadratic models can improve the performance of these methods. Our approach maintains the structure of these directional methods, organized around a search and a poll step, and uses the set of previously evaluated points generated during a direct-search run to build the models. The minimization of the models within a trust region provides an enhanced search step. Our numerical results show that such a procedure can lead to a significant improvement of direct search.

2 - Evolutionary Algorithms Guiding Local Search (EAGLS)

Josh Griffin, Operations Research Specialist, SAS Institute, Inc., 100 SAS Campus Drive, Cary, NC, 27513, United States of America, Joshua.Griffin@sas.com, Katie Fowler, Genetha Anne Gray

A parallel hybrid derivative-free algorithm is described for handling mixed-integer nonlinear programming. We focus on problems of relatively small dimension, with (possibly) expensive function evaluations, which we compute in parallel. To handle integer variables, we utilize an evolutionary algorithm; continuous variables are refined in parallel by multiple local search instances.

3 - Heuristics and Nonmonotonous Approaches in DF methods: A Good Combination for Global Optimization

Ubaldo Garcia-Palomares, Professor, Universidad Simon Bolivar, Departamento de Procesos y Sistemas, Valle de Sartenejas, Caracas, 89000, Venezuela, ubaldo@det.uvigo.es

In this talk we explain how to incorporate heuristic procedures in known Derivative Free methods without impairing convergence to a stationary point of a box constrained minimization problem. The inclusion of heuristics does not impose additional convergence conditions, although we should expect more function evaluations. Numerical results show the influence of simulated annealing and evolutionary programming. We also argue that parallelism might improve the algorithm's performance.

■ WA13

Marriott - Miami

Risk Management, Networks & Pricing

Cluster: Optimization in Energy Systems
Invited Session

Chair: Panos Pardalos, Distinguished Professor of Industrial and Systems Engineering, University of Florida, 303 Weil Hall, P.O. Box 116595, Gainesville, FL, 32611, United States of America, pardalos@ufl.edu

Co-Chair: Steffen Rebennack, University of Florida, Industrial & Systems Engineering, 303 Weil Hall, Gainesville, Fl, 32611, United States of America, steffen@ufl.edu

1 - Pricing Operational Flexibility

Stan Uryasev, Professor, University of Florida, ISE Department, 303 Weil Hall, P.O. Box 116595, Gainesville, FL, 32611, United States of America, uryasev@ufl.edu, Valeriy Ryabchenko

We introduce a new approach for pricing energy derivatives known as tolling agreement contracts. The pricing problem is reduced to a linear program. We prove that the optimal operating strategy for a power plant can be expressed through optimal exercise boundaries (similar to the exercise boundaries for American options). We find the boundaries as a byproduct of the pricing algorithm. The suggested approach can incorporate various real world power plant operational constraints. We demonstrate computational efficiency of the algorithm by pricing a 10-year tolling agreement contract.

2 - Pool Strategy of a Producer with Endogenous Formation of Prices

Carlos Ruiz, Univ. Castilla - La Mancha, Electrical Engineering, Campus Universitario s/n, Ciudad Real, 13071, Spain, Carlos.RMora@uclm.es, Antonio J. Conejo

This presentation considers a strategic producer that trades electric energy in a pool and provides a procedure to derive its optimal offering strategy. A multi-period network-constrained market-clearing algorithm is considered. Uncertainty on demand bids and offering strategies of rival producers is modeled. The proposed procedure to derive strategic offers relies on a bilevel programming model whose upper-level problem represents the profit maximization of the strategic producer while the lower-level one represents the market clearing and the corresponding price formation. This model is reduced to a MILP problem using the duality theory and the KKT optimality conditions. Results from an illustrative example and a case study are discussed.

3 - Introducing Risk Management Concepts from Finance to Networked Industries

Alexei Gaivoronski, Professor, NTNU, Alfred Getz vei 2, Trondheim, 7491, Norway, alexei.gaivoronski@iot.ntnu.no

In this paper we show how modern risk management methodology developed in finance can be utilized in order to develop optimization based planning tools for networked industries under conditions of uncertainty. The planning purpose goes beyond simple profit maximization or cost minimization: our explicit aim is to strike a balance between profits/costs and risks. Another important feature in such industries is the presence of different actors. We provide examples from telecom, service and water resources.

■ WA14

Marriott - Scottsdale

Optimization and Game Theory for Spectrum Management

Cluster: Game Theory
Invited Session

Chair: Tom Luo, Professor, University of Minnesota, 200 Union Street SE, Minneapolis, 55455, United States of America, luozq@ece.umn.edu

1 - Dynamic Spectrum Management with the Competitive Market Model

Benjamin Armbruster, Northwestern University, armbrusterb@gmail.com, Yao Xie, Dongdong Ge, Yinyu Ye

[Ye2007,LinTsai2008] have shown for the dynamic spectrum allocation problem that a competitive equilibrium (CE) model (which sets a price for transmission power on each channel) leads to a greater social utility than the Nash equilibrium (NE). We show that the CE is the solution of an LCP (like the NE), and when users of a channel experience the same noise levels and the cross-talk effects between users are low-rank and weak, then any tatonnement process for adjusting the prices will converge.

2 - Green DSL

Mung Chiang, Professor, Princeton University, chiangm@princeton.edu

We provide an overview of the emerging area of Green DSL: using spectrum management optimization to reduce energy consumption in DSL-based broadband access networks. We show how nonconvex optimization techniques can be used to provide 85% of data rate with only 50% of the energy budget, and to distribute the price of greening to interfering users in a fair way. This is joint work with Paschalis Tsiaflakis, Yung Yi, and Marc Moonen.

3 - Approaching User Capacity in a Multiuser Communication System via Harmonic Mean-rate Maximization

Tom Luo, Professor, University of Minnesota, 200 Union Street SE, Minneapolis, 55455, United States of America, luozq@ece.umn.edu, Yao Huang, Ramy Gohary

We consider the nonconvex optimization problem of optimally allocating power across the spectrum in a multiuser communication system. Given a certain power budget, our goal is to determine a power allocation that enables a maximum number of users to be supported by the system, defined as the user capacity, where each user is guaranteed to have a data rate that lies within a prescribed range. Finding such a power allocation directly is hard because it involves solving a (non-convex) mixed integer program. In order to circumvent this difficulty, we propose an alternate approach that is based on exploiting the fairness and per-tone convexity of the harmonic mean-rate objective. Using these features, we devise a computationally-efficient power allocation technique to approach the user capacity of a multiuser communication system.

■ WA15

Gleacher Center - 100

Stochastic Network Design

Cluster: Stochastic Optimization
Invited Session

Chair: Stein W. Wallace, Lancaster University, Department of Management Science, Lancaster University Management School, Lancaster, LA1 4YX, United Kingdom, Stein.W.Wallace@lancaster.ac.uk

1 - Meta-heuristic for Stochastic Service Network Design

Teodor Gabriel Crainic, Professor, Ecole des sciences de la gestion, UQAM, C.P. 8888, succ. centre-ville, Montreal, QC, H3C3P8, Canada, crainic.teodor@uqam.ca, Arnt-Gunnar Lium, Arild Hoff, Arne Lokketangen

We consider the time-dependent service network design problem with stochastic demand represented by scenarios. The goal is to select and schedule services and route freight to minimize the expected total system cost. The recourse combines the optimization of the flow distribution and the possibility to use extra capacity at a cost. We propose a meta-heuristic to address real life-size instances of this problem. Computational results are reported on a set of large new problem instances.

2 - Progressive Hedging-based Meta-heuristics for Stochastic Network Design

Walter Rei, Professor, University of Quebec in Montreal (UQAM), 315 Sainte-Catherine East, C.P. 8888, succ. Centre-ville, Montreal, QC, H3C 3P8, Canada, walter@crt.umontreal.ca, Michel Gendreau, Stein W. Wallace, Teodor G. Crainic, Xiaorui Fu

We consider the two-stage stochastic fixed-charge capacitated multicommodity network design (CMND) problem in which demands are stochastic. To solve this problem, we propose a meta-heuristic framework inspired by the progressive hedging algorithm, which takes advantage of efficient methods to solve deterministic CMND problems. We also propose and compare different strategies aimed at penalizing non-consensus amongst scenario subproblems to approximate the global design.

3 - Single Commodity Stochastic Network Design

Stein W. Wallace, Lancaster University, Department of Management Science, Lancaster University Management School, Lancaster, LA1 4YX, United Kingdom, Stein.W.Wallace@lancaster.ac.uk, Biju Kr. Thapalia, Teodor G. Crainic, Michal Kaut

We investigate how network designs from stochastic models differ from those of deterministic models, and hence, what structures that provide robustness in the design. As a first step we check the case of one single supply node serving many demand nodes.

■ WA16

Gleacher Center - 200

Efficient Stochastic Approximation Algorithms

Cluster: Stochastic Optimization
Invited Session

Chair: Alexander Shapiro, Georgia Institute of Technology, ISYE, 443 Groseclose Building, Atlanta, GA, 30332, United States of America, ashapiro@isye.gatech.edu

1 - Acceleration by Randomization: Randomized First Order Algorithms for Large-scale Convex Optimization

Arkadi Nemirovski, Professor, Georgia Institute of Technology, 765 Ferst Dr NW, Atlanta, GA, 30332, United States of America, nemirovs@isye.gatech.edu, Alexander Shapiro, Anatoli Juditsky, Guanghui Lan

We discuss the possibility to accelerate solving extremely large-scale well structured convex optimization problems by replacing computationally expensive in the large scale case deterministic first order oracles with their computationally cheap stochastic counterparts and subsequent utilizing state of the art techniques of Convex Stochastic Programming. We show that when medium-accuracy solutions are sought, there are situations where this approach allows to provably outperform the best known deterministic algorithms. This includes solving matrix games and bilinear Nash Equilibrium problems, minimizing convex polynomials over simplexes, recovering signals via L1 minimization, and eigenvalue minimization.

2 - Primal-dual Stochastic Subgradient Methods for Uniformly Convex Minimization

Anatoli Juditsky, UJF, Laboratoire J. Kuntzmann, BP 53, Grenoble Cedex 9, 38041, France, anatoli.juditsky@imag.fr, Yurii Nesterov

We discuss non-Euclidean stochastic approximation algorithms for optimization problems with strongly and uniformly convex objectives. These algorithms are adaptive with respect to the parameters regularity and of strong or uniform convexity of the objective: in the case when the total number of iterations N is fixed, their accuracy coincides, up to a logarithmic in N factor with the accuracy of optimal algorithms.

3 - Stochastic Approximation Approach to Stochastic Programming

Alexander Shapiro, Georgia Institute of Technology, ISYE, 443 Groseclose Building, Atlanta, GA, 30332, United States of America, ashapiro@isye.gatech.edu, Anatoli Juditsky, Arkadi Nemirovski, Guanghui Lan

A basic difficulty with solving stochastic programming problems is that it requires computation of expectations given by multidimensional integrals. One approach, based on Monte Carlo sampling techniques, is to generate a reasonably large random sample and consequently to solve the constructed so-called Sample Average Approximation (SAA) problem. The other classical approach is based on Stochastic Approximation (SA) techniques. In this talk we discuss some recent advances in development of SA type numerical algorithms for solving convex stochastic programming problems. Numerical experiments show that for some classes of problems the so-called Mirror Descent SA Method can significantly outperform the SAA approach.

WA17

Gleacher Center - 204

Optimization in Supply Chain Planning

Cluster: Logistics and Transportation
Invited Session

Chair: Joseph Geunes, University of Florida, 303 Weil Hall, Gainesville, FL, 32611, United States of America, geunes@ise.ufl.edu

1 - Economic Lot-sizing with Perishable Inventories

H. Edwin Romeijn, Professor, University of Michigan, Industrial and Operations Engineering, Ann Arbor, United States of America, romeijn@umich.edu, Mehmet Onal, Amar Sapra

We consider extensions of the classical dynamic economic lot sizing problem where items perish after a number of periods that depends on the period in which the item was produced. We distinguish between settings in which (i) the retailer has the power to supply customer demands in each period with any non-perished items, and (ii) the customer has the power to select from the collection of available items. We develop polynomial-time dynamic programming algorithms for several problem variants.

2 - Exact Algorithms for Integrated Facility Location and Production Planning Problems

Joseph Geunes, University of Florida, 303 Weil Hall, Gainesville, FL, 32611, United States of America, geunes@ise.ufl.edu, Thomas Sharkey, H. Edwin Romeijn, Max Shen

We consider a class of location problems with a time dimension, which requires assigning each customer in every time period to a facility and meeting customer demands through production and inventory decisions at the facility. We provide exact branch-and-price algorithms for this problem class. The pricing problem requires selecting a set of demands that maximize profit. We provide a polynomial-time dynamic programming algorithm for this problem class, as well as for several extensions of the problem. Computational testing compares the performance of our branch-and-price algorithm to solutions obtained via commercial software packages, and characterizes the value of integrating these decisions, rather than considering them sequentially.

3 - Robust Lot-sizing Problems with the Consideration of Disruptions

Yongpei Guan, Assistant Professor, Department of Industrial and Systems Engineering, University of Florida, Gainesville, FL, 32611, United States of America, guan@ise.ufl.edu, Zhili Zhou

In this paper, we consider lot-sizing problems in which severe events may happen such that the normal process will be disrupted. Our objective is to provide a robust schedule such that the total cost is minimized with the consideration of uncertain extreme events. A robust optimization formulation is studied to address the uncertainty in possible disruption periods. Several cases are studied and corresponding algorithms are developed. Our preliminary study verifies the effectiveness of our approaches. The applications of our models include production and inventory planning problems.

WA18

Gleacher Center - 206

MINLP Modeling and Applications

Cluster: Nonlinear Mixed Integer Programming
Invited Session

Chair: Pietro Belotti, Visiting Professor, Lehigh University, 200 W Packer Ave, Bethlehem, PA, 18015, United States of America, belotti@lehigh.edu

1 - A Bilevel Integer Nonlinear Programming Model for Cross-layer Network Design Optimization

Scott Denegre, Lehigh University, Industrial and Systems Engineering, 200 West Packer Avenue, Bethlehem, PA, 18015, sdenegre@lehigh.edu, Ted Ralphs

We consider the problem of cross-layer network design optimization. This problem is encountered in mobile ad hoc networks (MANET) consisting of moving nodes equipped with cognitive radios that dynamically adjust their transmission power and constellation size in response to channel and interference states. The objective is to minimize transmission power in the network's physical layer, while maximizing the throughput in the network layer. Previously, cross-layer network design optimization and transmit power minimization were treated as separate problems. We provide motivation for combining these problems and reformulate the problem as a bilevel integer nonlinear program. Exact and heuristic solution methods are given.

2 - Strengthening of Lower Bounds for Global Optimization of Nonconvex Generalized Disjunctive Programs

Ignacio Grossmann, Rudolph R. and Florence Dean University Professor, CMU, 5000 Forbes, Pittsburgh, PA, 15213, United States of America, grossmann@cmu.edu, Juan Ruiz

We present a framework to find relaxations that yields strong lower bounds for the global optimization of Bilinear and Concave Generalized Disjunctive Programs (GDPs). This framework combines linear relaxation strategies proposed in the literature for nonconvex MINLPs with the work of Sawaya & Grossmann for Linear GDPs. We exploit the theory behind Disjunctive Programming to guide the generation of relaxations efficiently. The performance of the method is shown through a set of test problems.

3 - A Hybrid Approach to Beam Angle Optimization in Intensity-modulated Radiation Therapy

Valentina Cacchiani, DEIS, University of Bologna, Viale Risorgimento 2, Bologna, 40136, Italy, valentina.cacchiani@unibo.it, Dimitris Bertsimas, Omid Nohadani, David Craft

Two decisions are fundamental in Intensity-Modulated Radiation Therapy: to select beam angles and to compute the intensity of the beams used to deliver the radiation, with the aim of reaching the dose prescription in the target while sparing the critical structures. We face the problem of optimizing both decisions, developing a hybrid heuristic method, which combines a simulated annealing procedure with the knowledge of the gradient. Experimental results are performed on real-life case studies.

WA19

Gleacher Center - 208

Nonlinear Programming B

Contributed Session

Chair: Ioannis Akrotirianakis, Operations Research Specialist, SAS Institute, Inc., 100 SAS Campuse Drive, Cary, NC, 27513, United States of America, ioannis.akrotirianakis@sas.com

1 - A Variant of Nonlinear Conjugate Gradient that Incorporates Second Order Information

Sahar Karimi, University of Waterloo, 200 University Ave. W., Waterloo, ON, N2L3G1, Canada, s2karimi@math.uwaterloo.ca, Steve Vavasis

In this talk we discuss a generalization of the nonlinear conjugate gradient algorithm for unconstrained optimization problems that incorporates some second order information via automatic differentiation. We evaluate the performance of the algorithm. For a certain class of strongly convex problems, the algorithm is close to optimal in the sense of Nemirovski and Yudin.

2 - A Modified CG Method for Large-scale Nonconvex Optimization

Wenwen Zhou, Operations Research Specialist, SAS Institute Inc., 100 SAS Campus Dr., Cary, NC, 27513, United States of America, wenwen.zhou@sas.com, Josh Griffin, Ioannis Akrotirianakis

We present a new matrix-free algorithm for large-scale nonlinear nonconvex optimization that incorporates inherited strengths of line-search and trust-region approaches. Krylov-based search directions are constructed based upon local geometry. The merit of new approach is demonstrated by numerical results.

3 - Simultaneous Solution of the Trust Region and the Minimum Eigenvalue Subproblems

Ioannis Akrotirianakis, Operations Research Specialist, SAS Institute, Inc., 100 SAS Campuse Drive, Cary, NC, 27513, United States of America, ioannis.akrotirianakis@sas.com, Josh Griffin, Wenwen Zhou

We describe a trust-region algorithm for large-scale nonconvex optimization that combines several existing preconditioned Krylov subspace strategies. Special small dimensional subspaces permit the simultaneous approximation of solutions to 1) the trust-region subproblem and 2) the minimum eigenvalue subproblem, with negligible computational overhead. Comprehensive numerical results demonstrate the algorithm's strength.

WA20

Gleacher Center - 300

Stability and Sensitivity Analysis in Cone and General Nonlinear Programming

Cluster: Nonlinear Programming
Invited Session

Chair: Henry Wolkowicz, Professor of Math., University of Waterloo, Dept of Combinatorics & Optimization, University of Waterloo, Waterloo, ON, N2L 3G1, Canada, hwolkowicz@uwaterloo.ca

1 - Bi-parametric Convex Quadratic Optimization

Tamas Terlaky, Lehigh University, 200 West Packer Avenue, Department of Industrial and Systems Eng, Bethlehem, PA 18015-1, United States of America, terlaky@Lehigh.EDU, Oleksandr Romanko, Alireza Ghaffari-Hadigheh

We consider the Convex Quadratic Optimization problem with simultaneous perturbation in the RHS and the linear term of the objective function with different parameters. The regions with invariant optimal partitions are investigated as well as the behavior of the optimal value function on the regions. We show that identifying these regions can be done in polynomial time in the output size. A computable algorithm for identifying all invariancy regions is presented.

2 - Feasibility and Constraint Analysis of Sets of Linear Matrix Inequalities

Rick Caron, Professor, University of Windsor, Math and Stats, 401 Sunset Avenue, Windsor, ON, N9B3P4, Canada, rcaron@uwindsor.ca, Tim Traynor, Shafiu Jibrin

We present a constraint analysis methodology for LMI constraints that seeks either a minimal representation (feasible case) or an irreducible infeasible system (infeasible case). The work is based on the solution of a set covering problem where each row corresponds to a sample point and is determined by constraint satisfaction. We develop a hit and run sampler that provides information for constraint analysis, and that find a feasible point, if one exists, with probability one.

3 - Strong Duality and Minimal Representations for Cone Optimization

Henry Wolkowicz, Professor of Math., University of Waterloo, Dept of Combinatorics & Optimization, University of Waterloo, Waterloo, ON, N2L 3G1, Canada, hwolkowicz@uwaterloo.ca, Levent Tuncel

The elegant results for strong duality and strict complementarity for LP can fail for nonpolyhedral cones. We take a fresh look at known and new results for duality, optimality, CQs, and strict complementarity.

■ WA21

Gleacher Center - 304

Network Optimization

Cluster: Telecommunications and Networks
Invited Session

Chair: Bruce Shepherd, McGill University, 805 Sherbrooke West, Montreal, QC, H3H1J2, Canada, bruce.shepherd@mcgill.ca

1 - Preserving Element-connectivity and Packing Steiner Forests

Nitish Korula, University of Illinois at Urbana-Champaign, 201, N. Goodwin Ave., Urbana, IL, 61801, United States of America, nkorula2@illinois.edu, Chandra Chekuri

In an undirected graph G with terminal set T \subseteq V(G), the element-connectivity of terminals u, v is the maximum number of u-v paths that share no edges and no non-terminals. We show that a graph reduction operation of Hind and Oellerman preserves the element-connectivity of all pairs of terminals, and illustrate the usefulness of this operation with an application to packing Steiner Forests: We prove that the connectivity of terminals is related to the number of element-disjoint forests.

2 - Flow-cut Gap for Integer and Fractional Multiflows

Christophe Weibel, Postdoctoral Fellow, McGill University, 805 Sherbrooke West, Montreal, QC, H3H1J2, Canada, christophe.weibel@gmail.com, Bruce Shepherd, Chandra Chekuri

In multicommodity flows, the max-flow/min-cut gap is the ratio between the edge capacity necessary to route every demand and the capacity verifying the cut condition. In the case of fractional flows, it was recently proved that the gap can be at most 2 for series-parallel graphs. In the case of integral flows, we prove an upper bound of 5 for the same series-parallel graphs. We also conjecture, and show some evidence, that the actual upper bound is 2 as in fractional flows.

3 - Solving Convex Programs in Mobile Ad-hoc Networks

Matthew Andrews, Member Technical Staff, Bell Laboratories, 600 Mountain Ave, Murray Hill, NJ, 07974, United States of America, andrews@research.bell-labs.com

In many instances the desired behavior of a mobile ad-hoc network can be formulated using a convex optimization problem. In this talk we shall show how such problems can be solved in a distributed manner using a set of networking protocols that are only slightly different from traditional ad hoc networking protocols such as those used by the 802.11 standard.

■ WA22

Gleacher Center - 306

Algorithms and Software for Semidefinite Programming

Cluster: Implementations, Software
Invited Session

Chair: Brian Borchers, New Mexico Intitute of Mining & Technology, Socorro, NM, 87801, United States of America, borchers@nmt.edu

1 - Preconditioners for Semidefinite Programming

Michael Overton, New York University, Courant Institute, New York, NY, United States of America, overton@cs.nyu.edu, Chen Greif, Ming Gu

We consider preconditioners for solving the linear systems that arise in interior point methods for semidefinite programming. These depend on computing or approximating the smallest eigenvalues of the dual slack matrix, and also the largest eigenvalues of the primal matrix variable when a primal-dual method is used. We present some theoretical results making centrality and nondegeneracy assumptions. The preconditioner can be improved by updating it during the conjugate gradient iteration.

2 - Multiple Precision Arithmetic Versions of SDP Solvers; SDPA-GMP, SDPA-QD and SDPA-DD

Maho Nakata, Postdoctoral fellow, RIKEN, 2-1 Hirosawa, Wako, Saitama, 351-0198, Japan, maho.nakata@gmail.com

In this talk, we introduce multiple precision arithmetic versions of semidefinite programming (SDP) solvers; SDPA-GMP, SDPA-QD and SDPA-DD. SDPA-GMP solves in arbitrary (variable) accuracy by utilizing GNU Multiple precision library. SDPA-QD, DD use QD library and solve in quasi octuple precision and quasi quadruple precision. These solvers solve some small SDPs very accurately; primal dual gap can be smaller than 1e-50. All program packages are available at the SDPA project home page.

3 - Issues In Implementing the Primal-dual Method for SDP

Brian Borchers, New Mexico Intitute of Mining & Technology, Socorro, NM, 87801, United States of America, borchers@nmt.edu

CSDP is an open source software package for semidefinite programming that has been under continuous development since 1997. We discuss accuracy and performance issues in the implementation of the primal-dual interior point method and lessons learned from applications of the software.

■ WA23

Gleacher Center - 308

Compressed Sensing, Sparse Recovery and Sparse PCA

Cluster: Sparse Optimization
Invited Session

Chair: Paul Tseng, Professor, University of Washington, Department of Mathematics, Box 354350, Seattle, WA, 98195, United States of America, tseng@math.washington.edu

Co-Chair: Peter Richtarik, Center for Operations Research and Econometrics (CORE), Batiment Euler (A-116), Avenue Georges Lemaitre 4, Louvain-la-Neuve, B-1348, Belgium, Peter.Richtarik@uclouvain.be

1 - Generalized Power Method for Sparse Principal Component Analysis

Peter Richtarik, Center for Operations Research and Econometrics (CORE), Batiment Euler (A-116), Avenue Georges Lemaitre 4, Louvain-la-Neuve, B-1348, Belgium, Peter.Richtarik@uclouvain.be, Yurii Nesterov, Rodolphe Sepulchre, Michel Journee

In this paper we propose two single-unit and two block penalty formulations of the sparse PCA problem. While the initial formulations involve nonconvex functions, and are thus computationally intractable, we rewrite them into the form of an optimization program involving maximization of a convex function on a compact set. We then propose and analyze a simple gradient method suited for the task. Finally, we demonstrate numerically that our approach leads to very fast scalable algorithms.

2 - Phase Transitions Phenomenon in Compressed Sensing

Jared Tanner, Reader, University of Edinburgh, JCBM, Edinburgh, eh16 5nj, United Kingdom, jared.tanner@ed.ac.uk, Coralia Cartis, Jeffrey Blanchard, David L. Donoho

Compressed Sensing reconstruction algorithms exhibit a phase transition phenomenon for large problem sizes, where there is a domain of problem sizes for which successful recovery occurs with overwhelming probability, and there is a domain of problem sizes for which recovery failure occurs with overwhelming probability. The mathematics underlying this phenomenon will be outlined for ℓ^1 regularization and non-negative feasibility point regions. Both instances employ a large deviation analysis of the associated geometric probability event. These results give precise if and only if conditions on the number of samples needed in Compressed Sensing applications. Lower bounds on the phase transitions implied by the Restricted Isometry Property for Gaussian random matrices will also be presented for the following algorithms: ℓ^q-regularization for $q\in (0,1]$, CoSaMP, Subspace Pursuit, and Iterated Hard Thresholding.

3 - Sparse Recovery by Non-convex Optimization — Instance Optimality

Ozgur Yilmaz, University of British Columbia, 1984 Mathematics Rd, Vancouver, BC, V6T 1Z2, Canada, oyilmaz@math.ubc.ca, Rayan Saab

It has been recently shown that one can recover/decode estimates of sparse signals from an "incomplete" set of noisy measurements via one-norm minimization methods under certain conditions on the "measurement matrix" that are satisfied, e.g., when it is a random Gaussian. In this talk, we present the theoretical recovery guarantees obtained when decoding by p-quasinorm minimization with p between 0 and 1: we prove that the corresponding guarantees are better than those one can obtain in the case of one-norm minimization. We show that these decoders are (2,p) instance optimal. Moreover, they are (2,2) instance optimal in probability (this relates to distances of p-convex bodies to their convex hulls).

■ WA25

Gleacher Center - 404

Computational Convex Analysis

Cluster: Variational Analysis

Invited Session

Chair: Yves Lucet, University of British Columbia, 3333 University Way, Kelowna, BC, V1V 1V7, Canada, yves.lucet@ubc.ca

1 - Convexity of the Proximal Average

Valentin Koch, University of British Columbia, Faculty of Mathematics, 3333 University Way, Kelowna, BC, V1V 1V7, Canada, valentin.koch@gmail.com, Jennifer Johnstone, Yves Lucet

We complete the study of the convexity of the proximal average by proving it is convex as a function of each one of its parameters but not as a function of any two of each parameters. An application to the efficient plotting of the family of proximal averages is presented.

2 - Numerical Computation of Fitzpatrick Functions

Bryan Gardiner, University of British Columbia, 3333 University Way, Kelowna, BC, V1V 1V7, Canada, khumba@gmail.com, Yves Lucet

The study of Fitzpatrick functions aids the understanding of the structure of operators. They are related to Rockafellar functions and operator antiderivatives. Using fast algorithms for computing Fenchel conjugates, we improve the existing quartic-time algorithm for computing Fitzpatrick functions on a 2-dimensional grid to quadratic time, and demonstrate a linear-time algorithm for constructing antiderivatives from a special case of the Fitzpatrick function.

3 - Applications of Computational Convex Analysis

Yves Lucet, University of British Columbia, 3333 University Way, Kelowna, BC, V1V 1V7, Canada, yves.lucet@ubc.ca

We review applications of Computational Convex Analysis in image processing (computing the distance transform, the generalized distance transform, and mathematical morphology operators), and partial differential equations (solving Hamilton-Jacobi equations, and using differential equations numerical schemes to compute the convex envelope). We will also mention applications in computer vision, robot navigation, thermodynamics, electrical networks, medical imaging, and network communication.

■ WA28

Gleacher Center - 600

Rank Minimization: Theory and Applications

Cluster: Nonsmooth and Convex Optimization

Invited Session

Chair: Lieven Vandenberghe, UCLA, 66-147L Engineering IV, Los Angeles, CA, 90095, United States of America, vandenbe@EE.UCLA.EDU

Co-Chair: Maryam Fazel, University of Washington, Department of Electrical Engineering, Campus Box 352500, Seattle, WA, 98195-2500, United States of America, mfazel@u.washington.edu

1 - Robust Recovery of Low-rank Matrices

Maryam Fazel, University of Washington, Department of Electrical Engineering, Campus Box 352500, Seattle, WA, 98195-2500, United States of America, mfazel@u.washington.edu

Compressed Sensing has demonstrated that sparse signals can be recovered from incomplete measurements even in the presence of noise. In this work, we focus on sensing and recovery of low-rank matrices. We consider two approaches, one based on a restricted isometry property, and the other based on sensing the row and column spaces of the matrix. We discuss the robustness of low-rank recovery in cases where measurements are noisy and the matrix is not perfectly low-rank.

2 - Null Space Conditions and Thresholds for Rank Minimization

Benjamin Recht, California Institute of Technology, 1200 E California Blvd, MC 136-93, Pasadena, CA, 91125, United States of America, brecht@caltech.edu, Babak Hassibi, Weiyu Xu

We assess the practical performance of the nuclear norm heuristic for finding the minimum rank matrix satisfying linear constraints. We obtain thresholds on the number of constraints beyond which the nuclear norm heuristic succeeds for almost all instances of the affine rank minimization problem. These thresholds are only in terms of dimensions of the decision variable and the true minimum rank. Our bounds agree empirically with the heuristic's performance in non-asymptotic scenarios.

3 - Nuclear Norm Minimization for the Planted Clique and Biclique Problems

Steve Vavasis, University of Waterloo, MC 6054, 200 University Avenue W., Waterloo, ON, N2L 3G1, Canada, vavasis@math.uwaterloo.ca, Brendan Ames

We consider the problems of finding a maximum clique in a graph and finding a maximum-edge biclique in a bipartite graph. Both problems are NP-hard. We write both problems as matrix rank minimization and then relax them using the nuclear norm. In special cases that the input graph has a planted clique or biclique (i.e., a single large clique or biclique plus diversionary edges) our algorithm successfully provides an exact solution to the original instance. For each problem, we provide two analyses of when our algorithm succeeds. In the first analysis, the diversionary edges are placed by an adversary. In the second, they are placed at random.

■ WA29

Gleacher Center - 602

Computational Methods for Dynamic Models in Economics - Part I

Cluster: Finance and Economics

Invited Session

Chair: Che-Lin Su, Assistant Professor of Operations Management, The University of Chicago Booth School of Business, 5807 S. Woodlawn Ave, Chicago, IL, 60637, United States of America, chelin.su@gmail.com

1 - Improving the Numerical Performance of BLP Discrete Choice Random Coefficients Demand Estimation

Jeremy Fox, Assistant Professor of Economics, The University of Chicago Department of Economics, Chicago, IL, United States of America, jeremyfox@gmail.com, Jean-Pierre Dube, Che-Lin Su

The nested-fixed point algorithm typically used for Berry, Levinsohn and Pakes (1995) random-coefficient demand estimation is computationally intensive, largely because a system of market-share equations must be repeatedly numerically inverted. We recast both static and dynamic BLP estimation as constrained optimization problems. Several Monte Carlo and real-data experiments support the advantages of the constrained optimization method.

2 - Dynamic Strategic Investment

Sevin Yeltekin, Associate Professor of Economics, Tepper School of Economics, CMU, sevin@andrew.cmu.edu

We present a general method for computing the entire set of equilibrium payoffs for dynamic games with state variables, with and without complete information. We extend our earlier methods (Judd, Yeltekin, Conklin (Econometrica, 2003)) to games with physical states variables, and apply the procedure to a dynamic oligopoly game with costly capacity investment. Our algorithm allows us to study the nature of cooperation and whether investment decisions increase the gains from cooperation.

3 - Estimating Dynamic Models with Smart Transformation

Panle Jia, Assistant Professor of Economics, MIT, Department of Economics, pjia@mit.edu

We propose a new method of calculating the Bellman equation in dynamic models that eliminates discretizing and interpolating the value function entirely. The method only requires solving the value function at a small number of points. Such a method makes it feasible to study dynamic models with a large number of the state variables, for example, 20-50 state variables.

Wednesday, 1:15pm - 2:45pm

■ WB01

Marriott - Chicago A

Online Algorithms

Cluster: Approximation Algorithms
Invited Session

Chair: Cliff Stein, Columbia University, 326 S W Mudd Building, 500 W. 120th Street, New York, NY, 10027, cliff@ieor.columbia.edu

1 - Stochastic Dominance for Comparing Online Algorithm

Tjark Vredeveld, Maastricht University, P.O.Box 616, Maastricht, 6200MD, Netherlands, T.Vredeveld@ke.unimaas.nl, Benjamin Hiller

In this talk, we consider a probabilistic method for comparing online algorithms, which is based on the notion of stochastic dominance. We consider the online bin coloring problem, in which colored items need to be assigned to bins so as to minimize the maximum colorfulness. Using methods for the stochastic comparison of Markov chains we establish a result that gives a more realistic view than competitive analysis and explains the behavior observed in simulations.

2 - Flooding Overcomes Small Covering Constraints

Christos Koufogiannakis, University of California, Riverside, Dept of Computer Science and Engineering, Engineering Building Unit II, Room 351, Riverside, CA, 92521, United States of America, ckou@cs.ucr.edu, Neal Young

We show d-approximation algorithms for covering problems, where d is the maximum number of variables on which any constraint depends. Results include: A d-approximation algorithm for CMILP running in nearly linear time. Online d-competitive algorithms for the setting where constraints are revealed in an online fashion. For $d=2$, a distributed algorithm taking $O(\log n)$ rounds. For general d, a d-approximation algorithm taking $O(\log^2 |E|)$ rounds.

3 - Online Scheduling of Weighted Packets with Deadlines in a Bounded Buffer

Fei Li, Assistant Professor, George Mason University, Department of Computer Science, Fairfax, VA, 22030, United States of America, lifei@cs.gmu.edu

We consider online scheduling of packets. Packets arrive over time, each has a positive value w_p and an integer deadline d_p. If p is transmitted by d_p, p contributes our objective w_p. At any time, the buffer can store at most b packets. In each step, at most one packet can be sent. We maximize the total value of the packets sent by their deadlines. We provide a deterministic 3-competitive, a randomized 2.618-competitive online algorithms, and a lower bound 2 for a broad family of algorithms.

■ WB02

Marriott - Chicago B

Joint Session Comp/Energy: Complementarity Models in Energy

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Daniel Ralph, University of Cambridge, Judge Business School, Trumpington Street, Cambridge, CB2 1AG, United Kingdom, d.ralph@jbs.cam.ac.uk

1 - A Stochastic Multiperiod Equilibrium Model in Generation Capacity Expansion with Plant (or Firm) Specific Discount Rates

Yves Smeers, Professor, Universite Catholique de Louvain, 34, Voie du Roman Pays, Louvain-la-Neuve, Belgium, smeers@core.ucl.ac.be

Starting from a CAPM formulation we construct an equilibrium model of investments in generation capacities where firms or plants have different cost of capital. The problem takes the form of a stochastic quasi-variational inequality problem for which we want to find a particular solution that reflects the diversity of costs of capital. We report numerical results.

2 - An Extended Mathematical Programming Framework

Michael Ferris, University of Wisconsin-Madison, 4381 Computer Sciences and Statistics, 1210 W Dayton Street, Madison, WI, 53706, United States of America, ferris@cs.wisc.edu

We outline a mechanism to describe an extended mathematical program by means of annotating the existing relationships that make up a model. These extensions facilitate higher level structure identification within a model. The structures, which often involve constraints on the solution sets of other models or complementarity relationships, can be exploited by modern large scale mathematical programming algorithms for efficient solution. Specific application to energy models will be given.

3 - Hybrid Bertrand-cournot Models of Electricity Markets with Strategic Decoupling

Shmuel Oren, Professor, University of California-Berkeley, Dept of I EO R, Rm 4119 Etcheverry Hall, Berkeley, CA, 94720, United States of America, oren@ieor.berkeley.edu, Jian Yao, Ben Hobbs

Nash-Cournot models of competition among electricity generators do not account for strategic decoupling due to permanently congested interfaces. We propose a hybrid Bertrand-Cournot model of such markets in which firms are assumed to behave a la Cournot regarding inter-subnetwork transmission quantities, but a la Bertrand regarding intra-subnetwork transmission prices. We also consider a Bertrand type model where frequently congested lines are designated as “common knowledge constraint” and treated as equality constraints by all generation firms and the ISO.

■ WB03

Marriott - Chicago C

Duality and Algorithms in Global Optimization-II

Cluster: Global Optimization
Invited Session

Chair: David Gao, Professor, Virginia Tech, Mathematics, 524 McBryde Hall, Blackburg, VA, 24061, United States of America, gao@vt.edu

1 - Linear Relaxations for Sum of Linear Ratios Problem

Jianming Shi, Muroran Institute of Technology, 27-1 Mizumoto Chou, Muroran, Japan, shi@mmm.muroran-it.ac.jp, Lianbo Gao

The difficulty of the problem mainly arises from the number of ratios. The main idea of the existing algorithms is to transfer the objective into the sum of single-variable ratios with curtain linear constrains. Then make a concave envelop of the sum of single-variable ratios’. So a number-of-ratios dimensional region is needed to look for an optimal solution. An algorithm on a space with a smaller dimension is proposed in this talk. Some numerical experiments will be reported as well.

2 - Unified Solutions to a Class of Global Optimization Problems

David Gao, Professor, Virginia Tech, Mathematics, 524 McBryde Hall, Blackburg, VA, 24061, United States of America, gao@vt.edu, Ning Ruan, Hanif D. Sherali

Canonical duality theory is a potentially useful methodology, which can be used to model complex systems with a unified solution to a wide class of discrete and continuous problems in global optimization and nonconvex analysis. This talk will present recent developments of this theory with applications to some well-know problems, including general polynomial minimization, Euclidean distance geometry, fractional programming, nonconvex minimization with nonconvex constraints, etc.

3 - Terrain and Barrier-terrain Methods of Global Optimization

Angelo Lucia, Professor, University of Rhode Island, Chemical Engineering Dept, Kingston, RI, 02881, lucia@egr.uri.edu

A survey of terrain and barrier-terrain methods of global optimization is presented with a focus on their ability to solve challenging problems in multi-phase equilibrium, simultaneous heat and mass transfer with reaction, and other applications in chemical engineering. Numerical results and geometric illustration will be presented to elucidate key ideas.

■ WB04

Marriott - Denver

Combinatorial Optimization E

Contributed Session

Chair: Bea Karla Machado, Student, UFRJ, Vitoria, 29060300, Brazil, profbea@hotmail.com

1 - Coloring of Polygon-circle Graphs and Sorting of Rail Cars

Ronny Hansmann, Technical University of Braunschweig, Pockelsstrasse 14, Braunschweig, 38106, Germany, r.hansmann@tu-bs.de, Uwe Zimmermann

We start the talk with an overview of various versions for sorting rail cars at hump yards and we show that many of these particular sorting problems can be formulated as Min Coloring of Polygon-Circle Graphs. For computing such minimal colorings we present heuristical as well as exact solution methods. We compare two integer programming models: a classical coloring IP and a new IP-formulation as Min Cost Flow with side constraints. Exploiting this network flow structure we propose a Branch-and-Bound algorithm using Min Cost Flows and Lagrangian Relaxation for determining lower bounds. Finally, we discuss the computational results, in particular for real-world data from the above-mentioned application.

2 - Integer Flow with Multipliers 1 and 2 and a Freight Car Disposition Problem

Birgit Engels, University of Cologne, Weyertal 80, Cologne, Germany, engels@zpr.uni-koeln.de, Rainer Schrader, Sven Krumke, Christiane Zeck

The problem to find a valid integer generalized flow is long known to be NP-complete (S. Sahni, 1974). We show that the problem is still hard restricted to multipliers 1 and 2 and that optimal solutions with (almost) arbitrary fractions can occur.In some (still NP-hard) application motivated network instances optimal solutions are halfintegral. To solve the latter (optimally) we modify the Successive Shortest Path Algorithm and try to (heuristically) find acceptable integral solutions.

3 - A Study of the Itineraries of Some Subway-bus Express Lines of Integration in the City of Rio de Janeiro

Bea Karla Machado, Student, UFRJ, Vitoria, 29060300, Brazil, profbea@hotmail.com

The present work introduces a proposal of itineraries for some subway-bus express lines of integration in the city of Rio de Janeiro, comprising the neighborhoods Andara, Estacio, Graja, Maracanã, Muda, Rio Comprido, Tijuca, Usina and Vila Isabel, aiming at using paths of minimum length, targeting an installed subway net in operation until the 30th of June, 2006. As a restriction, it has been established that each integration line must serve one exclusive subway station, so that the representative cycle of the bus itineraries contains only one point associated to each subway station.

■ WB05

Marriott - Houston

Combinatorial Optimization T

Contributed Session

Chair: A. Yu. Gornov, Institute of System Dynamics and Control Theory of SB of RAS, Lermontov Str., 134, Irkutsk, Russian Federation, 664033, gornov@icc.ru

1 - Test Collection of the Nonconvex Optimal Control Problems

T.S. Zarodnyuk, Institute of System Dynamics and Control Theory SB RAS, Irkutsk Lermontov St., 134, Irkutsk 664033, Russia, tz@icc.ru

We consider collection of nonconvex optimal control test problems. The source of collection are model and meaningful problems, published in the scientific literature and obtained with the fulfillment of applied projects. Construction procedures of new nonconvex test problems are developed. Now collection contains more than 100 tests. A number of technologies for testing the optimal control search methods is realized.

2 - On Viability for a Affine Nonlinear Control System

Yan Gao, School of Management, University of Shanghai for Science and Technology, Shanghai 200093, China, gaoyan@usst.edu.cn

This paper is devoted to verifying the viability condition for a affine nonlinear control system on a region which is expressed by inequality constraints.Based on convex analysis and nonsmooth analysis, a method of determining the viability condition at a point is given. In this method, determining the viability is transformed into determining the consistency of a system of convex inequalities, that is convex feasibility problem. Then, a project method is used to solving convex inequalities.

3 - The Global Extremum Search Methods in Optimal Control Problem

A. Yu. Gornov, Institute of System Dynamics and Control Theory of SB of RAS, Lermontov Str., 134, Irkutsk, Russian Federation, 664033, gornov@icc.ru

We discuss methods and new approaches to the solution of global extremum search problem in the optimal control problems. Four families of heuristic methods are considered: “random multi-start”, convexification, reduction to finite dimensional problem, approximation of attainability set. Proposed algorithms are realized in software OPTCON-III. Computational experiments confirm the effectiveness of algorithms.

■ WB06

Marriott - Kansas City

Algorithms for Large Scale Optimization

Cluster: Conic Programming

Invited Session

Chair: Renato Monteiro, Professor, Georgia Tech, School of Industrial & Systems Engineeri, 765 Ferst Drive, NW, Atlanta, GA, 30332, United States of America, renato.monteiro@isye.gatech.edu

1 - An Augmented Lagrangian Approach for Sparse Principal Component Analysis

Zhaosong Lu, Assistant Professor, Simon Fraser University, 8888 University Drive, Burnaby, BC, V3T 0A3, Canada, zhaosong@sfu.ca, Yong Zhang

We formulate sparse PCA as an nonsmooth constrained optimization problem, aiming at finding sparse, orthogonal and nearly uncorrelated PCs while explaining most of the variance. Then we develop a novel augmented Lagrangian (AL) method for a broad class of nonsmooth problems, whose global convergence is established. We also propose two methods for solving the subproblems of the AL method. Their global and local convergence are established. Finally we present some computational results.

2 - On the Complexity of the Hybrid Proximal Extragradient Method

Renato Monteiro, Professor, Georgia Tech, School of Industrial & Systems Engineering, 765 Ferst Drive, NW, Atlanta, GA, 30332, United States of America, renato.monteiro@isye.gatech.edu, Benar Svaiter

We analyze the iteration-complexity of the hybrid proximal extragradient (HPE) method for finding a zero of a maximal monotone operator (MMO). One of the key points of our analysis is the use of a new termination criteria based on the $epsilon$-enlargement of a MMO. We then show that Korpelevich’s extragradient method for solving monotone variational inequalities falls in the framework of the HPE method. As a consequence, we obtain new complexity bounds for Korpelevich’s extragradient method which do not require the feasible set to be bounded. We also study the complexity of a variant of a Newton-type extragradient algorithm for finding a zero of a smooth monotone function with Lipschitz continuous Jacobian.

3 - A Nonsymmetric Interior-point Solver for Linear Optimization with Sparse Matrix Cone Constraints

Martin Andersen, PhD Candidate, University of California, Los Angeles, Electrical Engineering Department, 66-124 Engineering IV, 6-06, Los Angeles, CA, 90095, United States of America, martin.andersen@ucla.edu, Joachim Dahl, Lieven Vandenberghe

We describe an implementation of nonsymmetric interior-point methods for linear cone programs defined by chordal sparse matrix cones. The implementation takes advantage of fast recursive algorithms for evaluating the function values and derivatives of the logarithmic barrier functions for these cones and their dual cones. We present extensive experimental results of two implementations, one of which is based on the augmented system approach.

■ WB07

Marriott - Chicago D

Integer and Mixed Integer Programming E

Contributed Session

Chair: Chuangyin Dang, City University of Hong Kong, 83 Tat Chee Avenue, Kowloon, Hong Kong - ROC, mecdang@cityu.edu.hk

1 - A Strengthened Integer Programming Model for Conflict Minimization in Cartographic Label Placement

Miguel Constantino, University of Lisbon - Faculty of Science, DEIO-CIO edC6 Campo Grande, Lisbon, 1749-016, Portugal, miguel.constantino@fc.ul.pt, Glaydston Ribeiro, Luiz Lorena

We address a variant of the point-feature cartographic label placement problem, in which all labels must be placed and the number of labels in conflict should be minimized. We consider an Integer Programming formulation by Ribeiro et al. which is an extension of the standard IP node packing formulation. Valid inequalities for the set of feasible solutions are obtained and used to strengthen the model. We present computational results with a set of benchmark instances from the literature.

2 - Constraint Integer Programming for Scheduling Problems

Jens Schulz, Dipl. Math. oec., TU Berlin, Str. des 17. Juni 135, Berlin, 10623, Germany, jschulz@math.tu-berlin.de, Timo Berthold, Stefan Heinz, Rolf Moehring, Marco Luebbecke

Scheduling problems occur in many real-world applications. Solving these to optimality has been done by MIP and CP techniques. Recently, hybrid approaches gain in importance. One of the outcomes is the Constraint Integer Programming paradigm where both techniques are integrated in one search tree. We follow this paradigm and report on our study how the techniques can be best brought together. Our testcases are based on the RCPSP and Labor Constraint Scheduling Problem.

3 - A New Arbitrary Starting Variable Dimension Algorithm for Computing an Integer Point in a Class of Polytopes

Chuangyin Dang, City University of Hong Kong, 83 Tat Chee Avenue, Kowloon, Hong Kong - ROC, mecdang@cityu.edu.hk

Let P be a polytope satisfying that each row of the defining matrix has at most one positive entry. Determining whether there is an integer point in P is an NP-complete problem. A new arbitrary starting simplicial algorithm is developed in this paper for computing an integer point in P. Starting from an arbitrary integer point of the space, the algorithm follows a finite simplicial path that either leads to an integer point in the polytope or proves no such point exists.

■ WB08

Marriott - Chicago E

Trends in Mixed Integer Programming VII

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Robert Weismantel, Professor, Otto-von-Guericke University Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, weismant@mail.math.uni-magdeburg.de

Co-Chair: Andrea Lodi, DEIS, University of Bologna, Viale Risorgimento, 2, Bologna, 40136, Italy, andrea.lodi@unibo.it

1 - Mixing and Lot-sizing with Stock Variable Upper Bounds

Marco Di Summa, UCL - CORE, Voie du Roman Pays, 34, Louvain-la-Neuve, 1348, Belgium, marco.disumma@uclouvain.be, Laurence Wolsey

We study the discrete lot-sizing problem with an initial stock variable and an associated variable upper bound constraint. This problem is of interest in its own right, and is also a natural relaxation of the constant capacity lot-sizing problem with upper bounds and fixed charges on the stock variables (LS-CC-SVUB). We show that the convex hull of solutions of the discrete lot-sizing problem is the intersection of two simpler sets. For these two sets we derive both inequality descriptions and compact extended formulations of their respective convex hulls. Finally we carry out some limited computational tests on LS-CC-SVUB in which we use the extended formulations derived above to strengthen the initial MIP formulations.

2 - 2-Level Supply Chains: MIP Formulations and Computation

Rafael de Melo, CORE - University Catholique de Louvain, Rue Voie du Roman Pays, 34, Louvain-la-Neuve, B1348, Belgium, rafael.demelo@uclouvain.be, Laurence Wolsey

We consider first the two-level production-in-series model whose two-levels can be viewed as production and transportation. We derive a compact and tight extended formulation with O(n3) variables for both the general and nested cases. We also analyze a family of valid inequalities related to the projection of the standard multi-commodity reformulation. We then consider the two-level multi-item supply chain in which the 0-level consists of production facilities and the 1-level of retail centers.

3 - Two-period Convex Hull Closures for Big Bucket Lot-sizing Problems

Kerem Akartunali, Research Fellow, University of Melbourne, Dept. of Mathematics and Statistics, Parkville, 3010, Australia, kerema@ms.unimelb.edu.au, Andrew Miller

Despite significant amounts of research, big bucket lot-sizing problems remain notoriously difficult to solve. We consider a two-period model, which is the simplest single-machine, multi-period, capacitated submodel. We propose a methodology that would approximate the closure of the convex hull of this submodel by generating violated inequalities using a distance function. We discuss the polyhedral characteristics of this submodel, as well as how to apply them to the original problem, and we conclude with detailed computational results.

■ WB09

Marriott - Chicago F

MILP Methodologies for Non-Convex Optimization

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Anureet Saxena, Research Associate, Axioma Inc, 2313 Charleston Place, Atlanta, GA, 30338, United States of America, anureet@cmu.edu

1 - Modeling Disjunctive Constraints with a Logarithmic Number of Binary Variables and Constraints

Juan Pablo Vielma, ISyE, Georgia Institute of Technology, 765 Ferst Drive, NW, Atlanta, GA, 30332, United States of America, jvielma@isye.gatech.edu, George Nemhauser

For specially structured disjunctive constraints we give sufficient conditions for constructing mixed integer programming (MIP) formulations with a number of binary variables and extra constraints that is logarithmic in the number of terms of the disjunction. Using these conditions we introduce formulations with these characteristics for SOS1, SOS2 constraints and piecewise linear functions. We present computational results showing that they can significantly outperform other MIP formulations.

2 - Generalized Disjunctive Programming Relaxation for the Global Optimization of QCQPs

Juan Ruiz, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States of America, jpruiz@andrew.cmu.edu, Ignacio Grossmann

We present a framework to find strong relaxations for the global optimization of Quadratically Constrained Quadratic Programs. The main idea consists of representing the partition of the domain of each bilinear/quadratic term with a set of disjunctions. This leads to a Bilinear Generalized Disjunctive Program (GDP) that can be relaxed by using some of our recent results for the Global Optimization of Nonconvex GDPs. The performance of the method is shown through a set of test problems.

3 - Linear Programming Relaxations of Non-convex Mixed Integer Quadratically Constrained Problems

Andrea Qualizza, Tepper School of Business, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15217, United States of America, qualizza@cmu.edu, Anureet Saxena, Francois Margot, Pietro Belotti

This talk concerns linear programming relaxations of non-convex Mixed Integer Quadratically Constrained Problems (MIQCP). We investigate cutting planes based approaches to approximate the well known SDP+RLT relaxations of MIQCP both in the lifted space containing the Yij=xi*xj variables, and in the space of original variables. We study linear inequalities arising from the outer-approximation of the cone of PSD matrices, sparsification of these inequalities using prinipal minors, and linearization of various convex quadratic inequalities including the class of projected SDP cuts recently proposed by Saxena, Bonami and Lee. Computational results based on instances from the literature will be presented.

■ WB10

Marriott - Chicago G

Global Optimization Methods and Applications

Cluster: Global Optimization
Invited Session

Chair: Sergiy Butenko, Texas A & M University, Dept. of Industrial Engineering, College Station, TX, 77843, United States of America, butenko@tamu.edu

1 - On Equivalent Reformulations for Absolute Value Equations and Related Problems

Oleg Prokopyev, University of Pittsburgh, Industrial Engineering, Pittsburgh, PA, 15260, United States of America, prokopyev@engr.pitt.edu, Sergiy Butenko, Andrew Trapp

We study absolute value equations (AVE) of the form Ax+B|x|=c. This problem is known to be NP-hard. We discuss relations of AVE with linear complementarity problem and mixed integer programming. Related problems in checking strong and weak solvability of linear interval equations and inequalities are also considered.

2 - Risk Optimization with p-Order Conic Constraints

Paul Krokhmal, Assistant Professor, University of Iowa, 3131 Seamans Center, Iowa City, IA, 52242, United States of America, krokhmal@engineering.uiowa.edu

We consider p-order conic programming problems that are related to a certain class of stochastic programming models with risk objective or constraints. The proposed solution approach is based on construction of polyhedral approximations for p-order cones, and then invoking a cutting-plane scheme that

allows for efficient solving of the approximating problems. The conducted case study demonstrates that the developed computational techniques compare favorably against a number of benchmark methods.

3 - A GRASP for a Biobjective Critical Node Detection Problem

Altannar Chinchuluun, University of Florida, Gainesville, United States of America, altannar@ufl.edu, Ashwin Arulselvan, Panos Pardalos

In this talk, we focus on a biobjective Critical Node Detection Problem. The problem finds applications in biomedicine, telecommunications, energy and military strategic planning. The goal of the problem is to find a set of nodes in the graph whose deletion results in the maximum network fragmentation while minimizing the total cost of removing the nodes. We propose a multistart metaheursitic (Greedy Randomized Adaptive Search Procedure) for solving the problem.

■ WB11

Marriott - Chicago H

New Developments in Robust Optimization: Multistage and Nonconvex Problems

Cluster: Robust Optimization
Invited Session

Chair: Dimitris Bertsimas, MIT, Sloan School of Management, E40-147, MIT, Cambridge, MA, 02139, United States of America, dbertsim@mit.edu

1 - A Hierarchy of Near-optimal Policies in Multi-stage Robust Optimization

Dan Iancu, Massachusetts Institute of Technology, Operations Research Center, E40-130, Cambridge, Ma, 02139, United States of America, daniancu@mit.edu, Dimitris Bertsimas, Pablo A. Parrilo

In this work, we examine the performance of disturbance-feedback policies in the context of multi-stage robust optimization. For the one-dimensional case, we prove the optimality of affine policies. For the general case, we introduce a hierarchy of near-optimal policies, which can be computed efficiently, by solving a single semidefinite programming problem, and we demonstrate their performance numerically, in the context of two inventory management applications.

2 - On the Power of Robustness in Two-stage Mixed Integer Optimization Problems

Vineet Goyal, Postdoctoral Associate, Massachusetts Institute of Technology, 77 Massachusetts Ave, E40-111, Cambridge, MA, 02139, United States of America, goyalv@mit.edu, Dimitris Bertsimas

We show that the benefit of adaptivity is bounded by a constant factor in a two-stage problem under fairly general assumptions for uncertainty sets. In particular, for a two-stage mixed integer optimization problem with uncertain costs and right hand side of constraints that belong to a convex and symmetric uncertainty set, we show that the worst-case cost of an optimal one-stage robust solution is at most four times the worst-case cost of an optimal fully adaptive two-stage solution.

3 - Nonconvex Robust Optimization for Constrained Problems

Omid Nohadani, MIT, ORC, MIT, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States of America, nohadani@MIT.EDU, Dimitris Bertsimas

Most robust optimization techniques assume that underlying cost functions are given explicitly. We discuss a novel method for problems with objective functions that may be computed via numerical simulations and incorporate constraints that need to be feasible under perturbations. We generalize the algorithm further to model parameter uncertainties. We demonstrate its practicability in a real-world application in optimizing the Intensity Modulated Radiation Therapy for cancer treatment.

■ WB12

Marriott - Los Angeles

Inequality Constrained Optimization with PDEs

Cluster: PDE-constrained Optimization
Invited Session

Chair: Michael Ulbrich, Technische Universitaet Muenchen, Department of Mathematics, Boltzmannstr. 3, Garching, 85748, Germany, mulbrich@ma.tum.de

1 - Interior Point Methods in Function Space for Hyperthermia Treatment Planning

Anton Schiela, ZIB, Division Scientific Computing, Takusstr. 7, Berlin-Dahlem, 14195, Germany, schiela@zib.de

Regional hyperthermia aims at heating a tumor by microwaves. The aim is to heat the tumor, while not damaging the healthy tissue. This yields a state constrained optimal control problems subject to a non-linear partial differential equation. We consider an algorithm in function space for the solution of this problem. The state constraints are tackled by a structure exploiting interior point method. A composite step method is used for its globalization in the presence of non-convexity.

2 - State-constrained Optimal Control of a Quasilinear Parabolic-elliptic System

Christian Meyer, TU Darmstadt, Graduate School CE, Dolivostr. 15, Darmstadt, 64289, Germany, meyer@wias-berlin.de

The talk is dealing with an optimal control problem governed by a quasilinearly coupled system of a parabolic and an elliptic PDE, known as the thermistor equations. This PDE system models the heating of a conducting material by means of direct current. As pointwise restrictions on the temperature field are essential in many applications, we impose pointwise state constraints on the optimization. This requires higher regularity of the state which is proven by means of maximum regularity results for elliptic and parabolic PDEs. This allows to derive associated optimality conditions. The theoretical results are illustrated by a numerical example motivated by an application from the automotive industry.

3 - On Goal-oriented Adaptivity for Elliptic Optimal Control Problems

Martin Weiser, Zuse Institute Berlin, Division Scientific Computing, Takusstr. 7, Berlin-Dahlem, 14195, Germany, weiser@zib.de

The talk discusses goal-oriented error estimation and mesh refinement for optimal control problems with elliptic PDE constraints. The value of the reduced cost functional is used as quantity of interest. Error representation and practical hierarchical error estimators are derived. For state constrained problems, their relation to barrier methods is discussed. The effectivity is demonstrated at numerical examples and compared to previous approaches.

■ WB13

Marriott - Miami

Electricity Markets I

Cluster: Optimization in Energy Systems
Invited Session

Chair: Andres Ramos, Professor, Universidad Pontificia Comillas, Alberto Aguilera 23, Madrid, 28015, Spain, andres.ramos@upcomillas.es

1 - A MILP Model for the Resourse Scheduling Problem of a Power Producer with Market Share Maximization

Maria Teresa Vespucci, Professor, University of Bergamo, viale Marconi, 5, Dalmine, BG, 24044, Italy, maria-teresa.vespucci@unibg.it, Dario Siface, Mario Innorta

A model for the medium-term resource scheduling problem of a power producer of large dimension is introduced, that maximizes the producer’s market share while garanteeing a minimum preassigned profit level and satisfying technical constraints. The nonlinearities, introduced into the model by representing the power producer influence on hourly zonal equilibrium prices and quantities, are linearized by means of binary variables. A case study related to the Italian electricity market is discussed.

2 - A Primal Dual Algorithm for Simulation-based Computation of Cournot Equilibrium

Mingyi Hong, University of Virginia, Charlotesville, 22904, United States of America, mh4tk@virginia.edu, Alfredo Garcia

We consider an oligopolistic model of competition among spatially separated electricity generators. Clearing prices may differ on a zonal basis depending upon specific congestion events. We are interested in computing Nash Cournot equilibrium via a primal-dual algorithm in which power flow is simulated at each iteration. This feature alleviates the computational burden vis-a vis other methods in which power flow is modeled explicitly. We present convergence analysis and experimental results on large-scale networks.

3 - Sequential Stochastic Unit Commitment for Large-scale Integration of RES and Emerging Technologies

Andres Ramos, Professor, Universidad Pontificia Comillas, Alberto Aguilera 23, Madrid, 28015, Spain, andres.ramos@upcomillas.es, Jesus M. Latorre, Luis Olmos, Kristin Dietrich, Ignacio J. Pérez-Arriaga

RES and emerging technologies are modeled by a UC as a SIP problem that represents the daily operation considering the distribution of RES generation. Once planning is done some events, such as forced failures of units or actual generation of RES, may happen and corrective actions are heuristically decided. Random events are obtained by simulation. The SIP and the stochastic simulation models are sequentially run for every day of the scope. Main stochastic variables are simulated by scenarios.

■ WB14

Marriott - Scottsdale

Network Game Theory

Cluster: Game Theory
Invited Session

Chair: Asu Ozdaglar, Associate Professor, Massachusetts Institute of Technology, 77 Massachusetts Ave, 32-D630, Cambridge, MA, 02139, United States of America, asuman@mit.edu

1 - Game Dynamics, Equilibrium Selection and Network Structure

Amin Saberi, Stanford University, saberi@stanford.edu, Andrea Montanari

Coordination games describe social or economic interactions in which the adoption of a common strategy has payoff. They are classically used to model the spread of conventions, behaviors, and technologies in societies. Since the pioneering work of Ellison (1993), specific network structures have been shown to have dramatic influence on the convergence of such dynamics. In this talk, I will try to make these results more precise and use the intuition for designing effective algorithms.

2 - Communication and Learning in Social Networks

Kostas Bimpikis, MIT, 77 Massachusetts Ave, Cambridge, MA, United States of America, kostasb@mit.edu, Daron Acemoglu, Asu Ozdaglar

We study a model of costly network formation, information aggregation through communication and decision making in large societies. We identify conditions under which there will be asymptotic learning, i.e., as the society grows, the fraction of agents taking correct actions converges to one. We identify properties of the communication cost structure that lead to topologies, that facilitate learning. Finally, we apply our results to random graph models, such as power law and Erdos-Renyi graphs.

3 - Distributed Spectrum Balancing via Game Theoretical Approach

Yao H. Morin, Research Assistant, University of Minnesota, 200 Union ST SE, Minneapolis, MN, 55414, United States of America, yaohuang@umn.edu, Tom Luo

In a multi-user communication system, users compete for spectrum. Service provider aims to devise a scheme to regulate users' power so its utility is maximized. We develop a distributed scheme based on a game theoretic model and a price of service, which enables the scheme to be executed in a distributed fashion and entitles the service provider to control users' power. We study the existence of Nash equilibrium and provide convergence conditions. The scheme is scalable to multi-system case.

■ WB15

Gleacher Center - 100

Algorithm Developments in Stochastic Integer Programming

Cluster: Stochastic Optimization
Invited Session

Chair: Lewis Ntaimo, Assistant Professor, Texas A&M University, 3131 TAMU College Station, College Station, TX, 77843, United States of America, ntaimo@tamu.edu

1 - Prioritization via Stochastic Optimization

Ali Koc, The University of Texas at Austin, Graduate Program in Operations Research, Austin, TX, 78703, United States of America, alikoc@mail.utexas.edu, David Morton, Elmira Popova

The operations research literature handles activity selection problems by forming an optimal portfolio of activities, as opposed to a common approach in industry which forms a prioritized list. We develop a novel prioritization approach incorporating both views. We illustrate our approach on stochastic k-median and capital budgeting models. We formulate two-stage and multi-stage stochastic integer programs and develop valid inequalities. We use parallel branch-cut price to improve solution time.

2 - Mixed-integer Stochastic Decomposition for Two-stage Stochastic Integer Programming

Yang Yuan, PhD Candidate, The Ohio State University, 210 Baker Systems Engineering, 1971 Neil Avenue, Columbus, OH, 43210, United States of America, yuan.65@osu.edu, Suvrajeet Sen

Most studies in stochastic integer programming represent uncertainty by a finite number of scenarios. In this talk, we propose a statistical algorithm for two-stage stochastic integer programming problems with infinitely many scenarios by extracting information from the empirical scenario pool through sequential sampling. This algorithm can be referred to as mixed-integer stochastic decomposition.

3 - Fenchel Decomposition for Stochastic Mixed-integer Programming

Lewis Ntaimo, Assistant Professor, Texas A&M University, 3131 TAMU College Station, College Station, TX, 77843, United States of America, ntaimo@tamu.edu

In this talk, we present a new cutting plane method for two-stage stochastic mixed-integer programming (SMIP) called Fenchel decomposition (FD). FD is based on a new class of valid inequalities termed, FD cuts, which are based on Fenchel cutting planes in integer programming. We consider FD cuts based on both the first- and second-stage variables, and based only on the second-stage variables. Preliminary computational results will be presented.

■ WB16

Gleacher Center - 200

Risk-averse Optimization via Stochastic Dominance

Cluster: Stochastic Optimization
Invited Session

Chair: Darinka Dentcheva, Professor, Stevens Institute of Technology, 1 Castle Point on Hudson, Hoboken, NJ, 07030, United States of America, darinka.dentcheva@stevens.edu

1 - Optimization with Stochastic Dominance Constraints and Sampling

Tito Homem-de-Mello, Northwestern University, 2145 Sheridan Rd, Evanston, IL, 60208, United States of America, tito@northwestern.edu, Jian Hu, Sanjay Mehrotra

In this talk we discuss some approaches to model optimization problems where the constraints are formulated using the concept of stochastic dominance. The notion of stochastic dominance provides a way to compare risks; its use in the optimization context has only recently been introduced. We discuss how such models can be integrated with sampling techniques, which is a crucial step for the development of algorithms for this class of problems when the underlying distributions are either continuous or have a large number of scenarios. We present some properties of the resulting approximating problems as well as procedures to calculate statistical bounds for the estimates obtained with finitely many samples. Numerical results are presented.

2 - An Enhanced Model for Portfolio Choice with SSD Criteria: A Constructive Approach

Csaba Fabian, Professor, Kecskemet College, 10 Izsaki ut, Kecskemet, H-6000, Hungary, fabian@cs.elte.hu, Diana Roman, Viktar Zviarovich, Gautam Mitra

We formulate a portfolio choice model applying Second-order Stochastic Dominance. This model is an enhanced version of the multi-objective model proposed by Roman, Darby-Dowman, and Mitra (2006). The proposed model can be formulated as minimisation of a convex risk measure. Moreover it offers a natural generalisation of the SSD-constrained model of Dentcheva and Ruszczynski (2006). We present a computational study comparing solution methods and demonstrating modelling capabilities.

3 - Inverse Dominance Constraints Duality and Methods

Darinka Dentcheva, Professor, Stevens Institute of Technology, 1 Castle Point on Hudson, Hoboken, NJ, 07030, United States of America, darinka.dentcheva@stevens.edu, Andrzej Ruszczynski

We consider optimization problems with second order nonlinear stochastic dominance constraints formulated as a relation of Lorenz curves (inverse dominance). We present two subgradient methods for solving the problems and discuss their convergence. We compare their performance to other methods. We infer rank dependent utility optimization problems and mean-risk models with coherent measures of risk which are equivalent to the problem with inverse dominance constraints.

■ WB17

Gleacher Center - 204

Logistics and Transportation A

Contributed Session

Chair: Kazuhiro Kobayashi, National Maritime Research Institute, 6-38-1 Shinkawa Mitaka, Tokyo, Japan, kobayashi@nmri.go.jp

1 - A Branch-and-price Algorithm for a 3-Level Location-routing Problem

Leonardo Ribeiro, Petrobras, Av. Nilo Pensanha 151 7o Andar, Rio de Janeiro, RJ, Brazil, leonardosribeiro@petrobras.com.br, Laura Bahiense, Virgilio Ferreira

We consider a 3-level location-routing problem, were products are transported from factories to depots and from there to clients, according to routes designed in the solution procedure. We present a set partitioning formulation for this problem. In order to generate integer solutions, we developed a branch-and-price algorithm and two heuristic pricing procedures. Optimal solutions were found for instances with 25, 40 and 60 clients.

2 - An Advanced Integer Programming Based Hybrid Heuristic for Generalized VRP-like Problems

Diego Klabjan, Northwestern University, 2145 Sheridan Road, Room C210, Evanston, IL, 60208, United States of America, d-klabjan@northwestern.edu, Anupam Seth, Placid Ferreira

Production planning for PCB assembly defies standard OR approaches due to the size and complexity of the problems. We examine the problem on the popular collect-and-place type machines and model it as a generalized vehicle routing problem. We present a hybrid heuristic consisting of an initial constructive phase with a worst-case guarantee and an improvement phase based on integer-linear programming. Computational results are presented to demonstrate the effectiveness of the technique.

3 - An Approximate Dynamic Programming Approach for Ship Scheduling Problems

Kazuhiro Kobayashi, National Maritime Research Institute, 6-38-1 Shinkawa Mitaka, Tokyo, Japan, kobayashi@nmri.go.jp, Takahiro Seta, Mikio Kubo

An approximate dynamic programming approach for ship scheduling problems is studied. The ship scheduling problem is the planning problem to determine the ship schedules with minimum cost. It is formulated as a set covering problem. In this set covering problem, it is assumed that the data are static. However, in ship operations, there is much uncertainty. In order to deal with uncertainty, we use an approximate dynamic programming approach. We show the formulation to incorporate the approximate dynamic programming framework in the set covering formulation, and also show some numerical experiments.

■ WB18

Gleacher Center - 206

Branch-and-Bound for MINLP

Cluster: Nonlinear Mixed Integer Programming
Invited Session

Chair: Jon Lee, IBM TJ Watson Research Center, P.O. Box 218, Yorktown Heights, NY, 10598, United States of America, jonlee@us.ibm.com

1 - Nonlinear Branch-and-bound Revisited

Sven Leyffer, Argonne National Laboratory, MCS Division 9700 South Cass Avenue, Argonne, IL, 60439, United States of America, leyffer@mcs.anl.gov

We present a new open-source implementation of nonlinear branch-and-bound that pays special attention to how the nonlinear subproblems are solved. In particular, we develop new warm-starting techniques and explore their effectiveness in the context of nonlinear strong-branching rules. We present preliminary numerical results.

2 - A Local Branching Heuristic for MINLPs

Giacomo Nannicini, Ecole Polytechnique, LIX, Ecole Polytechnique, Palaiseau, 91128, France, giacomon@lix.polytechnique.fr, Pietro Belotti, Leo Liberti

Local branching is an improvement heuristic, developed within the context of branch-and-bound algorithms for MILPs, which has proved to be very effective in practice. For the binary case, it is based on defining a neighbourhood of the current incumbent solution by allowing only a few binary variables to flip their value. The neighbourhood is then explored with a branch-and-bound solver. We propose a local branching scheme for (nonconvex) MINLPs which is based on iteratively solving MILPs and NLPs. Preliminary computational experiments within the open source solver Couenne show that this approach is able to improve the incumbent solution on the majority of the test instances, requiring only a very short CPU time.

3 - Heuristics for Mixed Integer Nonlinear Programming

João Goncalves, IBM Resarch, 1101 Kitchawan Road, Yorktown Heights, United States of America, jpgoncal@us.ibm.com, Pierre Bonami

We show how several heuristics for finding feasible solutions of Mixed Integer Linear programs can be adapted to Mixed Integer Nonlinear programs (MINLPs). We present computational results on a set of convex MINLP instances. The results show that the heuristics can find good feasible solutions faster than the branch-and-bound algorithm and also that they can help the branch-and-bound algorithm reduce the computational time to solve those instances.

■ WB19

Gleacher Center - 208

Nonlinear Programming C

Contributed Session

Chair: Laura Kettner, Graduate Student, Northern Illinois University, Department of Mathematical Sciences, DeKalb, IL, 60115, United States of America, kettner@math.niu.edu

1 - A Newton Method for Vector Optimization

Fernanda M. P. Raupp, Professor, PUC-Rio, Rua Marques de S. Vicente, 225 sala 959, Rio de Janeiro, 22453-900, Brazil, fraupp@puc-rio.br, L. M. Graña Drummond, Benar Svaiter

We propose a Newton method for solving smooth unconstrained vector optimization problems under partial orders induced by general closed convex pointed cones with nonempty interior. The method extends the one proposed by Fliege, GraÒa Drummond and Svaiter for multicriteria, which in turn is an extension of the classical Newton method for scalar optimization. We prove local existence of an efficient point and q-quadratic convergence to this point, under semi-local assumptions.

2 - Parallel Multistart Strategies for Nonlinear Optimization

S. Ilker Birbil, Associate Professor, Sabanci University, FENS, Orhanli-Tuzla, Istanbul, 34956, Turkey, sibirbil@sabanciuniv.edu, Figen Oztoprak

The basic motivation of most parallel nonlinear optimization algorithms is to speed up the execution of sequential tasks. In this study, we argue that parallel processing can provide further performance improvements by means of parallel generation and exchange of information. We apply our idea to some well-known methods and present theoretical as well as numerical results on how appropriate interaction strategies may create advantages by modifying the mechanisms of original algorithms.

3 - Well-posed Vector Optimization Problems

Laura Kettner, Graduate Student, Northern Illinois University, Department of Mathematical Sciences, DeKalb, IL, 60115, United States of America, kettner@math.niu.edu, Sien Deng

This presentation will focus on well-posedness of vector optimization problems. We will discuss some new results based on scalarization and convex analysis techniques, including a result pertaining to well-posedness by Hausdorff distance of epsilon-optimal solution sets. We will also discuss results concerning properties of extended well-posedness in vector optimization.

■ WB20

Gleacher Center - 300

On Formulating and Solving Subproblems in Nonlinear Optimization

Cluster: Nonlinear Programming
Invited Session

Chair: Anders Forsgren, KTH - Royal Institute of Technology, Department of Mathematics, Stockholm, SE-100 44, Sweden, andersf@kth.se

1 - A Regularized Method for General Quadratic Programming

Philip E. Gill, Professor, University of California San Diego, Department of Mathematics, 9500 Gilman Drive, # 0112, La Jolla, CA, 92093-0112, United States of America, pgill@ucsd.edu, Elizabeth Wong

We propose a general quadratic programming method designed for use in an SQP method for large-scale nonlinearly constrained optimization. The method reflects recent developments in mixed-integer nonlinear programming and optimization subject to differential equation constraints that require fast QP methods capable of being hot started from a good approximate solution.

2 - On Solving a Quadratic Program Approximately

Anders Forsgren, KTH - Royal Institute of Technology, Department of Mathematics, Stockholm, SE-100 44, Sweden, andersf@kth.se, Fredrik Carlsson, Philip E. Gill

Minimization of a strictly convex quadratic function is a fundamental optimization problem. The conjugate-gradient method is in a sense an ideal method for solving this problem approximately. We view the conjugate-gradient method in a column generation framework with a steepest-descent problem in the Euclidean norm as subproblem. We also discuss extensions to other norms and nonnegativity constraints on the variables. Our motivation comes from intensity-modulated radiation therapy.

3 - Globally Convergent Optimization Methods Based on Conservative Convex Approximations

Krister Svanberg, Professor, KTH - Royal Institute of Technology, Department of Mathematics, Stockholm, SE-100 44, Sweden, krille@kth.se

This presentation deals with a certain class of globally convergent optimization methods, based on sequential conservative convex separable approximations. These methods, which are frequently used in structural- and topology optimization, are intended primarily for inequality-constrained nonlinear programming problems for which the set of feasible solutions has a non-empty interior. The possible incorporation of equality constraints will also be discussed.

■ WB21

Gleacher Center - 304

Emerging Communication Networks

Cluster: Telecommunications and Networks
Invited Session

Chair: Iraj Saniee, Head, Math of Nertworks and Communications, Bell Labs, Alcatel-Lucent, 600 Mountain Avenue, Murray Hill, NJ, 07974, United States of America, iis@research.bell-labs.com

1 - Optimization of Collaborative P2P and Service Provider Traffic Engineering

Qiong Wang, Bell Labs, Lucent Technologies, Murray Hill, United States of America, qwang@research.bell-labs.com, Anwar Walid

P4P is a new paradigm for collaboration between peer-to-peer (P2P) applications and service providers (SP's). The objective of P4P is to improve P2P download times and reduce ISP network congestion by allowing certain information exchange. We consider an enhanced P4P model which includes content caches. We develop a mathematic programming model that matches content demand and supply, routes network traffic, and places content caches to preserve network resource and save infrastructure cost.

2 - Dantzig-Wolfe Algorithms for Packing LPs: Comparing Additive vs Multiplicative Weight Updates

Matthew Andrews, Member Technical Staff, Bell Laboratories, 600 Mountain Ave, Murray Hill, NJ, 07974, United States of America, andrews@research.bell-labs.com

In this talk we examine Dantzig-Wolfe algorithms for packing linear programs and compare the performance of additive weight updates vs multiplicative updates. We show that the running time of multiplicative schemes can be quadratic in the desired error whereas for additive schemes the running time can be linear. We also study how small the error needs to be before the linear behavior manifests itself.

3 - Continuing Work on Power Flow Problems

Abhinav Verma, Student, Columbia University, 500 West, 120th Street, S.W.Mudd Building, Rm 313, New York, NY, 10027, United States of America, av2140@columbia.edu, Daniel Bienstock

We present work on 3 topics in power transmission systems. First we address a new model for vulnerability analysis that scales to large network size and provides useful insight. In the last part of the talk we consider the throughput maximization problem. Flows are governed by balance equations, and, significantly, by the laws of physics which are typically described by nonlinear, non-convex systems of equations. Our work has produced scalable algorithms. Joint work with Daniel Bienstock.

■ WB22

Gleacher Center - 306

SQP Methods and Software

Cluster: Implementations, Software
Invited Session

Chair: Klaus Schittkowski, Professor, University of Bayreuth, Universitaetsstr. 1, Bayreuth, 95440, Germany, klaus.schittkowski@uni-bayreuth.de

1 - An SQP Method Without Hessian or Jacobian Evaluations

Torsten Bosse, Humboldt University, Unter den Linden 8, Berlin, 10099, Germany, bosse@mathematik.hu-berlin.de, Andreas Griewank

We propose an SQP approach that avoids the evaluation of the active constraint Jacobian through the use of low rank updates. The matrix approximations utilize an adjoint secant condition involving Jacobian traspose vector products. For the linear algebra we provided a null-space and a range-space version with a compact storage and limited memory option for the Hessian approximation. We present numerical results on the usual test sets and several special test problems.

2 - FA_SQP, A Feasible Arc Algorithm Based on SQP Method

Jose Herskovits, Professor, COPPE - Federal University of Rio de Janeiro, Caixa Postal 68503, Rio de Janeiro, RJ, 21945970, Brazil, jose@optimize.ufrj.br

Given a point at the interior of inequality constraints, FA_SQP produces a sequence of feasible point with decrescent values of the objective. At each iteration a feasible descent arc is computed employing the SQP search direction, a restoring direction and an arc that involves second order approximations of the constraints. These requires de solution of two linear systems. We present strong theoretical results and a very auspicious numerical study. In particular, Maratos, effect is avoided.

3 - SQP Codes - 30 Years Later

Klaus Schittkowski, Professor, University of Bayreuth, Universitaetsstr. 1, Bayreuth, 95440, Germany, klaus.schittkowski@uni-bayreuth.de

The success story of SQP methods started in 1979, when Mike Powell implemented the code VF02AD. Meanwhile, SQP codes are routinely used for solving practical optimization problems and became part of most engineering design and control systems. The talk gives a review of practical applications of a typical implementation and its development over a period of 25 years. It is shown, how SQP methods are extended to other areas, e.g., to solve large scale, mixed integer, or least squares problems.

■ WB23

Gleacher Center - 308

Optimization in Machine Learning I

Cluster: Sparse Optimization
Invited Session

Chair: Stephen Wright, Professor, University of Wisconsin-Madison, Computer Sciences, 1210 West Dayton Street, Madison, WI, 53706, United States of America, swright@cs.wisc.edu

1 - Simple and Efficient Optimization Techniques for Machine Learning

Olivier Chapelle, Yahoo! Research, 2181 Mission College Blvd, Santa Clara, CA, 95054, United States of America, chap@yahoo-inc.com

In this talk, I will present various machine learning problems such as ranking, boosting, structured output learning, multiple kernel learning and graph-based classification. In all cases, variants of simple optimization techniques can be used to solve these problems efficiently.

2 - Large Scale Transductive Relational Learning

Sathiya Keerthi, Senior Scientist, Yahoo! Research, 2821 Mission College Blvd, Santa Clara, CA, 95054, United States of America, selvarak@yahoo-inc.com, S Sundararajan

This talk will look at optimization methods and issues related to the solution of large scale transductive relational learning problems arising in web mining.

3 - Large-scale Machine Learning and Stochastic Gradient Learning Algorithm

Leon Bottou, NEC Laboratories, 4 Independence Way, Suite 200, Princeton, NJ, 08540, United States of America, leon@bottou.org, Olivier Bousquet

During the last decade, data sizes have outgrown processor speed. Computing time is then the bottleneck. The first part of the presentation theoretically uncovers qualitatively different tradeoffs for the case of small-scale and large-scale learning problems. The large-scale case involves the computational complexity of the underlying optimization algorithms in non-trivial ways. Unlikely optimization algorithm such as stochastic gradient descent show amazing performance for large-scale machine learning problems. The second part makes a detailed overview of stochastic gradient learning algorithms, with both simple and complex examples.

■ WB25

Gleacher Center - 404

Generalized Derivatives and Derivative Free Optimization Methods

Cluster: Variational Analysis
Invited Session

Chair: Vaithilingam Jeyakumar, Professor, University of New South Wales, Department of Applied Mathematics, Sydney, Australia, v.jeyakumar@unsw.edu.au

1 - Various Lipschitz like Properties for Functions and Sets: Directional Derivative and Tangential Characterizations

Pedro Gajardo, Universidad Tecnica Federico Santa Maria, Avda Espana 1680, Valparaiso, Chile, pedro.gajardo@usm.cl, Lionel Thibault, Rafael Correa

In this talk we introduce for extended real valued functions, defined on a Banach space X, the concept of K directionally Lipschitzian behavior where K is a bounded subset of X. For different types of sets K (e.g. zero, singleton or compact), the K directionally Lipschitzian behavior recovers well-known concepts in variational analysis (locally Lipschitzian, directionally Lipschitzian or compactly epi-Lipschitzian properties respectively). Characterizations of this notion are provided in terms of the lower Dini subderivatives. We also adapt the concept for sets and establish characterizations of the mentioned behavior in terms of the Bouligand tangent cones. The special case of convex functions and sets is also studied.

2 - On Solving Generalized Nash Equilibrium Problems via Optimization

Barbara Panicucci, University of Pisa, Italy, panicucc@mail.dm.unipi.it

This talk concerns the generalized Nash equilibrium problem (GNEP). We consider an equivalent optimization reformulation of GNEP using a regularized Nikaido-Isoda function so that solutions of GNEP coincide with global minima of theoptimization problem. We then propose a derivative-free descent type method with inexact line search to solve the equivalent optimization problem and we prove that the algorithm is globally convergent. Finally, we present some numerical results

3 - Learning Lessons Across Deterministic and Stochastic Direct Search Methods

Mason Macklem, Doctor, University of British Columbia Okanagan, Kelowna, V1V1V7, Canada, mason.macklem@gmail.com

The terms “direct search” and “derivative-free” are often used to refer to both deterministic grid-sampling continuous optimization and evolutionary strategy algorithms. In this talk, we compare issues surrounding performance comparisons of both methods, and introduce some examples of how lessons learned in one class of methods can improve performance in the other.

■ WB28

Gleacher Center - 600

Nonsmooth Optimization: Theory and Applications

Cluster: Nonsmooth and Convex Optimization

Invited Session

Chair: Dominikus Noll, Professor, University of Toulouse, 118, Route de Narbonne, Toulouse, 31062, France, noll@mip.ups-tlse.fr

1 - Incremental-like Bundle Methods with Application to Energy Planning

Gregory Emiel, Doctor, IMPA, Estrada Dona Castorina 110, Rio de Janeiro, 22460-320, Brazil, gregoryemiel@gmail.com, Claudia Sagastizabal

An important field of application of non-smooth optimization refers to decomposition of large-scale problems by Lagrangian duality: the dual problem consists in maximizing a convex non-smooth function defined as the sum of sub-functions, some of them being hard to evaluate. We propose to take advantage of such separable structure by making a dual bundle iteration after having evaluated only a subset of the dual sub-functions and apply this incremental approach to generation planning.

2 - A Bundle Method for Non-smooth and Non-convex Optimization

Dominikus Noll, Professor, University of Toulouse, 118, Route de Narbonne, Toulouse, 31062, France, noll@mip.ups-tlse.fr

We discuss a bundle algorithm to minimize non-smooth and non-convex functions. Trial steps are obtained by solving convex quadratic programs, or in some cases, SDPs. The major difference with convex bundle methods is that cutting planes have to be replaced by a new technique. We prove that every accumulation point of the sequence of serious iterates is critical. The option of second order steps is included and in a variety of situations allows local super-linear convergence.

3 - Nonsmooth Methods for Robust Feedback Controller Synthesis

Olivier Prot, Doctor, University of Limoges, 123, Avenue Albert Thomas, Limoges, 87060, France, olivier.prot@unilim.fr, Dominikus Noll, Pierre Apkarian

We consider the problem of robust feedback controller synthesis. For this problem the Kalman-Yakubovitch-Popov Lemma leads to a program with bilinear matrix inequality constraint. We use a different approach in order to avoid the identification of Lyapunov variables. Problem is reformulated as a semi-infinite optimization program and solved using a non-smooth spectral bundle method. We present some numerical examples in the case of H_infinity and Integral Quadratic Constraint synthesis.

■ WB29

Gleacher Center - 602

Computational Methods for Dynamic Models in Economics - Part II

Cluster: Finance and Economics

Invited Session

Chair: Che-Lin Su, Assistant Professor of Operations Management, The University of Chicago Booth School of Business, 5807 S. Woodlawn Ave, Chicago, IL, 60637, United States of America, chelin.su@gmail.com

1 - Computational Approaches for Markov Inventory Games

Rodney Parker, Assistant Professor of Operations Management, The University of Chicago Booth School of Business, 5807 S. Woodlawn Ave, Chicago, IL, 60637, United States of America, Rodney.Parker@chicagobooth.edu

We discuss two separate approaches for computationally determining the Markov equilibrium policies in two dynamic inventory games. In the first game, two capacity-limited firms in a serial supply chain face stochastic market demand, choosing inventory levels in every period. In the second game, two retailers compete with stockout-based substitution.

2 - Competition and Innovation in the Microprocessor Industry

Ron Goettler, Assistant Professor of Marketing, The University of Chicago Booth School of Business, 5807 S. Woodlawn Ave, Chicago, IL, 60637, United States of America, ron.goettler@gmail.com

We propose and estimate a model of dynamic oligopoly with durable goods and endogenous innovation to examine the relationship between market structure and the evolution of quality. We estimate the model for the PC microprocessor industry and perform counterfactual simulations to measure the benefits of competition. Consumer surplus is 2.5 percent higher (\$5 billion per year) with AMD than if Intel were a monopolist. Innovation, however, would be higher without AMD present.

3 - Structural Estimation of Games with Multiple Equilibria

Che-Lin Su, Assistant Professor of Operations Management, The University of Chicago Booth School of Business, 5807 S. Woodlawn Ave, Chicago, IL, 60637, United States of America, chelin.su@gmail.com

We consider a model of an empirical pricing game with multiple equilibria and propose the constrained optimization formulation for estimation of the game. We present numerical results of our method on a Bertrand pricing example.

Wednesday, 3:15pm - 4:45pm

■ WC01

Marriott - Chicago A

Steiner Trees and Forests

Cluster: Approximation Algorithms

Invited Session

Chair: Cliff Stein, Columbia University, 326 S W Mudd Building, 500 W. 120th Street, New York, NY, 10027, cliff@ieor.columbia.edu

1 - Node-weighted Steiner Tree and Group Steiner Tree in Planar Graphs

Mohammad Hajiaghayi, Research Afflliate, MIT, Computer Science, 77 Massachusettes Avenue, Cambridge, MA 02139, hajiagha@mit.edu

We improve the approximation ratios for two optimization problems in planar graphs. For nodeweighted Steiner tree, a classical network-optimization problem, the best achievable approximation ratio in general graphs is O(log n), and nothing better was previously known for planar graphs. We give a constant-factor approximation for planar graphs. Our algorithm generalizes to allow as input any nontrivial minor-closed graph family, and also generalizes to address other optimization problems such as Steiner forest, prize-collecting Steiner tree, and network-formation games. The second problem we address is group Steiner tree: given a graph with edge weights and a collection of groups (subsets of nodes), find a minimum-weight connected subgraph that includes at least one node from each group. The best approximation ratio known in general graphs is O(log^{3n}), or O(log^{2n}) when the host graph is a tree. We obtain an O(log n polyloglog n) approximation algorithm for the special case where the graph is planar embedded and each group is the set of nodes on a face. We obtain the same approximation ratio for the minimum-weight tour that must visit each group.

2 - Polynomial-time Approximation Schemes for Connectivity Problems in Planar Graphs

Glencora Borradaile, Oregon State University, EECS, Corvallis, OR, United States of America, glencora@eecs.oregonstate.edu

We present a framework for designing polynomial-time approximation schemes for network design problems such as Steiner tree and 2-edge connectivity in planar graphs. For a fixed epsilon, a polynomial-time approximation scheme finds, in polynomial time, a solution whose value is within 1+epsilon of the optimal solution. This work is joint with Philip Klein and Claire Mathieu.

3 - Improved Approximation Algorithms for Prize-collecting Steiner Tree and TSP

Howard Karloff, ATT Labs—Research, 180 Park Ave., Room C231, Florham Park, NJ, 07932, United States of America, howard@research.att.com

We study the prize-collecting versions PCST of Steiner tree and PCTSP of TSP: find a tree (for PCST) or cycle (for PCTSP) in a graph minimizing the sum of the edge costs in the tree/cycle and the node penalties of the unspanned nodes. The previously best(2-approximation)-algorithm appeared in 1992. The LP relaxation of PCST has integrality ratio 2. We present (2-epsilon)-approximation algorithms for both problems. With Aaron Archer, Mohammad Hossein Bateni, and MohammadTaghi Hajiaghayi.

■ WC02

Marriott - Chicago B

Algorithms for Variational Inequalities and Related Problems I

Cluster: Complementarity Problems and Variational Inequalities

Invited Session

Chair: Andreas Fischer, TU Dresden, Institute of Numerical Mathematics, Dresden, 01062, Germany, Andreas.Fischer@tu-dresden.de

1 - Newton's Method for Computing a Generalized Nash Equilibrium Through Fixed Point Formulation

Anna von Heusinger, University of Wuerzburg, Department of Mathematics, Am Hubland, Wuerzburg, 97074, Germany, heusinger@mathematik.uni-wuerzburg.de, Masao Fukushima, Christian Kanzow

The generalized Nash equilibrium problem (GNEP) differs from the standard Nash equilibrium problem in that not only the players' cost functions depend on the rivals' decision variables, but also their strategy spaces. Fixed point formulations are typically connected with showing existence of a Nash equilibrium. Here we use a particular single-valued fixed point formulation in order to develop numerical methods for the computation of a generalized Nash equilibrium.

2 - Generalized Complementarity as Unconstrained Optimization

Mohamed Tawhid, Doctor, Thompson Rivers University, Department of Mathematics and Statistics, 900 McGill Road, P.O. Box 3010, Kamloops, BC, V2C 5N3, Canada, Mtawhid@tru.ca

We consider an unconstrained minimization reformulation of the generalized complementarity problem GCP(f,g). We show under appropriate conditions, a local/global minimum of a merit function (or a "stationary point" of a merit function) is coincident with the solution of the given generalized complementarity problem. Further, we give some conditions on the functions f and g to get a solution of GCP(f,g) by introducing the concepts of relative monotonicity and {\bf P_0}-property and their variants. Our results further give a unified/generalization treatment of such results for the nonlinear complementarity problem.

3 - Regulating HazMat Transportation: A Game Theory Approach

Veronica Piccialli, Dipartimento di Ingegneria dell'Impresa Universita' degli Studi di Roma Tor Vergata, Via del Politecnico 1, Rome, Italy, piccialli@disp.uniroma2.it, Massimiliano Caramia, Stefano Giordani, Lucio Bianco

Hazardous materials transportation is characterized by the risk of accidental release of hazardous materials. We propose a game theory approach to regulate the hazmat transportation flow. We assume that the authority is able to introduce different tax levels on the links to force carriers to take routes where the induced risk is lower and to reduce the risk concentration on a single link. Taxes imply a mutual influence of the carriers on their costs, and this naturally leads to a Nash game.

■ WC03

Marriott - Chicago C

New Game Theory Applications to Electricity

Cluster: Optimization in Energy Systems

Invited Session

Chair: Marcia Fampa, COPPE UFRJ, Brigadeiro Trompowski s/n, Rio de Janeiro, Brazil, fampa@cos.ufrj.br

1 - Worst-case Analysis for Modelling the Interaction Between Forward and Spot Markets

Nalan Gulpinar, Warwick University, Warwick Business School, Coventry, United Kingdom, Nalan.Gulpinar@wbs.ac.uk, Fernando Oliveira

In this paper we consider worst-case analysis of strategic decisions in oligopolistic future markets under uncertainty. The interaction between futures and spot prices is modelled by taking into consideration the players in the industry. The two-stage risk-neutral stochastic model is extended to a minimax model with rival demand scenarios. We investigate the impact of demand uncertainty at the level of players in terms of robust optimal strategies and compare the performance of the robust optimization with the cases of no uncertainty, and risk-neutral uncertainty.

2 - Computing Core Allocations for Firm Energy Rights: A MIP and a Randomized Procedures

Marcia Fampa, COPPE UFRJ, Brigadeiro Trompowski s/n, Rio de Janeiro, Brazil, fampa@cos.ufrj.br, Sergio Granville, Juliana Pontes, Luiz Barroso, Mario Pereira

Firm energy is the maximum constant production achieved by a set of hydro plants in a dry period. There is a synergic gain whenever a cooperative operation occurs. The key question is to find a distribution of the benefits shares among the hydro plants which is fair, i.e., a core element. The core constraints increase exponentially with the number of players. We propose a MIP algorithm, based on constraint generation and a randomized procedure in which a constraint sampling is applied.

■ WC04

Marriott - Denver

Combinatorial Optimization F

Contributed Session

Chair: Sylvia Boyd, Professor, SITE, University of Ottawa, 800 King Edward Ave., Ottawa, ON, K1N 6N5, Canada, sylvia@site.uottawa.ca

1 - A Large-scale Computational Study of Optimal Tour Lengths for Geometric Instances of the TSP

David S. Johnson, AT&T Labs - Research, 180 Park Avenue, Room C239, Florham Park, NJ, 07932, United States of America, dsj@research.att.com, Neil Sloane, David Applegate, William Cook

We report on a computational study of optimal TSP solutions for points distributed uniformly in the unit square, both as a function of n and of the particular topology chosen (planar, toroidal, projective plane, etc.). With the Concorde optimization code, we can now test millions of instances for each n <= 100, and thousands for n = 1,000. Earlier, more limited studies yielded conflicting estimates of the Beardwood-Halton-Hammersley asymptotic constant and missed some interesting (and as-yet-unexplained) "small n" behavior that our experiments reveal.

2 - On a Time-dependent Two Path Formulation for the (Cumulative) TSP

Maria Teresa Godinho, ESTIG-Instituto Politecnico de Beja and CIO, Rua Afonso III, 1, 7800-050, Beja, Portugal, mtgodinho@ipbeja.pt, Luis Gouveia

It is well known that the so-called 2-path multi commodity formulations for the TSP do not improve upon the linear programming bound of the corresponding 1-path multi commodity formulation. We introduce a new 2-path time dependent formulation which produces a tighter linear programming bound than the corresponding 1-path formulation and present computational results showing that the new formulation appears to produce very tight linear bounds (with emphasis on the so-called cumulative TSP).

3 - Structure of the Extreme Points of the Subtour Elimination Polytope of the STSP

Sylvia Boyd, Professor, SITE, University of Ottawa, 800 King Edward Ave., Ottawa, ON, K1N 6N5, Canada, sylvia@site.uottawa.ca, Paul Elliott-Magwood

Knowledge of the structure of the extreme solutions of LP relaxations has been useful in obtaining new approximation algorithms for several NP-hard problems. We study the extreme solutions of the Subtour Elimination Problem (SEP), which is an LP relaxation of the STSP, and give some new results on the underlying structure and the defining cobasis structure of these solutions. We use our results to find the exact integrality gap for the metric SEP for some new small values of n.

■ WC05

Marriott - Houston

Complementarity Problems and Variational Inequalities A

Contributed Session

Chair: Osman Guler, Professor, UMBC (University of Maryland), 1000 Hilltop Circle, Baltimore, MD, 21250, United States of America, guler@umbc.edu

1 - Minty Variational Principle for Set-valued Variational Inequalities

Giovanni P. Crespi, Professor, Universite de la Valle d'Aoste, Faculty of Economics and Business Management, Loc. Grand Chemin, 73/75, Saint-Christophe, 11020, Italy, g.crespi@univda.it, Matteo Rocca, Ivan Ginchev

For scalar functions, a solution of a Minty variational inequality of differential type is also a solution to the primitive optimization problem. The variational inequality is defined as some directional derivative of the objective function of a minimization problem. This result, also known as Minty Variational Principle, holds under mild lower semicontinuity assumption. Several attempt to extend the principle to the vector case has been undertaken. Yang, Yang and Teo proved it holds true only for pseudoconvex functions. Here we try to extend the result to set-valued optimization.

2 - Some Properties of a Smoothing Function Based on the Fischer-Burmeister Function for SOCCP

Yasushi Narushima, Tokyo University of Science, 1-3, Kagurazaka, Shinjyuku-ku, Tokyo, 162-8601, Japan, narusima@rs.kagu.tus.ac.jp, Hideho Ogasawara, Nobuko Sagara

The second-order cone complementarity problem (SOCCP) is an important class of problems containing a lot of optimization problems. By using an SOC complementarity function, the SOCCP can be transformed into a system of nonsmooth equations. To solve this nonsmooth system, smoothing techniques are often used. In this talk, we consider a smoothing function based on the Fischer-Burmeister function for SOCCP. We present some favorable properties on it and propose an algorithm.

3 - New Applications of Ekeland's Epsilon-variational Principle

Osman Guler, Professor, UMBC (University of Maryland), 1000 Hilltop Circle, Baltimore, MD, 21250, United States of America, guler@umbc.edu

Since 1972, Ekeland's variational principle has been one of the most important tools in all of optimization and nonlinear analysis. We first give an overview of some of its most important applications to date. We then give several new applications, to the existence of solutions in some optimization problems, asymptotic analysis of solutions, and to some new results of implicit function type.

■ WC06

Marriott - Kansas City

High Performance Solvers and Techniques for SDP

Cluster: Conic Programming

Invited Session

Chair: Makoto Yamashita, Tokyo Instittute of Technology, 2-12-1-W8-29 Ookayama Meguro-ku, Tokyo, Japan, Makoto.Yamashita@is.titech.ac.jp

1 - Reduction of SDP Relaxations for Polynomial Optimization Problems

Martin Mevissen, Tokyo Institute of Technology, Meguro-ku, Ookayama 2-12-1-W8-29, Tokyo, Japan, martime6@is.titech.ac.jp, Masakazu Kojima

SDP relaxations for a polynomial optimization problem (POP) were constructed by Lasserre and Waki et al. Still, the size of the SDP relaxation remains the major obstacle for POPs of higher degree. An approach to transform general POPs to quadratic optimization problems (QOPs) is proposed, that reduces the size of the SDP relaxation substantially. We introduce different heuristics resulting in equivalent QOPs and show how sparsity is maintained under the transformation procedure. As the most important issue we discuss how to increase the quality of the SDP relaxation for QOPs. We increase the accuracy of the SDP relaxation by applying local optimization techniques and by imposing additional polynomial bounds to the QOP.

2 - New Technologies in the SDPA Project

Katsuki Fujisawa,Chuo University, 1-13-27, Kasuga, Bunkyo, Tokyo 112-8551, Japan, fujisawa@indsys.chuo-u.ac.jp

The SDPA Project started in 1995 have provided several software packages for solving large-scale Semidefinite Programs(SDPs). Further improvements are necessary for the software packages since optimization problems become larger and more complicated. We show some current works and new technologies in the SDPA project as follows; (I) The memory hierarchy is carefully considered to specify the bottleneck of the algorithm and improve the performance. The latest version of the SDPA supports the multi-thread computing on multi-core processor, and solves large-scale SDPs quickly and efficiently. (II) We have developed a web portal system utilizing the cloud computing technology for some software packages in the SDPA Project.

3 - Parallel Software for SemiDeinfite Programming with Sparse Schur Complement Matrix

Makoto Yamashita, Tokyo Instittute of Technology, 2-12-1-W8-29 Ookayama Meguro-ku, Tokyo, Japan, Makoto.Yamashita@is.titech.ac.jp, Kazuhide Nakata, Maho Nakata, Mituhiro Fukuda, Kazuhiro Kobayashi, Masakazu Kojima, Yoshiaki Futakata, Katsuki Fujisawa

When primal-dual interior-point methods are employed to solve SemiDefinite Programming (SDP) Problem, evaluating Schur complement matrix (SCM) and its Cholesky factorization occupy most computation time. To shorten the computation time, SDPARA (SemiDefinite Programming Algorithm paRAllel version) applies parallel computation to these two bottlenecks. However, the SCM turns out to be considerably sparse in some SDP applications. To address both dense and sparse Schur complement matrix, we add a new distributed computation using sparse/dense evaluation formulas for the SCM. Numerical results verifies SDPARA can solve extremely large SDPs with sparse SCM more efficiently than handling SCM in dense format.

■ WC07

Marriott - Chicago D

Integer and Mixed Integer Programming F

Contributed Session

Chair: Eduardo Uchoa, Professor, Universidade Federal Fluminense, Rua Passo da Patria 156 D-440, Niterai, 24210-240, Brazil, uchoa@producao.uff.br

1 - Computationally Tractable Stochastic Integer Programming Models for Air Traffic Management

Charles N. Glover, PhD Candidate, University of Maryland, 3117 AV Williams, College Park, MD, 20742, United States of America, cnglover@math.umd.edu, Michael O. Ball

Convective weather is a major contributor to air traffic delays. Responding to predictions of convective weather requires the solution of resource allocation problems that assign a combination of ground delay and route adjustments to many flights. Since there is much uncertainty associated with weather predictions, stochastic models are necessary. We describe a multi-period stochastic integer program for this problem. We show that under certain conditions the LP-Relaxation yields integer optimal solutions. For more general cases we compare the strength of alternate formulations and provide computationally tractable formulations.

2 - On BFC-MSMIP Strategies for Scenario Cluster Partitioning, and Twin Node Family Branching Selection

Maria Araceli Garin, Doctor, University of the Basque Country, Lehendakari Aguirre, 83, Bilbao, 48015, Spain, mariaaraceli.garin@ehu.es, Maria Merino, Laureano Escudero, Gloria Pérez

In the Branch-and-Fix Coordination algorithm for solving large-scale multistage stochastic mixed integer programming problems, we can find it is crucial to decide the stages where the nonanticipativity constraints are explicitly considered in the model. This information is materialized when broken down the full model in a scenario cluster partition with smaller subproblems. In this paper we present a scheme for obtaining strong bounds and branching strategies for the Twin Node Families to increase the efficiency of the procedure BFC- MSMIP. Some computational experience is reported to support the efficiency of the new scheme.

3 - Time Dependent Traveling Salesman Problem: Polyhedra and Branch-cut-and-price

Eduardo Uchoa, Professor, Universidade Federal Fluminense, Rua Passo da Patria 156 D-440, Niterai, 24210-240, Brazil, uchoa@producao.uff.br, Ricardo Fukasawa, Hernan Abeledo, Artur Pessoa

The TDTSP is a generalization of the TSP, where arc costs depend on their position in the tour with respect to a chosen source node. We study the polyhedra associated to the TDTSP formulation by Picard and Queyranne, determining their dimension and finding some families of facet defining cuts. It is worthy noting that known TSP facets correspond to quite low dimensional TDTSP faces. Very good computational results were obtained with a BCP algorithm using the new cuts.

■ WC08

Marriott - Chicago E

Trends in Mixed Integer Programming VIII

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Robert Weismantel, Professor, Otto-von-Guericke University Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, weismant@mail.math.uni-magdeburg.de

Co-Chair: Andrea Lodi, DEIS, University of Bologna, Viale Risorgimento, 2, Bologna, 40136, Italy, andrea.lodi@unibo.it

1 - An Integer Programming Approach to Robust Tail Assignment

Ivan Dovica, Zuse Institute Berlin, Takustrasse 7, Berlin, Germany, dovica@zib.de, Ivo Nowak, Ralf Borndoerfer, Thomas Schickinger

This talk considers a robust version of the tail assignment problem, which considers the routing of individual aircraft. We model this problem as optimization problem in which non-robustness costs are minimized. Our approach is based on a stochastic model of the operation of an airline. In our talk we propose possible measures of robustness such as expected propagated delay, and solve the robust tail assignment problem by column generation technique.

2 - A Tricriteria Steiner Tree Problem

Leizer Pinto, PhD Student, Federal University of Rio de Janeiro, Department of Systems Engineering and Computer Science, Centro de Tecnologia, Bloco H, Sala 319, Rio de Janeiro, 21941-972, Brazil, leizer@cos.ufrj.br, Gilbert Laporte

The problem considered in this paper is a tricriteria Steiner tree problem, where the objective functions consist of maximizing the revenue and of minimizing the maximum distance between each pair of interconnected nodes and the maximum number of arcs between the root and each node. A polynomial algorithm is developed for the generation of a minimal complete set of Pareto-optimal Steiner trees.

3 - Application of Network Design with Orientation Constraints

Emiliano Traversi, DEIS - University of Bologna, Viale Risorgimento 2, Faculty of Engineering, Bologna, Italy, emiliano.traversi2@unibo.it, Alberto Caprara, Joerg Schweizer

We address the problem of orienting the edges of an undirected graph so as to minimize the sum of the distances between a given set of origin-destination pairs in the resulting directed graph. The problem originates from the design of Personal Rapid Transit (PRT) networks. We present also the real-world version with nonlinear travel costs depending on the congestion. For both versions exact and heuristic methods are presented.

■ WC09

Marriott - Chicago F

The Complexity of Integer Hulls

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Andreas Schulz, Massachusetts Institute of Technology, E53-357, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States of America, schulz@mit.edu

1 - Small Chvatal Rank and Stable Set Polytopes

Annie Raymond, Massachusetts Institute of Technology, 6360 Duquesne, Montreal, QC, H1M3K5, Canada, away@mit.edu, Rekha Thomas, Tristram Bogart

Given a rational polyhedron, the small Chvatal rank is the number of rounds of a Hilbert basis procedure needed to generate all of the normals of the facets of its integer hull. We will discuss how certain interesting normals appear within two steps of this procedure when applying it to the fractional stable set polytope.

2 - On the Rank of Cutting-plane Proof Systems

Sebastian Pokutta, Technische Universitat Darmstadt, Schlossgartenstr. 7, Darmstadt, 64289, Germany, pokutta@mathematik.tu-darmstadt.de, Andreas Schulz

We introduce a natural abstraction of cutting-plane proof systems, which includes well-known operators such as Gomory-Chvatal, lift-and-project, Sherali-Adams, Lovasz-Schrijver, and split cuts. We exhibit a family of lattice-free polytopes contained in the n-dimensional 0/1-cube that has rank Omega(n/log n) for any proof system in our family. We also construct a new cutting-plane procedure that has worst-case rank n/log n for any lattice-free polytope, showing that the lower bound is tight.

3 - On the Membership Problem for the {0,1/2}-Closure

Andreas Schulz, Massachusetts Institute of Technology, E53-357, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States of America, schulz@mit.edu, Sebastian Pokutta, Adam Letchford

Caprara and Fischetti introduced {0,1/2}-cuts and showed that the associated separation problem is strongly NP-hard. We show that separation remains strongly NP-hard, even when all integer variables are binary, even when the integer linear program is a set packing problem, and even when the matrix of left-hand side coefficients is the clique matrix of a graph containing a small number of maximal cliques. We show these results for the membership problem, which is weaker than separation.

■ WC10

Marriott - Chicago G

Recent Advances in Global Optimization

Cluster: Global Optimization
Invited Session

Chair: Oliver Stein, University of Karlsruhe (TH), Institute of Operations Research, Karlsruhe, 76128, Germany, stein@wior.uni-karlsruhe.de

1 - Global Optimization of Fixed-point Iterations

Paul Barton, Lammot du Pont Professor, MIT, Room 66-464, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States of America, pib@mit.edu, Matthew Stuber

A method for globally solving nonconvex optimization problems constrained by functions defined through embedded fixed-point iterations is presented. Embedded fixed-point iterations are encountered when the decision variables cannot be expressed explicitly but only numerically by solving for an implicit function. Interval methods and McCormick's relaxations are utilized to calculate valid convex/concave relaxations of the implicitly defined constraint, and refined using the Branch-and-Bound framework.

2 - Difference of Convex Monotonic Functions. Applications in Continuous Location Problems

Emilio Carrizosa, Professor, Universidad de Sevilla, Fac Matematicas. Reina Mercedes s/n, Sevilla, C.P. 41012, Spain, ecarrizosa@us.es, Rafael Blanquero

A function is said to be dcm if it can be expressed as a difference of two convex monotonic functions. For dcm functions, it is possible to combine convexity and monotonicity properties to obtain sharp bounds, to be used in global optimization procedures such as Branch and Bound. In this talk we will illustrate the use of dcm-based bounds in some continuous location problems. Numerical comparison with standard dc-based bounds will be made, showing the usefulness of our procedure.

3 - Enhancing RLT Relaxations for Polynomial Problems with a Class of v-Semidefinite Cuts

Evrim Dalkiran, PhD Candidate, Virginia Polytechnic Institute and State University, Grado Dept. of Industrial&Systems Eng., 250 Durham Hall (0118), Blacksburg, VA, 24061, United States of America, dalkiran@vt.edu, Hanif D. Sherali, Jitamitra Desai

We enhance RLT-based relaxations for polynomial programs with a class of v-semidefinite cuts that are derived by imposing positive semidefiniteness on (constraint-factor scaled) dyadic variable-product matrices. We explore various strategies for generating cuts, and exhibit their relative effectiveness for tightening relaxations and solving the underlying polynomial programs. Insights are provided to reveal classes of v-semidefinite cuts that significantly improve performance.

■ WC11

Marriott - Chicago H

Methodology and Applications of Robust Optimization

Cluster: Robust Optimization
Invited Session

Chair: David Brown, Duke University, dbbrown@duke.edu

1 - Beyond First and Second Moment Constraints in Distributionally Robust Optimization

Erick Delage, Assistant Professor, HEC Montréal, Montreal, Qc, H3T 2A7, Canada, erick.delage@hec.ca, Yinyu Ye

Although distributionally robust optimization can account for uncertainty in the stochastic program, its solution can be unnecessarily conservative if the uncertainty set only uses first and second order moment information. We present a class of distributional set which can account for a much wider range of moment information while ensuring that the resulting decision model is tractable for many applications. Experiments with portfolio selection will provide valuable insights on this problem.

2 - Distributionally Robust Optimization

Joel Goh, National University of Singapore, Department of Decision Sciences, 1 Business Link, Singapore, 117592, Singapore, bizgwj@nus.edu.sg, Melvyn Sim

We study a linear optimization problem with uncertainties, having expectations in the objective and in the set of constraints. We present a modular framework to approximate its solution using linear decision rules (LDRs), by first affinely-extending the set of primitive uncertainties to generate new (LDRs) of larger dimensions. Next, we present new piecewise-linear decision rules which allow a more flexible re-formulation of the original problem. We also demonstrate how to construct upper bounds to approximate the re-formulated problem, and conclude with an example illustrating how our framework can be applied to robustly optimize a multi-period inventory management problem with service constraints.

3 - From CVaR to Uncertainty Set: Implications in Joint Chance Constrained Optimization

Melvyn Sim, Professor, National University of Singapore, National University of Singapore, Singapore, Singapore, dscsimm@nus.edu.sg, Jie Sun, Chung-Piaw Teo, Wenqing Chen

We review the different tractable approximations of individual chance constraint problems using robust optimization on a varieties of uncertainty set, and show their interesting connections with bounds on the condition-value-at-risk CVaR measure. We also propose a new formulation for approximating joint chance constrained problems that improves upon the standard approach that decomposes the joint chance constraint into a problem with m individual chance constraints and then applies safe robust optimization approximation on each one of them.

4 - A Satisficing Alternative to Prospect Theory

David Brown, Duke University, dbbrown@duke.edu, Melvyn Sim, Enrico De Giorgi

We introduce a target-based model of choice that allows decision makers to be both risk averse and risk seeking, depending on the security of a position's payoff relative to a given target. The approach captures in spirit two celebrated ideas: the satisficing concept from Simon and the switch between risk aversion and risk seeking behaviors popularized by Kahneman and Tversky's prospect theory. Our axioms are simple and practical use of our theory involves only specification of decision maker goals. We show that this approach is dual to a known approach using risk measures. Though our approach is intended to be normative, we also show that our approach results in resolution of some of the classical ``paradoxes" of Allais and Ellsberg.

■ WC12

Marriott - Los Angeles

Simulation Based Algorithms for PDE-constrained Optimization

Cluster: PDE-constrained Optimization

Invited Session

Chair: Andreas Griewank, Professor, Humboldt University, Unter den Linden 8, Berlin, 10099, Germany, griewank@mathematik.hu-berlin.de

1 - One-shot Design Optmization with Bounded Retardation

Andreas Griewank, Professor, Humboldt University, Unter den Linden 8, Berlin, 10099, Germany, griewank@mathematik.hu-berlin.de

We consider a methodology for converting fixed point solvers for state equations into one-shot iterations on associated equality constrained optimization problems. We attempt to estimate and bound the resulting deterioration of the convergence rate in terms of a retardation factor. It depends on the the interplay between the Hessian of the Lagrangian and the particular state equation solver, e.g. Jacobi and its multigrid variants. We present numerical results from aerodynamics.

2 - Real-time Control of Hydrodynamic Models on Networks

Johannes Hild, Friedrich-Alexander-Universitaet Erlangen-Nuernberg, AM2, Martensstrasse 3, Erlangen, 91058, Germany, hild@am.uni-erlangen.de, Guenter Leugering

We present a software framework to compute the weir control for an urban drainage system in real-time. The framework generates an infinite control sequence in a moving horizon setting in real-time. A hydrodynamic model based on shallow water equations is discretized on networks via FVM, the state variables - water mass, flow rate and pollution - are computed by an explicit Godunov scheme. Interfacing of the AD-tool ADOL"C with a C++-template technique grants fast and robust gradients.

3 - Optimization of Fluid Flows with Reduced Order Methods

Andrea Walther, Professor, Universitaet Paderborn, Warburger Str. 100, Paderborn, 33098, Germany, andrea.walther@uni-paderborn.de

This talk presents first results for the optimal steering of fluid flows with electromagnetic forces when the optimization is performed for a reduced order method. A sophisticated simulation software is used to generate a corresponding POD basis. Subsequently, this information is applied for an adjoint calculation and hence a gradient-based optimization approach. Numerical results are presented for the flow around an obstacle.

■ WC13

Marriott - Miami

Models for Unit Commitment and Transmission Switching

Cluster: Optimization in Energy Systems

Invited Session

Chair: Michael Ferris, University of Wisconsin-Madison, 4381 Computer Sciences and Statistics, 1210 W Dayton Street, Madison, WI, 53706, United States of America, ferris@cs.wisc.edu

1 - Optimal Transmission Switching

Emily Fisher, PhD Candidate, The Johns Hopkins University, 3400 N. Charles St., Ames Hall 313, Baltimore, MD, 21218, United States of America, ebartho3@jhu.edu, Richard O'Neill, Michael Ferris, Kory Hedman

In this paper, we formulate the problem of finding an optimal generation dispatch and transmission topology to meet a specific inflexible load as a mixed-integer program. In our model binary variables represent the state of the equipment and linear relationships describe the physical system. We also analyze first order conditions of the optimal solution to gain insight on prices, or dual variables, for the non-continuous (switching) primal variables.

2 - Optimal Multi-period Generation Unit Commitment and Transmission Switching with N-1 Reliability

Kory Hedman, PhD Candidate, University of California at Berkeley, 4124 Etcheverry Hall, University of California, Berkeley, Berkeley, CA, 94720, United States of America, kwh@berkeley.edu, Michael Ferris, Emily Fisher, Shmuel Oren, Richard O'Neill

There is a national push for a smarter electric grid, one that is more controllable and flexible. Current electric transmission optimization models do not incorporate the full control of transmission lines. Optimal transmission switching is a straightforward way to leverage grid controllability; it is a smart grid application where we co-optimize generation and the network topology. We present the generation unit commitment and optimal transmission switching problem with reliability constraints.

3 - Representing Voltage Constraints in a Proxy-limited DC Optimal Power Flow

Bernard Lesieutre, Associate Professor, University of Wisconsin, 1415 Engineering Drive, Madison, WI, 53706, lesieutre@engr.wisc.edu

This presentation proposes a mixed-integer programming formulation that finds the best proxy power flow line limits to represent the effects of a known voltage problem in a simplified DC optimal power flow. The two-part objective minimizes error in both locational marginal prices (LMPs) and generator dispatch. The technique was tested with three models: IEEE 9-bus, 30-bus, and 118-bus cases. Tests were carried out for various real power system demand levels in GAMS using CPLEX.

■ WC14

Marriott - Scottsdale

The Complexity of Equilibria in Markets and Games

Cluster: Game Theory

Invited Session

Chair: Constantinos Daskalakis, MIT, 97 Hancock Street, Apt. 7,, Cambridge, MA, 02139, United States of America, costis@csail.mit.edu

1 - Combinatorial Algorithms for Convex Programs: Market Equilibria and Nash Bargaining

Vijay Vazirani, Professor, Georgia Tech, vv.vazirani@gmail.com

The primal-dual paradigm has had two highly successful ``lives" — in combinatorial optimization and in approximation algorithms. It has not only yielded efficient and practically useful algorithms, but also deep insights into the combinatorial structure underlying the problems solved. Recently, motivated by some fundamental problems from game theory, a third life appears to be emerging: efficient algorithms for solving certain classes of convex programs.

2 - Computing Market Equilibria in Polynomial Time for Fixed Number of Goods or Agents

Nikhil Devanur, Microsoft Research, One Microsoft Way, Redmond, WA, 98033, United States of America, nikdev@microsoft.com

We show that for general (non-separable) Piecewise Linear Concave utilities, an exact equilibrium can be found in polynomial time if the number of goods is constant. Note that if the number of goods and agents both can vary, the problem is PPAD hard even for the special case of Leontief utilities. The algorithm has 2 phases: a ``cell-decomposition" of the space of price vectors using polynomial surfaces, followed by an LP-duality based method to solve the problem inside each cell.

3 - Settling the Complexity of Arrow-Debreu Equilibria in Markets with Additively Separable Utilities

Xi Chen, Postdoctoral Researcher, Princeton University, 301 Trinity Court Apt. 11, Princeton, NJ, 08540, United States of America, csxichen@gmail.com

We prove that the problem of computing an approximate Arrow-Debreu market equilibrium is PPAD-complete (or equivalently, as hard as the computational version of Brouwer's fixed point problem), even when all traders use additively separable, piecewise-linear and concave utility functions. The result follows from a reduction from the two-player Nash equilibrium problem.

4 - The Complexity of Nash Equilibria

Constantinos Daskalakis, MIT, 97 Hancock Street, Apt. 7,, Cambridge, MA, 02139, United States of America, costis@csail.mit.edu

We review recent results on the complexity of Nash equilibria. We argue that finding a Nash equilibrium is computationally equivalent to computing Brouwer fixed points of continuous piecewise linear functions, in a precise technical sense captured by the complexity class PPAD. We proceed to show examples of games in which Nash equilibria can be computed efficiently, such as anonymous games, and networks with strictly competitive (zero-sum) games on their edges.

■ WC15

Gleacher Center - 100

Stochastic Optimization and Financial Applications

Cluster: Stochastic Optimization

Invited Session

Chair: Chanaka Edirisinghe, University of Tennessee, 610 Stokely Management Center, 916 Volunteer Boulevard, Knoxville, TN, 37996, United States of America, chanaka@utk.edu

1 - Scenario Generation for Financial Modelling: Desirable Properties and a Case Study

Leelavati Mitra, Brunel University, CARISMA, Brunel University, Uxbridge, UB8 3PH, United Kingdom, Leelavati.Mitra@brunel.ac.uk, Gautam Mitra, Viktar Zviarovich

Investment decisions are made ex ante, that is based on parameters that are not known at the time of decision making. Scenario generators are used not only in the models for (optimum) decision making under uncertainty, they are also used for evaluation of decisions through simulation modelling. We review those properties of scenario generators which are regarded as desirable; these are not sufficient to guarantee the ``goodness" of a scenario generator. We also review classical models for scenario generation of asset prices. In particular we consider some recently reported methods which have been proposed for distributions with `heavy tails'.

2 - An Algorithm for Finding the Complete Efficient Frontier

Yuji Nakagawa, Professor, Kansai University, Faculty of Informatics, Ryozenjicho, Takatsuki-City, Japan, kunakagawa@gmail.com, Chanaka Edirisinghe, Ross James, Sakuo Kimura

The Sayin-Kouvelis algorithm is a state-of-the-art algorithm for finding all efficient solutions to the bicriteria 0-1 multi-knapsack problems within a given level of precision. We propose a new algorithm, based on surrogate constraint techniques, to find all efficient solutions. Experiments confirm that this approach outperforms the Sayin-Kouvelis algorithm and can be used to solve problems that are relatively large, multi-valued, nonlinear, and multi-constrained which previously could not be solved. One prominent application of our method is risk-return financial optimization with integrality restrictions.

3 - Risk Neutral/Averse DEA Models of Fundamental Analysis under Stochastic Data and Applications

Chanaka Edirisinghe, University of Tennessee, 610 Stokely Management Center, 916 Volunteer Boulevard, Knoxville, TN, 37996, United States of America, chanaka@utk.edu, Xin Zhang

Traditional models of Data Envelopment Analysis (DEA) assume deterministic data. We present risk-based stochastic versions of the DEA model when parameters are random variables described by discrete probability distributions. The robustness of performance evaluation of underlying firms under the stochastic DEA model is established relative to the standard DEA model. These results are applied within the framework of generalized DEA model by Edirisinghe/Zhang (2007) for fundamental Analysis toward equity selection for portfolio optimization. Limited computational results are presented for validation of the proposed methodology.

■ WC16

Gleacher Center - 200

Stochastic Optimization for National Security and Military Applications

Cluster: Stochastic Optimization

Invited Session

Chair: Nedialko Dimitrov, University of Texas at Austin, 1 University Station C2200, Austin, TX, 78712, United States of America, ned.dimitrov@gmail.com

1 - Path Optimization for Multiple Searchers

Johannes Royset, Assistant Professor, Naval Postgraduate School, 1411 Cunningham Rd, Monterey, CA, 93943, United States of America, joroyset@nps.edu, Hiroyuki Sato

We consider a discrete time-and-space path-optimization problem where multiple searchers seek to detect one or more probabilistically moving targets across a given time horizon. We present a convex mixed-integer nonlinear program for this problem, along with equivalent linearizations for important special cases, and develop a cut for use with Kelley's cutting plane method. We empirically compare the calculation times of the resulting algorithm with those of standard solvers.

2 - Interdicting a Network by Securing Edges

Feng Pan, Los Alamos National Laboratory, P.O. Box 1663, Los Alamos, NM, 87545, United States of America, fpan@lanl.gov, Michael Chertkov, Nandakishore Santhi

In an evasion network, edge reliability is the probability that the evader will traverse the edge successfully. Interdicting/Securing an edge will reduce the edge reliability. Consider all paths between a set of origin-destination pairs, and the goal is to thwart the evasion by securing at least one edge in each path. A min-max-min interdiction model is developed for this problem. We will discuss the solution techniques and its stochastic variants.

3 - Adversarial Markov Decision Process Design

David Morton, University of Texas, Graduate Program in Operations Research, Austin, TX, 78712, United States of America, morton@mail.utexas.edu, Nedialko Dimitrov

We formulate a bi-level adversarial MDP design problem. First, with limited budget, we remove actions from an MDP to minimize the MDP's optimal value. Second, an adversary operates the MDP to maximize its value. We apply our model to interdict nuclear smuggling. A smuggler operates an MDP to select a path from his origin to destination. Uncertainty in the smuggler's origin, destination, and other attributes add further stochastics to our adversarial MDP design problem.

■ WC17

Gleacher Center - 204

Logistics and Transportation B

Contributed Session

Chair: Vladimir Deineko, Associate Professor, Warwick University, Warwick Business School, Coventry, CV49JA, United Kingdom, v.deineko@warwick.ac.uk

1 - Partial Path Column Generation for the Vehicle Routing Problem with Time Windows

Bjorn Petersen, PhD Student, Technical University of Denmark, Produktionstorvet bygn. 424, Kgs. Lyngby, 2800, Denmark, bjorn@diku.dk, Mads Kehlet Jepsen

This talk presents a column generation algorithm for the VRPTW. Traditionally, column generation models of the VRPTW have consisted of a Set Partitioning master problem with each column representing a route. We suggest to relax that `each column is a route' into `each column is a part of the giant tour'; a so-called partial path. This way, the length of the partial path can be bounded and a better control of the size of the solution space for the pricing problem can be obtained.

2 - The Combinatorics of (S,M,L,XL) or the Best Fitting Delivery of T-shirts

Joerg Rambau, University of Bayreuth, Universitätsstr. 30, Bayreuth, 95440, Germany, joerg.rambau@uni-bayreuth.de, Constantin Gaul, Sascha Kurz

A fashion discounter supplies its branches with apparel in various sizes. Apparel is ordered in pre-packs three months in advance from overseas: replenishment impossible. Thus, the supply in each size and branch must be consistent with the demand right away. We present new ILP-models for the resulting lot-type design problem: For each branch, find lot types and delivery volumes so that the demand is met best. The results are applied by a german fashion discounter with over 1000 branches.

3 - Local Search for Capacitated Vehicle Routing Problems: Dynamic Programming Revisited

Vladimir Deineko, Associate Professor, Warwick University, Warwick Business School, Coventry, CV49JA, United Kingdom, v.deineko@warwick.ac.uk

We consider the capacitated vehicle routing problem (VRP) and its practical siblings in waste collection services provided by Coventry City Council. We suggest a local search procedure to improve a feasible solution of the VRP. The algorithm behind the procedure is the well-known Held & Karp dynamic programming algorithm for the travelling salesman problem. Results of computational experiments on known benchmark problems show the competitiveness of our algorithm with the best known heuristics.

■ WC18

Gleacher Center - 206

Polynomial Programming

Cluster: Nonlinear Mixed Integer Programming
Invited Session

Chair: Jon Lee, IBM TJ Watson Research Center, P.O. Box 218, Yorktown Heights, NY, 10598, United States of America, jonlee@us.ibm.com

1 - Comparing Convex Relaxations of Quadrilinear Terms

Sonia Cafieri, Ecole Polytechnique, LIX, Ecole Polytechnique, Rue de Saclay, Palaiseau, F-91128, France, cafieri@lix.polytechnique.fr, Jon Lee, Leo Liberti

Branch and Bound based optimization methods, applied to formulations involving multivariate polynomials, rely on convex envelopes for the lower bound computation. Although convex envelopes are explicitly known for bilinear and trilinear terms on arbitrary boxes, such a description is unknown, in general, for multilinear terms of higher order. We present four different ways to compute a convex linear relaxation of a quadrilinear monomial on a box and analyze their relative tightness. We apply our results to the Molecular Distance Geometry Problem and the Hartree-Fock Problem.

2 - Strong Relxations and Computations for Global Optimization Problems with Multilinear Terms

Jeff Linderoth, Associate Professor, University of Wisconsin-Madison, 1513 University Avenue, Madison, WI, 53706, United States of America, linderot@cae.wisc.edu, Mahdi Namazifar, James Luedtke

Multilinear functions appear in many global optimization problems, including blending and electricity transmission. A common technique for creating relaxations for these problems is to decompose the functions into bilinear terms and then use a relaxation (the McCormick envelope) for each term separately. We study an approach which generates a relaxation directly from the multilinear term. We will demonstrate via numerical examples the advantages of such an approach.

3 - Mixed Integer Second Order Cone Programming

Sarah Drewes, Technische Universitaet Darmstadt, Department of Mathematics, Schlossgartenstr. 7, Darmstadt, 64289, Germany, drewes@mathematik.tu-darmstadt.de, Stefan Ulbrich

We present different linear and convex quadratic cut generation techniques for mixed integer second-order cone problems. These cuts are applied in the context of two algorithms: A nonlinear branch-and-cut method and a branch-and-bound based outer approximation approach. The latter is an extension of outer approximation based approaches for continuously differentiable problems to subdifferentiable second order cone constraint functions. Convergence is guaranteed,since subgradients are identified that satisfy the KKT conditions. Computational results for test problems and real world applications are given.

■ WC19

Gleacher Center - 208

Multicriteria and Global Optimization A

Contributed Session

Chair: Delphine Sinoquet, Doctor, IFP, 1-4, avenue de Bois-Préau, Rueil Malmaison, 92852, France, delphine.sinoquet@ifp.fr

1 - A Provably Efficient Algorithm for the Multicriteria Linear Programming

Yoshio Okamoto, Tokyo Institute of Technology, 2-12-1-W8-88, Ookayama, Meguro-ku, Tokyo, 152-8552, Japan, okamoto@is.titech.ac.jp, Takeaki Uno

We propose a poly-time-delay poly-space algorithm to enumerate all efficient extreme solutions of a multicriteria minimum-cost spanning tree problem by reverse search, while only the bicriteria case was studied so far. We also show that the same technique works for enumeration of all efficient extreme solutions of a multicriteria linear program. If there is no degeneracy, it runs in poly-time delay and poly space. To best of our knowledge, they are the first algorithms with such guarantees.

2 - Feasibility in Reverse Convex Mixed-Integer Programming

Wieslawa Obuchowska, East Carolina University, Department of Mathematics, Greenville, NC, 27858, United States of America, obuchowskaw@ecu.edu

We discuss the problem of infeasibility of systems defined by reverse convex inequality constraints, where some or all of the variables are integer. In particular, we provide an algorithm that identifies a set of all constraints critical to feasibility (CF), that is constraints that may affect feasibility status of the system after some perturbation of the right-hand sides. We also show that all irreducible infeasible sets and infeasibility sets are subsets of the set CF.

3 - Multi-objective Optimization and Global Map Optimization for Engine Calibration

Delphine Sinoquet, Doctor, IFP, 1-4, avenue de Bois-Préau, Rueil Malmaison, 92852, France, delphine.sinoquet@ifp.fr, Hoél Langouét

The optimization problem of engine calibration consists of the determination of engine tuning parameters that minimize the cumulated fuel consumption and pollutant emissions on a driving cycle generally associated with legislation norms. The engine responses are modelled from experimental data obtained at test bench. We illustrate the difficulties associated with this application and propose adapted optimization methodologies applied on real dataset: LoLiMoT models for engine map parameterization in order to handle intrinsic constraints on the map regularity, multi-objective optimization method based on CMA-ES approach.

■ WC20

Gleacher Center - 300

Model Management for Optimization with PDE Based Simulations

Cluster: Nonlinear Programming
Invited Session

Chair: Natalia Alexandrov, NASA Langley Research Center, Mail Stop 442, Hampton, VA, 22681-2199, United States of America, n.alexandrov@nasa.gov

1 - Assessing the Quality of Approximate Models

Stephen Nash, Professor, George Mason University, Engineering Building, Room 2100, Mail Stop 4A6, Fairfax, VA, 22030-4444, United States of America, snash@gmu.edu

Model management can be used to optimize a high-fidelity model via less expensive approximate models. Convergence can be guaranteed if first-order approximate models are used. We go beyond this to examine practical tools that measure properties of the approximate models that influence the performance of the model-management framework, i.e., to determine whether it significantly improves over applying traditional optimization directly to the high-fidelity model.

2 - Numerical Experience with a Multilevel Optimization Approach

Robert Michael Lewis, Associate Professor, College of William & Mary, Department of Mathematics, P.O. Box 8795, Williamsburg, VA, 23187-8795, United States of America, buckaroo@math.wm.edu

We discuss numerical tests of a multilevel optimization method based on the MG/Opt approach. Some of these tests are intended to exercise the self-diagnostics in the MG/Opt method and to examine whether we have correctly identified the interactions between optimization algorithm and problem structure that make multilevel/multigrid solution possible with MG/Opt. In particular,

some of these problems are designed to be resistant to a multigrid solution. Other tests, such as those involving a dissimilarity parameterized approach to graph embedding, are intended to be more benign from the perspective of multilevel solution.

3 - Self-adaptive Metamodels for Numerical Optimization

Daniele Peri, Researcher, INSEAN - The Italian Ship Model Basin, Via di Vallerano 139, Rome, Italy, D.Peri@insean.it, Emilio Campana, Giovanni Fasano

Optimization with PDE-based analyses often needs simplified models to facilitate solution. Metamodels have been adopted widely. We use the disagreement between two different metamodels as a criterion for new training point computation. We build a multidimensional linear interpolation metamodel and add new training points where the differences between this and a Kriging metamodel are large. The technique yields a more efficient training set and enhances global predictive qualities of the model.

■ WC21

Gleacher Center - 304

Optimization in Networks

Cluster: Telecommunications and Networks
Invited Session

Chair: S. (Raghu) Raghavan, University of Maryland, 4345 Van Munching Hall, College Park, MD, 20742, United States of America, raghavan@umd.edu

1 - Cutting Plane Algorithms for Solving a Robust Edge-partition Problem

Cole Smith, The University of Florida, Industrial and Systems Engineering, P.O. Box 116595, Gainesville, FL, 32611, cole@ise.ufl.edu

We consider an edge-partition problem that arises in SONET design problems. The edge-partition problem considers an undirected weighted graph, and partitions edges among several subgraphs, subject to various subgraph capacity constraints. The objective is to minimize the total number of induced nodes in the subgraphs. We consider a stochastic version of this problem, and compare the use of a two-stage integer cutting-plane approach with an alternative IP/constraint-programming algorithm.

2 - The Generalized Regenerator Location Problem

Si Chen, Assistant Professor, Murray State University, Dept. of CSIS, School of Business and Public Affairs, Murray, KY, 42071, United States of America, si.chen@murraystate.edu, Ivana Ljubic, S. (Raghu) Raghavan

In the generalized regenerator location problem (in optical networks) we are given a set of terminal nodes T that need to communicate. It is necessary to install regenerators if the distance between a pair of nodes in T is greater than L. Regenerators can only be installed at a subset of nodes S in the network. We wish to minimize the number of regenerators (or a weighted combination). We describe heuristics for the problem, and an MIP model, and our computational experiences with both.

3 - Exact Solution Algorithms for a Selective Vehicle Routing Problem to Minimize the Longest Route

Alexandre Salles da Cunha, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil, acunha@dcc.ufmg.br, Christiano A. Valle, Geraldo Mateus, Leonardo C. Martinez

In this paper, we study a non-capacitated Vehicle Routing Problem where not necessarily all clients need to be visited and the goal is to minimize the length of the longest vehicle route. An Integer Programming Formulation, a Branch-and-Cut (BC) method, and a Local Branching (LB) framework that uses BC as the inner solver are presented. Sharper upper bounds are obtained by LB, when the same time limit was imposed on the execution times of both approaches. Our results also suggest that the min-max nature of the objective function combined with the fact that not all vertices need to be visited make such problem very difficult to solve.

■ WC22

Gleacher Center - 306

Open-source Modeling Frameworks for Mathematical Programming

Cluster: Implementations, Software
Invited Session

Chair: Jean-Paul Watson, Principal Member of Technical Staff, Sandia National Laboratories, P.O. Box 5800, MS 1318, Albuquerque, NM, 87185-1318, United States of America, jwatson@sandia.gov

1 - Instance-specific Generation in POAMS

Leonardo Lopes, University of Arizona, Department of Systems and Industrial Engineering, Tucson, AZ, leo@sie.arizona.edu, Kate Smith-Miles

POAMS optimization models support object-oriented semantics. They have interfaces, can be composed and specialized from each other, etc. This makes possible a stronger separation between model and instance. We demonstrate generating different instance types (integer programs, constraint programs, etc.) depending on characteristics of the specific input and on the performance measures relevant to the analyst. We demonstrate this technique and its benefits using time-tabling problems.

2 - Coopr: A Python Optimization Package

William Hart, Distinguished Member of T echnical Staff, Sandia National Laboratories, P.O. Box 5800, MS 1318, Albuquerque, NM, 87185-1318, United States of America, wehart@sandia.gov

We describe Coopr, a Common Optimization Python Repository. Coopr provides a set of optimization packages that support modeling and solution of math programming applications. A core element of Coopr is Pyomo, which provides a modling capability that is commonly associated with algebraic modeling languages like AMPL and GAMS. This talk will provide an overview of these capabilities and describe motivating applications at Sandia National Laboratories.

3 - PySP: Modeling and Solving Stochastic Mixed-Integer Programs in Python

Jean-Paul Watson, Principal Member of Technical Staff, Sandia National Laboratories, P.O. Box 5800, MS 1318, Albuquerque, NM, 87185-1318, United States of America, jwatson@sandia.gov, David L Woodruff

We describe PySP, an open-source extension of Pyomo - a Python-based modeling language for mathematical programming - that enables modeling and solution of stochastic mixed-integer programs. PySP contains a number of generic decomposition-based solution strategies made possible through Python language features such as introspection. We discuss the design and implementation of these generic strategies, in addition to computational results on standard stochastic benchmarks.

■ WC23

Gleacher Center - 308

Some Advances in First-order Methods for Sparse Optimization

Cluster: Sparse Optimization
Invited Session

Chair: Yu-Hong Dai, Chinese Academy of Sciences (CAS), LSEC, Institute of Computational Mathema, P.O. Box 2719, Beijing, 100190, China, dyh@lsec.cc.ac.cn

1 - On the Trust Region Subproblem for Nonlinear L_1 Norm Minimization Problem

Xin LIU, Dr., Academy of Mathematics and Systems Science, Chinese Academy of Sciences, 518, ICMSEC(LanBai Building), 55, ZhongGuanCunDongLu, HaiDian District, Beijing, 100190, China, liuxin@lsec.cc.ac.cn

In this talk, the trust region subproblem for nonlinear L_1 norm minimization problem is considered. We prove that this kind of nonsmooth trust region subproblem is NP-hard, and propose a sequential 2-dimensional subspace minimization method for it. The convergence properties are also studied.

2 - Several Advances on Gradient and Conjugate Gradient Methods

Yu-Hong Dai, Chinese Academy of Sciences (CAS), LSEC, Institute of Computational Mathema, P.O. Box 2719, Beijing, 100190, China, dyh@lsec.cc.ac.cn

Both the steepest descent method and the conjugate gradient method are fundamental nonlinear optimization methods and only requires a storage of several vectors. In this talk, I shall briefly address several advances on the two classes of methods, making them more attractive for large-scale problems.

3 - A Study of Algorithms and Models for Sparse Solution Recovery via L1-Minimization

Junfeng Yang, Dept. Math., Nanjing University, 22 Han-kou Road, Nanjing, 210093, China, jfyang2992@gmail.com, Yin Zhang

Based on the classical approach of alternating directions method, we propose a primal-dual algorithm for solving L1-minimization problems for sparse solution recovery. The proposed algorithm is simple and applicable to several L1-models. Extensive numerical results are given to demonstrate the superiority of the proposed algorithm and an L1-L1 model. Besides, we put forward some basic ideas on how to evaluate algorithmic speed relative to solution accuracy.

■ WC25

Gleacher Center - 404

Calculus of Variations on Time Scales

Cluster: Variational Analysis
Invited Session

Chair: Delfim F. M. Torres, Professor, University of Aveiro, Department of Mathematics, Aveiro, 3810-193, Portugal, delfim@ua.pt

1 - Natural Boundary Conditions in the Calculus of Variations

Agnieszka B. Malinowska, Post-Doc, University of Aveiro, Aveiro, Portugal, abmalinowska@ua.pt, Delfim F. M. Torres

We prove necessary optimality conditions for problems of the calculus of variations on time scales with a Lagrangian depending on the free end-point.

2 - On the Dubois-Reymond Equation on Time Scales

Natalia Martins, Professor, University of Aveiro, Department of Mathematics, Aveiro, Portugal, natalia@ua.pt, Zbigniew Bartosiewicz, Delfim F. M. Torres

The fundamental problem of the calculus of variations on time scales concerns the minimization of a delta-integral over all trajectories satisfying given boundary conditions. In this paper we prove a Du Bois-Reymond necessary optimality condition for optimal trajectories. As an example of application of the main result, we give an alternative and simpler proof to the Noether theorem on time scales recently obtained in [J. Math. Anal. Appl. 342 (2008), no. 2, 1220—1226].

3 - Calculus of Variations on Time Scales With Delta-nabla Iterated Integrals

Delfim F. M. Torres, Professor, University of Aveiro, Department of Mathematics, Aveiro, 3810-193, Portugal, delfim@ua.pt

The discrete, the quantum, and the continuous calculus of variations have been recently unified and extended by using the theory of time scales. Two approaches are followed in the literature of time scales: one dealing with minimization of delta integrals; the other dealing with minimization of nabla integrals. Here we propose a unifying approach that allows to obtain both delta and nabla results as particular cases.

■ WC28

Gleacher Center - 600

Structured Nonsmooth Optimization

Cluster: Nonsmooth and Convex Optimization
Invited Session

Chair: Claudia Sagastizabal, Electric Energy Research Center, P.O. Box 68007, Rio de Janeiro, 21944-970, Brazil, sagastiz@impa.br

1 - Algorithms for Convex Minimization Based on VU-theory

Robert Mifflin, Professor, Washington State University, Mathematics Department, P.O. Box 643113, Pullman, WA, 99164, United States of America, mifflin@math.wsu.edu, Claudia Sagastizabal

For many nonsmooth functions a VU-algorithm converges superlinearly by alternating U-space predictor steps with V-space corrector steps. The latter come from a proximal bundle subroutine that constructs cutting-plane models of the objective function while the former depend on quadratic models of an associated U-Lagrangian. Numerical results showing rapid convergence for both U-Newton and U-quasi-Newton versions are given.

2 - Bundle Methods for Nonconvex Optimization

Warren Hare, Assistant Professor, UBC-O, Department of Mathematics, 3333 University Way, Kelowna, BC, V1V 1V7, Canada, whare@irmacs.sfu.ca, Claudia Sagastizabal

Proximal bundle methods have been shown to be highly successful optimization methods for nonsmooth convex optimization. We address the question of whether bundle methods can be extended to work for nonconvex problems. We review some past results for proximal bundle methods and demonstrate a method for extending bundle methods to a nonconvex setting. The method is based on generating cutting planes model not of the objective function but of a local convexification of the objective function. The convexification parameter is calculated “on the fly,” which allows for both strong convergence results and the ability to inform the user on when proximal parameters are too small to ensure a unique proximal point of the objective function.

3 - A Proximal Bundle Method for Composite Minimization

Claudia Sagastizabal, Electric Energy Research Center, P.O. Box 68007, Rio de Janeiro, 21944-970, Brazil, sagastiz@impa.br

We consider minimization of nonsmooth functions which can be represented as the composition of a positively homogeneous convex function and a smooth mapping. This is a sufficiently rich class that includes max-functions, largest eigenvalue functions, and norm 1-regularized functions. The bundle method uses an oracle that is able to compute separately the function and subgradient information for the convex function and the function and derivatives for the smooth mapping. With this information, it is possible to solve approximately certain proximal linearized subproblems in which the smooth mapping is replaced by its Taylor-series linearization around the current serious step.

■ WC29

Gleacher Center - 602

Computational Methods in Economics and Finance - Part III

Cluster: Finance and Economics
Invited Session

Chair: Che-Lin Su, Assistant Professor of Operations Management, The University of Chicago Booth School of Business, 5807 S. Woodlawn Ave, Chicago, IL, 60637, United States of America, chelin.su@gmail.com

1 - Fast LCP Computational Methods for American Options Pricing

Jose Luis Morales, Doctor, ITAM, Selva 45-104. Edificio Omega, Insurgentes Cuicuilco, Mexico, jmorales@itam.mx

In this talk we present numerical results with LCP-based methods for American options pricing. The solution of the LCPs is computed by means of an algorithm that combines: a) cycles of projected Gauss-Seidel; b) subspace minimization iterations that make use of preconditioned GMRES(m). We illustrate the performance of the methods on models with/without stochastic volatility.

2 - Multigrid Solvers for Calibration and Estimation of Dynamic Structural Models

Adam Speight, Georgia State University, 198 15th St NW, Atlanta, GA, United States, aspeight@gmail.com

A new methodology for calibrating parameters of dynamic structural models is developed. It also allows for formal estimation and hypothesis testing in a Generalized Method of Moment framework. The method is based on multigrid techniques used in many state of the art solvers from engineering applications. These techniques are adapted to solve Bellman and Euler-type equations and to handle subtleties arising from the interaction of statistical and numerical errors.

3 - A User’s Guide to Solving Dynamic Stochastic Games Using the Homotopy Method

Ron Borkovsky, Rotman School of Management, University of Toronto, Toronto, Canada Ron.Borkovsky@rotman.utoronto.ca

This paper provides a step-by-step guide to solving dynamic stochastic games using the homotopy method. The homotopy method facilitates exploring the equilibrium correspondence in a systematic fashion; it is especially useful in games that have multiple equilibria. We discuss the theory of the homotopy method and its implementation and present two detailed examples of dynamic stochastic games that are solved using this method.

Thursday, 10:30am - 12:00pm

■ ThA01

Marriott - Chicago A

Approximation Algorithms for Network Design

Cluster: Approximation Algorithms
Invited Session

Chair: Cliff Stein, Columbia University, 326 S W Mudd Building, 500 W. 120th Street, New York, NY, 10027, cliff@ieor.columbia.edu

1 - Traffic Grooming in Optical Networks

Lisa Zhang, Bell Labs, 600 Mountain Ave, 2A-442, Murray Hill, NJ, 07974, United States of America, ylz@research.bell-labs.com, Spyridon Antonakopoulos

Traffic grooming in optical networks offers economic advantage by aggregating low-bandwidth streams to efficiently utilize high-bandwidth media. Grooming is related to but different from buy-at-bulk network design. For example, even for the restricted special case of a line topology, grooming is APX-hard. We present results for a number of interesting special cases as well as the general case of grooming traffic streams of arbitrary bandwidth over a network of arbitrary topology.

2 - Uncrossing Almost Uncrossable Setpair Families

Zeev Nutov, Open University of Israel, 108 Ravutski Street, Raanana 43107, Israel, nutov@openu.ac.il

I will present a simple method to decompose setpair families arising from the Survivable Network Design Problem (SNDP) into uncrossable families. For rooted requirements this implies the ratios O(k^2) for edge costs and O(k^2 log n) for node costs, where k is the maximum requirement. Previous ratios were O(k^2 log n) and O(k^8 log^2 n), respectively. We also obtain an O(k log n)-approximation for the element-connectivity version with node costs.

■ ThA02

Marriott - Chicago B

Complementarity Problems and Variational Inequalities in Transportation

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Siriphong Lawphongpanich, University of Florida, Dept of Industrial and Systems Engineer, 303 Weil Hall, Gainesville, FL, 32611, United States of America, lawphong@ise.ufl.edu

1 - Numerical Solution Procedures for the Morning Commute Problem

Marco Nie, Assistant Professor, Northwestern University, 2145 Sheridan Road, Evanston, United States of America, y-nie@northwestern.edu, Michael Zhang

This paper discusses solution techniques for the morning commute problem that is formulated as a discrete variational inequality (VI). Two groups of non-heuristic algorithms for general VIs, namely projection-type algorithms and ascent direction algorithms, were examined. The performance of these algorithms are compared on simple instances of the morning commute problem. The implications of numerical results are discussed.

2 - On the Complexity of the Minimum Tollbooth Problem

Lihui Bai, Doctor, Valparaiso University, 1909 Chapel Drive, Valparaiso, IN, 46383, United States of America, lihui.bai@valpo.edu, Siriphong Lawphongpanich, Donald Hearn

The minimum tollbooth problem considers travelers seeking the least cost routes to reach their destinations in a road network. The problem is to determine both prices and locations at which to toll in order to persuade these travelers to choose routes leading to a desired traffic distribution, e.g., one with the least congestion. The objective is to minimize the number of toll locations. In this talk, we present complexity analyses of the problem under different sets of assumptions.

3 - Risk-neutral Second Best Toll Pricing

Jeff Ban, Assistant Professor, Rensselaer Polytechnic Institute, Civil and Environmental Engineering, Troy, NY, 12180, United States of America, banx@rpi.edu, Michael Ferris

We propose a risk-neutral second best toll pricing scheme to account for the possible nonuniqueness of user equilibrium solutions. The scheme is designed to optimize for the expected objective value as UE solution varies within the solution set. Such a risk-neutral scheme can be formulated as a stochastic program and solved by a simulation-based optimization algorithm. The algorithm contains three major steps: characterization of the UE solution set, random sampling over the solution set, and optimization over approximate objective functions. Numerical results are provided to illustrate the model and solution algorithm.

■ ThA03

Marriott - Chicago C

Optimization Models Applied to Transmission Planning in Electricity Markets Considering Large-scale Penetration of Renewables

Cluster: Optimization in Energy Systems
Invited Session

Chair: Luiz Barroso, PSR, Praia de Botafogo 228/1701-A, Rio de Janeiro, 22250-906, Brazil, luiz@psr-inc.com

1 - Cost-benefit Analysis for Optimum N-k Transmission Criteria with Wind Penetration

Rodrigo Moreno, Imperial College London, South Kensington Campus, Electrical and Electronic Dept./CAP, London, United Kingdom, rmoreno@imperial.ac.uk, Danny Pudjianto, Goran Strbac

A Cost-Benefit Analysis in the form of a Linear Programming Model is presented in order to find the optimum security constraints, named N-k, for transmission operation and planning in the presence of wind penetration. N-k rules play a key role to efficiently and securely release transfer capability to users when alleviating congestions and displacing transmission upgrades. In this framework, the model optimally balances cost of transmission investment, system operation and unsupplied demand.

2 - Optimal Layout of Wind Farms in Complex Terrain

Klaus Vogstad, Head of Wind & Site, Agder Energi, Agder Energi Produksjon, Sbox 603, Kristiansand, 4606, Norway, klaus-ole.vogstad@ae.no, Raphael Chabar, Fabiano Oliveira

A new algorithm for wind park design is presented to solve the locational problem of optimal turbine layouts in complex terrain. The algorithm maximizes total energy yield subject to wind characteristics (in the form of wind energy maps), wakes effects, minimum distance between turbines and site constraints (restricted areas). Present industry standard tools rely on heuristic methods, and do not guarantee optimum. The developed algorithm, which involves MIP and guarantees global optimum, consist in an iterative method for generating minimum distance feasibility cuts. The algorithm is successfully applied and embedded in Agder Energi's in-house tools for wind power projects.

3 - Optimization of the Location, Topology and Capacity of a Transmission Network: A MINLP Approach

Raphael Chabar, PUC-Rio, R. Professor Gastao Bahiana, 496 apt 502, Rio de Janeiro, RJ, 22071-030, Brazil, rchabar@gmail.com, Mario Pereira, Luiz Barroso, Alvaro Veiga, Luiz Mauricio Thomé

This work presents an optimization model for a transmission network planning considering the large-scale penetration of renewables. The problem is to define the network topology, positioning of the substations (SE), length of circuits, circuits' capacities and dimensioning of transformation equipment that result in the least cost investment plan. This involves the trade-off between using longer radial circuits with individual lower capacities connecting each generator to the main grid or shorter circuits connecting the generators to a SE and a longer high capacity circuit connecting the SE to the main grid. Transmission losses are also considered. This problem is formulated as a Mixed-Integer Non-Linear Program with linear constraints.

ThA04

Marriott - Denver

Combinatorial Optimization G

Contributed Session

Chair: Dennis Egbers, Technische Universitaet Braunschweig, Pockelsstr. 14, Braunschweig, 38106, Germany, dennis.egbers@tu-bs.de

1 - An Adaptive LNS Algorithm for the Resource-constrained Project Scheduling Problem

Laurent Flindt Muller, University of Copenhagen, Universitetsparken 1, København, 2100, Denmark, laurent@diku.dk

We present an application of the Adaptive Large Neighborhood Search (ALNS) framework to the Resource-constrained Project Scheduling Problem (RCPSP). The ALNS framework was first proposed by Pisinger and Ropke and can be described as a large neighborhood search algorithm with an adaptive layer, where a set of destroy/repair neighborhoods compete to modify the current solution in each iteration of the algorithm. To the best knowledge of the author this is the first application of the ALNS framework to the RCPSP. Experiments performed on the well-known j30, j60 and j120 benchmark instances show that the proposed algorithm is competitive and confirms the strength of the ALNS framework previously reported for the Vehicle Routing Problem.

2 - Minimizing the Makespan in Resource Constrained Project Scheduling with Feeding Precedence Relations

Lucio Bianco, Professor, University of Roma Tor Vergata, Via del Politecnico 1, Roma, 00133, Italy, bianco@disp.uniroma2.it, Massimiliano Caramia

We study an extension of the Resource-Constrained Project Scheduling Problem (RCPSP) with minimum makespan objective by introducing as precedence constraints the so called Feeding Precedences (FP). A new mathematical formulation of the RCPSP with FP and a branch and bound algorithm have been developed. Also a computational experimentation on randomly generated instances has been provided.

3 - Optimal Shift Schedules for Hospitals

Dennis Egbers, Technische Universitaet Braunschweig, Pockelsstr. 14, Braunschweig, 38106, Germany, dennis.egbers@tu-bs.de

Creating cost-efficient shift schedules satisfying demands of patients and employees is an important task for health care institutions. The Nurse Scheduling Problem (NSP) formulates this task mathematically, giving the possibility to apply optimization methods. Hard restrictions include demand, legal regulations and labour agreements while other constraints to be considered are wishes of the staff and regular working hours. We present a general model for NSP and algorithms developed in cooperation with a company engaged in this business. Exact solution methods and heuristics (partly relaxation based) will be proposed. For real data we compare these approaches to solve the NSP both in reasonable time as with results with sufficient quality.

ThA05

Marriott - Houston

Combinatorial Optimization N

Contributed Session

Chair: Elisabeth Guenther, TU Berlin, Strasse des 17. Juni 136, Berlin, Germany, eguenth@math.TU-Berlin.DE

1 - Partition Problems: Optimality and Clustering

Uriel G. Rothblum, Prof., Technion, Technion City, Haif, 32000, Israel, rothblum@ie.technion.ac.il

Partition problems constitute a large class of combinatorial optimization problems. Of particular interest are problems where it is possible to restrict attention to solutions that exhibit clustering properties, facilitating the solution of the partition problem in polynomial time. The talk will introduce a classification of partition problem and survey of numerous approaches to solve such problems by focusing on partitions that exhibit clustering properties.

2 - The Time-cost Tradeoff Curves in Cyclic Networks

Stephan Held, Post Doc, Bonn University, Lennestr. 2, Bonn, 53129, Germany, held@or.uni-bonn.de

We present a new algorithm for computing time-cost tradeoff curves in activity-on-edge networks that contain cycles. Instead of a single project duration time, as in the acyclic time-cost tradeoff problem, the worst slack on a certain subset of edges is to be maximized. Starting with a cheapest solution we compute the support points of the piecewise-linear curve one-by-one. Combining minimum cost flow and the parametric shortest path algorithms, we achieve a strongly polynomial running time for proceeding from one support point to the next. Finally, we present the overall speed in practice on VLSI-instances with millions of vertices and edges.

3 - Scheduling Generally Malleable Jobs with Precedence Constraints of Bounded Width

Elisabeth Guenther, TU Berlin, Strasse des 17. Juni 136, Berlin, Germany, eguenth@math.TU-Berlin.DE, Felix Koenig, Nicole Megow

We consider a generalization of a well-studied makespan minimization problem where malleable jobs (the processing time of each job depends on the number of allotted processors) have to be scheduled on identical parallel processors. We present an FPTAS for the NP-hard special case of precedence constraints of bounded width and give an O(log n)-approximation for the general case. This also leads to results for related problems like bin scheduling and strip packing.

ThA06

Marriott - Kansas City

SDP Relaxations for Sensor Network Localization

Cluster: Conic Programming

Invited Session

Chair: Sunyoung Kim, Professor, Ewha W. University, 11-1 Dahyun dong, Seoul, 120-750, Korea, Republic of, skim@ewha.ac.kr

Co-Chair: Masakazu Kojima, Tokyo Institute of Technology, Dept of Math & Comp Sci, 2-12-1-W8-29 Oh-Okayama Meguro, Tokyo, Japan, kojima@is.titech.ac.jp

1 - A Unified Theorem on Semidefinite Programming Rank Reduction and its Applications

Yinyu Ye, Stanford University, Dept of MS&E, Stanford, CA, 94305, United States of America, yinyu-ye@stanford.edu, Dongdong Ge, Jiawei Zhang, Anthony So

We present a unified theorem on semidefinite programming solution rank reduction that provides a unified treatment of and generalizes several well—known results in the literature. We also illustrate its applications on semidefinite programming (SDP) based model and method for the position estimation problem in Euclidean distance geometry such as graph realization and wireless sensor network localization.

2 - Measurement Sparsification and Chordal Decomposition for Sensor Network Localization

Anthony So, The Chinese University of Hong Kong, Dept of Sys Engr & Engr Mgmt, Shatin, NT, Hong Kong - ROC, manchoso@se.cuhk.edu.hk, Dongdong Ge, Zhisu Zhu, Yinyu Ye

We consider sensor network localization with sparse and local edge-distance measurements. We develop a necessary and sufficient condition on the localizability of the graph using only a small number of edge-distance measurements. Using that condition, we develop a more efficient semidefinite programming (SDP) method for the localization problem and prove that it is guaranteed to find the same localization as the original SDP relaxation problem.

3 - Exploiting Sparsity in SDP Relaxation for Sensor Network Localization

Sunyoung Kim, Professor, Ewha W. University, 11-1 Dahyun dong, Seoul, 120-750, Korea, Republic of, skim@ewha.ac.kr

We derive a sparse variant of Biswas-Ye's full SDP relaxation (FSDP) for sensor network localization problem using the sparsity of the problem. It is shown to be equivalent to FSDP. Numerical experiments with the sparse SDP relaxation, FSDP, and the sparse variant of FSDP exhibit that the sparse variant of FSDP outperforms all the other SDP relaxations in speed.

ThA07

Marriott - Chicago D

Integer and Mixed Integer Programming G

Contributed Session

Chair: Robert Nauss, Professor, University of Missouri-St. Louis, 209 CCB, 1 University Blvd., St. Louis, MO, 63121, United States of America, robert_nauss@umsl.edu

1 - Characterization of 0/1/-1 Facets of the Hop Constrained Path Polytope by Dynamic Programming

Ruediger Stephan, ZIB, Takustrasse 7, Berlin, Germany, stephan@math.tu-berlin.de

We present a dynamic programming based polyhedral approach for the hop constrained shortest path problem defined on a directed graph. We show that many facet defining inequalities with coefficients 0, 1, or -1 for the polytope associated with this problem can be classified by means of the well-known Bellman equations.

2 - Practical Mixed Integer Kriging Models

Joseph Simonis, The Boeing Co., P.O. Box 3707 MC 7L-21, Seattle, WA, 98124, United States of America, joseph.p.simonis@boeing.com, Paul Frank, Andrew Booker

Many optimization problems require the evaluation of computationally expensive functions. In practice, the expensive function evaluations are sometimes replaced by ``cheaper” evaluations on surrogate models. We are interested in models that accurately approximate responses when design variables are a mixture of continuous and categorical types. This talk examines the use of mixed-integer Kriging models as surrogates; focusing on the steps of efficiently building and updating the models.

3 - Solving Hard Single Source Capacitated Facility Location Problems

Robert Nauss, Professor, University of Missouri-St. Louis, 209 CCB, 1 University Blvd., St. Louis, MO, 63121, United States of America, robert_nauss@umsl.edu

We investigate solving hard instances of SSCFLP that take CPLEX over 8hrs to solve. A property of SSCFLP is that by fixing all facility variables, the remaining problem of binary assignment variables is a generalized assignment problem. We capitalize on this by using projection. After certain relaxation tightenings and a heuristic to generate a good feasible solution, we generate a list of GAP problems that must be solved in order to ensure that an optimal solution to the SSCFLP is found.

■ ThA08

Marriott - Chicago E

Branch-and-Price I

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Marco Luebbecke, TU Berlin, Institute of mathematics, Strasse des 17. Juni 136, Berlin, 10623, Germany, m.luebbecke@math.tu-berlin.de

1 - Stronger Bounds by Enforcing Complete Solution Properties in Column Generation Subproblems

Ricardo Fukasawa, Assistant Professor, University of Waterloo, Waterloo, Ontario, Canada, Artur Pessoa

Column generation is usually applied in a way that the subproblems correspond to parts of a solution; e.g., in the BPP, the knapsack subproblems yield possible fillings of a single bin, in the VRP, subproblems correspond to a single route. The proposed approach consists in associating the subproblems to complete solutions, while enforcing some global properties (not valid for solution parts) without increasing the pricing complexity. Computational results on classical problems are given.

2 - A Branch-and-cut-and-price Approach for a Two-level Hierarchical Location Problem

Alberto Ceselli, Assistant Professor, DTI - University of MIlan, Via Bramante, 65, Crema, CR, 26013, Italy, alberto.ceselli@unimi.it, Bernardetta Addis, Giuliana Carello

In many telecommunication networks a given set of client nodes must be served by different sets of facilities, which must be located and dimensioned in designing the network. We provide a compact and an extended formulation for that problem and we design an exact branch-and-cut-and-price optimization algorithm. We test our approach on a set of instances derived from the facility location literature.

3 - Review and Classification of Branching Schemes for Branch-and-price

Francois Vanderbeck, Professor, University Bordeaux 1 & INRIA, Institut de Mathamatiques de Bordeaux, 351, cours de la Libaration, Talence, 33405, France, fv@math.u-bordeaux1.fr, Sophie Michel

Developing a branch-and-price algorithm requires an ad-hoc branching scheme. One must consider the impact of the branching scheme on the pricing procedure. The paper reviews the schemes that have been proposed in an application specific context. They can be classified into branching on original variables, auxiliary variables (arising from an extended formulation) or on constraints. Another distinction is whether branching is implemented in the master or the subproblem. The review is complete by direct numerical comparisons between alternative schemes on some standard problems.

■ ThA09

Marriott - Chicago F

Branching Strategies for Mixed Integer Programming

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Emilie Danna, IBM, 1195 W Fremont Avenue, Sunnyvale, CA, 94087, United States of America, edanna@us.ibm.com

1 - To Branch or To Cut

Ashutosh Mahajan, Doctor, Argonne National Lab, MCS Division, Bldg 221, 9700 S Cass Avenue, Chicago, IL, 60439, United States of America, asm4@lehigh.edu, Ted Ralphs

Given a valid disjunction for a Mixed Integer Program (MIP), one can either use it for branching or for generating valid inequalities (VIs). Even though considerable research has gone in to identifying disjunctions useful for solving a MIP, little attention has been paid to whether to use these for branching or for generating VIs. In this talk, we present computational results from several experiments performed towards understanding this question and also discuss some theoretical results.

2 - Bilevel Branching

Ted Ralphs, Associate Professor, Lehigh University, Industrial and Systems Engineering, 200 West Packer Avenue, Bethlehem, PA, 18015, United States of America, ted@lehigh.edu, Andrea Lodi, Stefano Smriglio, Fabrizio Rossi

We describe a new branching strategy for binary integer programs in which fixing variables to 1 results in a significant change in the bound obtained by solving the LP relaxation, whereas fixing to 0 has little or no impact. In such cases, branching on variables can be ineffective. The new strategy involves simultaneously branching on a set of variables chosen by solving a bilevel program. Computational results show that this strategy can be effective for combinatorial problems.

3 - Using Infeasible Nodes to Select Branching Variables

Emilie Danna, IBM, 1195 W Fremont Avenue, Sunnyva le, CA, 94087, United States of America, edanna@us.ibm.com, Andrea Lodi

In mixed integer programming, the choice of the branching variable is traditionally based on the history of changes in objective value caused by branching. This pseudocost strategy does not take into account branching decisions that create an infeasible child node. In this presentation, we describe how to integrate infeasible nodes into the branching variable selection. We discuss several alternatives and we show with computational experiments that our approach improves on the state of the art.

■ ThA10

Marriott - Chicago G

Developments and Applications of Global Optimization in Chemical Engineering

Cluster: Global Optimization
Invited Session

Chair: Angelo Lucia, Professor, University of Rhode Island, Chemical Engineering Dept., Kingston, RI, 02881, lucia@egr.uri.edu

1 - Large Scale Dynamics of Phase Transitions

Rajeswar Gattupalli, Senior R&D Scientist, UOP LLC, 25 E Algonquin Road, Des Plaines, IL, 60017, United States of America, Rajeswar.Gattupalli@UOP.com, Angelo Lucia, Sam LeBlanc

In this work, a novel probing procedure is used within the terrain/funneling method of global optimization to find stationary points on the potential energy landscape for all-atom representations of n-alkane molecules and to quantify liquid-solid (or rotator-low ordered temperature) phase transitions. Numerical results for tetracosane are presented.

2 - Role of Random Numbers in Global Optimization

Urmila Diwekar, President, Vishwamitra Research Institute, 368 56th Street, Clarendon Hills, IL, 60514, US Minor Outlying Islands, urmila@vri-custom.org

Random numbers play an important role in global optimization based on probabilistic methods. This paper exploits uniformity properties of random number to design new global optimization algorithms based on simulated annealing (SA) and genetic algorithms (GA). These algorithms are further extended for optimization under uncertainty. These new variants of SA and GA are found to be extremely efficient compared to traditional SA and GA.

3 - A Hybrid Sequential Niche Algorithm for Multimodal Optimization Problems

Jeonghwa Moon, Graduate Student, University of Illinois-Chicago, 851 S. Morgan St. - 218 SEO, Chicago, 60607, United States of America, jmoon8@uic.edu, Andreas Linninger

Detection of multiple solutions is important because multimodal objective functions are common in engineering and physics. In this talk, we will present a novel hybrid algorithm for locating all solutions in multimodal problems. This algorithm combines a sequential niche technique with deterministic local optimization to detect all extrema efficiently. We will show the efficiency and robustness of our algorithm with several examples in engineering designs.

■ ThA11

Marriott - Chicago H

Robust Optimization in Finance

Cluster: Robust Optimization

Invited Session

Chair: Aurelie Thiele, Assistant Professor, Lehigh University, 200 W Packer Ave, Bethlehem, PA, 18015, United States of America, aurelie.thiele@lehigh.edu

1 - Log-robust Portfolio Management

Aurelie Thiele, Assistant Professor, Lehigh University, 200 W Packer Ave, Bethlehem, PA, 18015, United States of America, aurelie.thiele@lehigh.edu, Ban Kawas

We present a robust optimization approach to portfolio management under uncertainty that (i) builds upon the well-established Lognormal model for stock prices while addressing its limitations, and (ii) incorporates the imperfect knowledge on the true distribution of the uncertainty drivers in an intuitive manner. We derive theoretical insights into the the optimal asset allocation and the degree of diversification in the portfolio, in the cases with and without short sales.

2 - Worst-case Value-at-risk of Non-linear Portfolios

Steve Zymler, Mr, Imperial College London, 180 Queen's Gate, South Kensington Campus, London, SW7 2AZ, United Kingdom, sz02@doc.ic.ac.uk, Berc Rustem, Daniel Kuhn

Models which aim to minimize the Value-at-Risk of a portfolio assume that the distribution of the underlying risk factors is known precisely. When the distributional assumptions do not hold, the calculated risk may be grossly underestimated. We will give an overview of Worst-Case VaR (WCVaR), which aims to overcome this modeling risk. We extend WCVaR for portfolios which are quadratic functions of the risk factors, and show how it can be used to minimize the WCVaR of derivative portfolios.

3 - Tractable Robust Expected Utility and Risk Models for Portfolio Optimization

Joline Uichanco, PhD Candidate, MIT, 77 Massachusetts Avenue, Cambridge, MA, United States of America, uichanco@mit.edu, Karthik Natarajan, Melvyn Sim

We derive exact and approximate optimal trading strategies for a robust or maximin expected utility model where the distributions of the random returns are practially characterized. The investorís utility is modeled as a piecewise-linear concave function. We also provide connections of our results with robust or ambiguous convex risk measures, in which the investor minimizes his worst case risk under distributional ambiguity.

■ ThA12

Marriott - Los Angeles

Optimal Design with PDE Constraints

Cluster: PDE-constrained Optimization

Invited Session

Chair: Eldad Haber, Emory University, 400 Dowman Drive, E414, 30322, United States of America, haber@mathcs.emory.edu

1 - Optimal Experimental Design for Large-scale Non-linear Ill-posed Problems

Lior Horesh, IBM, Watson Research Center, Yorktown Heights, NY, United States of America, lhoresh@us.ibm.com, Eldad Haber, Luis Tenorio

Many theoretical and practical problems in science involve acquisition of data via an indirect observation of a model. The observed data are determined by the physical properties of the model sought, the physical governing laws, but also by the experimental settings. The experimental setup can be controlled by the experimentalist, and evidently a proper experimental design can substantially improve the obtained results. Optimal experimental design for ill-posed problems was seldom tackled. In this study we propose a generic numerical and statistically sound optimal experimental design methodology for non-linear, ill-posed problems. We present the utilization of this approach for large-scale, non-linear electromagnetic inversion problems.

2 - Optimal Experimental Design for the Surveillance of the Glucose Metabolism

Matthias Conrad, Emory University, 400 Dowman Drive, E429, Atlanta, GA, 30322, United States of America, conrad@mathcs.emory.edu, Eldad Haber

The glucose metabolism is a tight regulated system providing energy in humans. Dysfunctions in the glucose metabolism may lead to pathologies like obesity or diabetes. Establishing mathematical algorithms for control and optimal design is therefore essential in imbalanced glucose metabolisms. We will present new combined computational methods for ODE systems, optimization, parameter estimation, and optimal design to target this problem. The goal is to monitor the glucose metabolism via mathematical optimal control and to design minimal invasive methods.

3 - Optimum Experimental Design for Nonlinear Differential Equation Models

Stefan Körkel, Head of a Junior Research Group, IWR, Heidelberg University, Im Neuenheimer Feld 368, Heidelberg, D-69120, Germany, Stefan.Koerkel@iwr.uni-heidelberg.de

This talk deals with optimum experimental design for parameter estimation in the validation process of nonlinear differential equation models. Numerical methods for this class of non-standard optimal control problems are discussed including a new multiple shooting formulation and tailored methods for automatic derivative evaluation. A new online experimental design approach is presented applied to an example from chemical engineering.

■ ThA13

Marriott - Miami

Robust and Multi-Criteria Models in Energy

Cluster: Optimization in Energy Systems

Invited Session

Chair: Christiano Lyra, Professor, University of Campinas - UNICAMP, Av. Albert Einstein 400 (CP 6101), Cidade Universitaria, Campinas, SP, 13083-852, Brazil, christiano@pq.cnpq.br

1 - Robust Optimization Applied to the French Unit-commitment Problem

Sinda Ben Salem, PhD Student, EDF R&D and Ecole Centrale Paris, 1 Avenue General de Gaulle, Clamart, France, sinda.ben-salem@edf.fr, Ala Ben Abbes, Michel Minoux, Gerald Vignal

This work concerns a robust optimization approach to the unit-commitment problems for the French daily electricity production. Our aim is to minimize production costs with an uncertain electricity demand, supposed to be specified by a given polyhedral uncertainty set. We formulate the problem in terms of minimizing a convex nonsmooth function, which is achieved via a proximal algorithm. Numerical results will be reported, showing that the proposed approach appears to be promising.

LATE CANCELLATION

2 - Robust Pricing in Electricity Markets with a Variable Demand

Eugene Zak, AREVA T&D, 10865 Willows Road NE, Redmond, WA, 98052, United States of America, eugene.zak@areva-td.com, Kwok Cheung

Clearing prices in a linear dispatch problem come from a dual solution. The situation is getting more complicated when a power demand is not constant but depends on current prices. Following Bulavskii [Soviet Math. Dokl., Vol 23 (1981), No. 2] a corresponding primal-dual model incorporates both primal and dual variables. Under linearity assumption for the demand-price function with a semi-definite matrix a resultant quadratic program yields stable prices and optimal levels of the demand.

3 - Hierarchical Multiple Criteria Optimization of Maintenance Procedures on Power Distribution Networks

Christiano Lyra, Professor, University of Campinas - UNICAMP, Av. Albert Einstein 400 (CP 6101), Cidade Universitaria, Campinas, SP, 13083-852, Brazil, christiano@pq.cnpq.br, Celso Cavellucci, Jose Gonzalez, Fabio Usberti

Utilities must supply energy with reliability levels above minimum values. This work represents the relationship between maintenance and reliability with a mathematical model which allows formulating a multiple criteria optimization problem to unveil the best compromise for maintenance activities. The problem is solved for all local networks with two objective functions: maintenance costs and network reliability. Local solutions are coordinated to give global solutions for the whole company.

■ ThA15

Gleacher Center - 100

Approximation and Dynamics

Cluster: Stochastic Optimization
Invited Session

Chair: Silvia Vogel, Professor, Technische Universitat Ilmenau, Postfach 100565, Ilmenau, 98684, Germany, Silvia.Vogel@tu-ilmenau.de

1 - Dynamic Portfolio Optimization with Bounded Shortfall Risks

Ralf Wunderlich, Professor, Zwickau University of Applied Sciences, Mathematics Group, PSF 201037, Zwickau, D-08056, Germany, ralf.wunderlich@fh-zwickau.de

We consider the optimal selection of portfolios for utility maximizing investors under joint budget and shortfall risk constraints. The shortfall risk is measured in terms of the expected loss. Stock returns satisfy a stochastic differential equation with an unobservable drift process leading to a market model with partial information. Using martingale method we first find the optimal level of terminal wealth. Then, under general conditions on the corresponding drift process we provide the optimal trading strategy using Malliavin calculus. For a hidden Markov model (HMM) for the drift we present numerical results.

2 - Approximation of Multistage Stochastic Programs Via Scenario Trees

Holger Heitsch, Humboldt-University Berlin, Unter den Linden 6, Berlin, 10099, Germany, heitsch@math.hu-berlin.de, Werner Roemisch

Recent stability results for multistage stochastic programs state that for consistent approximation schemes we have to consider approximations with respect to two different types of distances namely a distribution and a information (or filtration) distance. We take up the latter issue and present a general framework for scenario tree construction and reduction in multistage stochastic programming models.

3 - Universal Confidence Sets for Constrained Decision Problems

Silvia Vogel, Professor, Technische Universitat Ilmenau, Postfach 100565, Ilmenau, 98684, Germany, Silvia.Vogel@tu-ilmenau.de

We will consider universal confidence sets, i.e. sequences of random sets which converge to the true constraint set or solution set and have the property that for each n the true set is covered at least with a prescribed probability. In addition to suitable convergence assumptions for the objective functions and the constraint functions the approach requires knowledge about certain characteristics of the unknown true decision problem. We will explain how estimates for these characteristics can be incorporated.

■ ThA16

Gleacher Center - 200

Stochastic Optimization D

Contributed Session

Chair: Olga Myndyuk, Graduate Student, Rutgers University, RUTCOR, 640 Bartholomew Road, Piscataway, NJ, 08854, United States of America, olgamyn@eden.rutgers.edu

1 - On the Certainty Equivalent and Probability Dependent Utility Function of CVaR based Preferences

Alexandre Street, Assistant Professor, Pontifical Catholic University of Rio de Janeiro, Marques de Sao Vicente Str., 225, Cardeal Leme Build., 4th Floor - DEE, Rio de Janeiro, RJ, 22451-900, Brazil, street@ele.puc-rio.br

The Conditional Value-at-Risk (CVaR) has been paving the way for an enormous number of applications in risk management problems. This work aims to introduce the characterization of the associated Certainty Equivalent (CE) and Utility Function (UF) of two types of well known decision agents: CVaR maximizers and CVaR constrained maximizers. A discussion on the need of time consistency in multistage stochastic decision will be provided based on a coherent usage of the CVaR utility.

2 - Corporate Asset Liability Management (ALM) via Stochastic Programming

Davi Valladão, PhD Student, PUC-Rio, Guimarães Rosa 203/2003, Rua Marqués de São Vicente, 225, Gávea, Rio de Janeiro, 22793620, Brazil, davimv@ele.puc-rio.br, Alvaro Veiga, Alexandre Street

ALM is the practice of managing a business so that decisions taken with respect to assets and liabilities are coordinated, in order to achieve financial objectives, given a tolerance to risk. For a corporation, the main financial objective is to increase de value for the stockholders and the main risk is to bankrupt. In this paper we discuss a linear stochastic programming model to select projects and fundings of a corporation.

3 - Probabilistic Programming with Uniformly Didtributed Random Variable

Olga Myndyuk, Graduate Student, Rutgers University, RUTCOR, 640 Bartholomew Road, Piscataway, NJ, 08854, United States of America, olgamyn@eden.rutgers.edu

We assume that in the underying LP the vector on the right hand side has multivariate uniform distribution in a convex set. We solve the probabilistic constrained stochastic programming problem by the supporting hyperplane and the logarithmic barrier methods. The combination of these methods provide us with lower and upper bounds for the optimum values. The problem to calculate the volumes of convex polyhedra will also be discussed. Numerical results will be presented.

■ ThA17

Gleacher Center - 204

Logistics and Transportation C

Contributed Session

Chair: Uwe Zimmermann, Technical University Braunschweig, Pockelsstrasse 14, Braunschweig, 38106, Germany, u.zimmermann@tu-bs.de

1 - An Exact Method for the Vehicle Routing Problem with Time Windows

Roberto Roberti, PhD Student, DEIS - University of Bologna, Via Sacchi, 3, Cesena, 47521, Italy, roberto.roberti6@unibo.it, Roberto Baldacci, Aristide Mingozzi

We present an exact method for the Vehicle Routing Problem with Time Windows (VRPTW) based on the set partitioning formulation with subset-row inequalities. A valid lower bound is computed by combining different dual ascent procedures and a pricing and cut method. The final dual solution is used to generate a reduced IP problem solved using CPLEX. The proposed method solved all but one Solomon benchmark instances, outperforming the best known methods.

2 - Efficient Lower and Upper Bounds for the Multi-commodity Capacitated Multi-facility Weber Problem

Temel Oncan, Galatasaraay University, Ciragan Cad NO 36, Istnbul, 34357, Turkey, oncantem@yahoo.com, I. Kuban Altinel, M. Hakan Akyuz

The Capacitated Multi-facility Weber Problem is concerned with locating I capacitated facilities in the plane to satisfy the demand of J customers with the minimum total transportation cost of a single commodity. This is a non-convex optimization problem and difficult to solve. In this study, we focus on a multi-commodity extension and consider the situation where K distinct commodities are shipped to the customers subject to capacity and demand constraints. Customer locations, demands and capacities for each commodity are known a priori. We propose specially tailored Lagrangean relaxation schemes to obtain lower bounds on the MCMWP ant present efficient heuristic algorithms.

3 - Large-scale Vehicle Routing for Urban Waste Disposal

Uwe Zimmermann, Technical University Braunschweig, Pockelsstrasse 14, Braunschweig, 38106, Germany, u.zimmermann@tu-bs.de, Ronny Hansmann

An ongoing project with waste disposal companies aims at simultaneously planning routes and crews of collection-vehicles. We focus on the optimization of routes. We illustrate practical constraints extending classical Arc Routing. Best exact methods for Arc Routing solve instances with up to 200 demand arcs to optimality. Our street network of the German city of Bochum consists of about 15000 arcs with demand, i.e. street segments with waste to collect. Based on adequate aggregations and relaxations we present optimization approaches for finding efficient routes. We discuss computational results for real data and we compare our solutions with the routes applied in practice. We conclude with some remarks on planning routes and crews at once.

■ ThA18

Gleacher Center - 206

Non-linear Combinatorial Optimization

Cluster: Nonlinear Mixed Integer Programming
Invited Session

Chair: Jesus De Loera, Professor, University of California-Davis, Dept of Mathematics, One Shields Avenue, Davis, CA, 95616, United States of America, deloera@math.ucdavis.edu

1 - Optimality Certificates, N-fold IPs and Nash Equilibria

Raymond Hemmecke, Visiting Professor, Technical University Darmstadt, Dept. of Mathematics, Darmstadt, Germany, hemmecke@mail.math.uni-magdeburg.de

In this talk I present a polynomial oracle-time algorithm to minimize a separable convex function over the lattice points in a polyhedron. Applying this algorithm to structured problems, such as N-fold integer programs, even yields a polynomial time algorithm for their solution. Based on this, I present a polynomial time algorithm for finding a generalized Nash equilibrium for a family of integer programming games.

2 - A New SDP Approach to the Max-cut problem

Joao Gouveia, Graduate Student, University of Washington, Dept of Mathematics, Seattle, WA, 98195, United States of America, jgouveia@math.washington.edu, Monique Laurent, Pablo A. Parrilo, Rekha Thomas

Using sums-of-squares techniques we generalize Lovasz's theta body construction and use it to derive a new hierarchy of SDP relaxations for the Max-Cut problem, solving an open question by Laszlo Lovasz.

3 - A Hierarchy of Theta Bodies for Polynomial Systems

Rekha Thomas, Professor, University of Washington, Box 354350, Department of Mathematics, Seattle, WA, 98195, United States of America, thomas@math.washington.edu, Joao Gouveia, Pablo A. Parrilo

We extend Lovasz's theta body of a graph to a hierarchy of SDP relaxations for the convex hull of real solutions to any polynomial system. I will discuss the geometry of these relaxations.

■ ThA19

Gleacher Center - 208

Nonlinear Mixed Integer Programming C

Contributed Session

Chair: Qing Wang, The World Gates, Inc., 11545Parkwoods Circle, Suite B-1, Alpharetta, GA, United States of America, qingwangtct@yahoo.com

1 - An Interior Point Lagrangian Decomposition Method for Convex Programming

Ion Necoara, K.U.Leuven, Kasteelpark Arenberg 10, Electrical Engineering Department, Leuven-Heverlee, 3001, Belgium, ion.necoara@esat.kuleuven.be, Johan Suykens

We present a decomposition algorithm that incorporates the interior point method into augmented Lagrangian decomposition technique for solving large-scale separable convex problems. By adding self concordant barrier terms to the ordinary Lagrangian we prove under mild assumptions that the corresponding family of dual functions is self concordant. This makes it possible to efficiently use the Newton method for tracing the central path. We also show that the new algorithm is globally convergent.

2 - The End Set and the Extent of a Convex Set, the Closedness of a Convex Cone, and Applications

Hui Hu, Northern Illinois University, Math Dept., Watson Hall 333, DeKalb, IL, 60115, United States of America, hu@math.niu.edu, Qing Wang

This article presents new conditions that ensure the closedness of a convex cone in terms of the end set and the extent of its generator. The results significantly extend the classical condition of the same problem. The new closedness conditions are utilized to obtain a simple formula of the least global error bound and a suitable regularity condition of the set containment problem for positively homogeneous convex functions.

■ ThA20

Gleacher Center - 300

Large Scale Nonlinear Programming and PDE-based Problems

Cluster: Nonlinear Programming

Invited Session

Chair: Stefan Ulbrich, Technische Universitaet Darmstadt, Fachbereich Mathematik, Schlossgartenstr. 7, Darmstadt, 64289, Germany, ulbrich@mathematik.tu-darmstadt.de

1 - Optimization of Time Dependent PDEs using Model Reduction

Matthias Heinkenschloss, Rice University, CAAM Dept. - MS 134, Houston, TX, 77005, United States of America, heinken@rice.edu

Optimization of time dependent PDEs involve the solution of large scale systems that arise from the forward in time state PDE and the backward in time adjoint PDE. We investigate the use of model reduction techniques as a method to reduce the storage and computing time requirements that arise. We present a model reduction approach that allows the derivation of a-priori bounds for the error in the solution and we present numerical examples for shape optimization and optimal control problems.

2 - Trust Region Methods for Reduced Order Models

Ekkehard Sachs, Universitat Trier, Trier, 54286, Germany, sachs@uni-trier.de

Optimization problems with PDEs lead to large scale optimization problems with demand for very efficient software. In several applications the use of recuded order models have proven to become highly efficient. We present an adaptive approach to manage the models and discuss several issues in selecting the models related to proper orthognal decomposition (POD).

3 - Inexact Null-space Iterations in Large Scale Optimization

Michael Hintermueller, Professor, Humboldt-Universitaet zu Berlin, Department of Mathematics, Unter den Linden 6, Berlin, 10099, Germany, hint@math.hu-berlin.de

For a class of PDE-constrained optimization problems it is assumed that the following building blocks for a solver of the KKT-system are available: an iterative procedure for the forward as well as the adjoint equation and a (simple) preconditioner for the KKT-system, which itself has the flavor of an iterative procedure. In fact, the overall method defines an inexact null space iteration (within an SQP framework). Therefore, in general it cannot be guaranteed that a search direction provides sufficient progress toward optimality. In this talk, under suitable conditions, a convergence analysis of such inexact null space iterations is provided and a report on numerical tests is given.

■ ThA21

Gleacher Center - 304

Algorithmic Game Theory for Networks

Cluster: Telecommunications and Networks

Invited Session

Chair: Stavros Kolliopoulos, National & Kapodistrian University of Athens, Department of Informatics, Panepistimiopolis, Ilissia, Athens, 157 84, Greece, sgk@di.uoa.gr

1 - Selfish Routing with Oblivious Users and User Preferences

George Karakostas, McMaster University, 1280 Main St. W., Hamilton, ON, Canada, karakos@mcmaster.ca, Taeyon Kim, Anastasios Viglas, Hao Xia

We extend the known models of selfish routing by considering users oblivious to congestion. For example, a percentage of travelers may base their route simply on the distances they observe on a map, without any concerns about the delays experienced on this route due to their fellow travelers. We also consider the selfish routing of users with individual route preferences and the problem of inducing these selfish users to follow the optimal flow pattern through taxes.

2 - Utilitarian Mechanism Design for Multi-objective Optimization

Piotr Krysta, University of Liverpool, Department of Computer Science, Ashton Building, Ashton Street, Liverpool, L69 3BX, United Kingdom, P.Krysta@liverpool.ac.uk, Stefano Leonardi, Fabrizio Grandoni, Carmine Ventre

We study mechanism design for NP-hard multi-objective optimization problems with one objective function and secondary objectives modeled by budget constraints. Our main contribution is showing that two of the main tools for the design of approximation algorithms for multi-objective optimization problems, approximate Pareto curves and Lagrangian relaxation, can lead to truthful approximation schemes. By exploiting the first method, we devise truthful FPTASs for the multi-budgeted versions of minimum spanning tree, shortest path, maximum matching, and matroid intersection. By building on the second method, we present a universally truthful Las Vegas PTAS for minimum spanning tree with a single budget constraint, without violating the budget.

3 - On the Complexity of Price Wars

Adrian Vetta, McGill University, 805 Sherbrooke St, McGill University, Canada, vetta@math.mcgill.ca, Nithum Thain

We consider the complexity of decision making with regards to predatory pricing in multi-market models. Specifically, we develop multi-market extensions of the classical oligopoly models of Bertrand, Cournot and Stackelberg. Using the current legal framework, we then show that it is hard for a firm to decide whether engaging in predatory behaviour will be profitable, even with complete information. On the positive side, we present approximation algorithms for this problem.

■ ThA22

Gleacher Center - 306

Implementations, Software A

Contributed Session

Chair: Geraldo Veiga, RN Ciancia e Tecnologia, R. Aperana 57/404, Rio de Janeiro, 22453-900, Brazil, gveiga@gmail.com

1 - Mathematical Programming with Mathematica: Forming Models, Executing Methods, and Confirming Results

James Noyes, Emeritus Professor of Computational Science, Wittenberg University, P.O. Box 190, 140 Owners Drive, Tremont City, OH, 45372, United States of America, jnoyes@wittenberg.edu

Using Mathematica 7, many types of optimization problems (UO, LP, QP, NLP, MILP, etc.) can be easily formulated and solved, often by a single command. Integrated features include: symbolic and numeric processing (e.g., partial derivatives), exact and arbitrary precision arithmetic, static vs. dynamic visualization, and user-selected vs. auto-selected hybrid solution algorithms. Performance on test problems will be investigated and code will be demonstrated that extends Mathematica's capability.

2 - On the Implementation of the Primal-dual Interior-point Method for SDPs with Log-determinants

Mituhiro Fukuda, Assistant Professor, Tokyo Institute of Technology, 2-12-1-S6-5, Oh-okayama, Meguro-ku, Tokyo, 152-8550, Japan, mituhiro@is.titech.ac.jp

We incorporate new routines to adapt the general semidefinite programming (SDP) solver SDPA version 7 to solve SDPs with weighted log-determinant terms. Numerical experiments show that the current version inherits all the best features of the new SDPA.

3 - Parallel Implementation of Interior Point Algorithms for Linear Programming

Geraldo Veiga, RN Ciancia e Tecnologia, R. Aperana 57/404, Rio de Janeiro, 22453-900, Brazil, gveiga@gmail.com, Fernanda Thomé, Luiz Carlos Costa Jr., Nelson Maculan

In interior point methods, the computational effort lies in solving a sequence of symmetric linear systems. We explore the parallelization of a primal-dual algorithm by incorporating linear system solvers from highly scalable parallel toolkits. Using MPI and OpenMP, we consider MUMPS, a parallel implementation of the multi-frontal method, and iterative methods from the PETSc toolkit. Computational experiments solve problems from a standard testbed and a large-scale power system planning model.

■ ThA23

Gleacher Center - 308

Optimization in Machine Learning II

Cluster: Sparse Optimization

Invited Session

Chair: Kristin Bennett, Professor, Rensselaer Polytechnic Institute, Dept of Mathematical Sciences, 110 Eighth Street, Troy, NY, 12180, United States of America, bennek@rpi.edu

1 - Privacy-preserving Support Vector Machine Classification via Random Kernels

Olvi Mangasarian, Professor Emeritus, University of Wisconsin, Computer Sciences Dept., 1210 West Dayton Street, Madison, WI, 53706, United States of America, olvi@cs.wisc.edu, Edward Wild

Privacy-preserving support vector machine (SVM) classifiers are proposed for vertically and horizontally partitioned data. Vertically partitioned data represent instances where distinct entities hold different groups of input space features for the same individuals, but are not willing to share their data or make it public.Horizontally partitioned data represent instances where all entities hold the same features for different groups of individuals and also are not willing to share their data or make it public. By using a random kernel formulation we are able to construct a secure privacy-preserving kernel classifier for both instances using all the data but without any entity revealing its privately held data.

2 - MetricBoost: AdaBoosting Positive Semi-definite Matrices for Metric Learning

Jinbo Bi, Scientist, Siemens Medical Solutions, 51 Valley Stream Parkway, Malvern, PA, 19355, United States of America, jinbo_bi@yahoo.com

We study a boosting algorithm, MetricBoost, for learning a distance metric to preserve proximity relationship among objects. The problem of learning a proper distance metric arises in many applications, eg in content-based image retrieval. PSD matrices can be used to define Mahalanobis distance. We give mathematical derivation of MetricBoost which builds a Mahalanobis metric by combining rank-one matrices into a PSD matrix. We discuss the options for choosing alpha and weak models. Efficient implementations of MetricBoost are also developed to dramatically scale it up. Computational results on benchmark data sets as well as on a real-world medical problem to identify diffused lung diseases demonstrate the effectiveness of MetricBoost.

3 - SVM Cross-validation as a Bilevel Program with Unconstrained Lower Level Problems

Greg Moore, Rensselaer Polytechnic Inst, 110 8th Street, AE 301, Troy, NY, 12180, United States of America, mooreg5@rpi.edu, Kristin Bennett, Jong-Shi Pang

We formulate selection of support vector machine (SVM) hyper-parameters via cross-validation as a bilevel program. The lower level SVM problems are treated directly as convex unconstrained optimization problems. We replace the lower level problems with a nonsmooth penalty function of the optimality conditions. The resulting penalty problems are solved using successive convex function approximations with proximity control. This novel approach is scalable and generalizes well.

■ ThA25

Gleacher Center - 404

Variational Analysis

Cluster: Variational Analysis

Invited Session

Chair: Shu Lu, University of North Carolina-Chapel Hill, 355 Hanes Hall CB 3260, Chapel Hill, NC, 27599, United States of America, shulu@email.unc.edu

1 - Prox-regularity

Rene Poliquin, Professor, University of Alberta, Edmonton, AB, T6G2G1, Canada, rene.poliquin@ualberta.ca

A survey of prox-regularity will be given. Operations that preserve prox-regularity will be presented. New results concerning the second-order epi- and parabolic derivatives of these functions will be examined.

2 - Implications of the Constant Rank Constraint Qualification

Shu Lu, University of North Carolina-Chapel Hill, 355 Hanes Hall CB 3260, Chapel Hill, NC, 27599, United States of America, shulu@email.unc.edu

This talk concerns a parametric set defined by finitely many equality and inequality constraints under the constant rank constraint qualification (CRCQ). The CRCQ generalizes both the linear independence constraint qualification (LICQ) and the polyhedral case, and is also related to the Mangasarian-Fromovitz constraint qualification (MFCQ) in a certain way. It induces some nice properties of the set defined by a fixed parameter, and some nice behavior of the set-valued map that assigns parameters to sets defined by them. Such properties are useful in analysis of variational conditions.

3 - Coderivatives in Parametric Optimization in Asplund Spaces

Nhi Nguyen, Wayne State University, Department of Mathematics, Detroit, MI, 48202, United States of America, ax4667@wayne.edu

In this talk, we first develop some calculus rules for second-order partial subdifferentials of extended real-valued functions in the framework of Asplund spaces. We then apply these rules in the study of a family of parameterized optimization problems in which both cost function and constraint function are nonsmooth extended real-valued on Asplund spaces, and conduct a local sensitivity analysis for the stationary point multifunctions.

■ ThA28

Gleacher Center - 600

Convex Optimization Algorithms

Cluster: Nonsmooth and Convex Optimization

Invited Session

Chair: Angelia Nedic, Assistant Professor, University of Illinois at Urbana-Champaign, 117 Transportation Building, 104 South Mathews Avenue, Urbana, IL, 61801, United States of America, angelia@illinois.edu

1 - Multi-dimensional Mechanism Design: Finite Dimensional Approximations and Efficient Computation

Alexadre Belloni, Duke University, The Fuqua School of Business, 1 Towerview Drive, Durham, NC, 27708, abn5@duke.edu, Giuseppe Lopomo, Shouqiang Wang

Multi-dimensional mechanism design problems have proven difficult to solve. We consider mechanism design problems with multi-dimensional types when the seller's cost function is not separable across buyers. We transform the seller's problem into a representation that only involves `interim' variables and eliminates the dimensionality dependence on the number of buyers. We show that the associated infinite dimensional optimization problem can be approximated arbitrary well by a sequence of finite dimensional LPs.

2 - Convex Optimization for Multi-task/kernel Learning

Paul Tseng, Professor, University of Washington, Department of Mathematics, Box 354350, Seattle, WA, 98195, United States of America, tseng@math.washington.edu, Jieping Ye, Ting Kei Pong

We describe ongoing work on convex optimization arising in multi-task and multi-class discriminant kernel learning. These problems involve matrix variables and are large scale. We study primal and dual formulations, some of which involve SDP and/or nuclear/trace norm minimization, and efficient algorithms, including accelerated gradient methods. One application is gene expression pattern analysis.

3 - Distributed Convex Optimization

Sundhar Ram Srinivasan, University of Illinois, 1308 W. Main Street, Urbana, IL, 60801, United States of America, ssriniv5@illinois.edu, Angelia Nedic, Venugopal Veeravalli

We first consider the problem of minimizing the sum of convex functions, when each function is known only to a network agent. We briefly review two distributed algorithms that solve this problem. We then introduce a new class of objective functions that can be solved using distributed algorithms and discuss the associated algorithm. We motivate both the problems using regression. Finally, we also discuss extensions to the case when there are gradient errors, communication errors and quantization effects.

■ ThA29

Gleacher Center - 602

Mathematical Programming Approaches in Financial Modeling

Cluster: Finance and Economics

Invited Session

Chair: Stan Uryasev, Professor, University of Florida, ISE Department, 303 Weil Hall, P.O. Box 116595, Gainesville, FL, 32611, United States of America, uryasev@ufl.edu

1 - Implied Copula CDO Pricing Model: Entropy Approach

Alex Veremyev, University of Florida, 303 Weil Hall, Gainesville, United States of America, averemyev@ufl.edu, Stan Uryasev, Alex Nakonechnyi, Tyrrell Rockafellar

An implied copula CDO pricing model is considered for calibrating obligor hazard rates. To find the probability distribution of the hazard rates we propose an entropy approach to the implied copula model by Hull and White. We maximize entropy with no-arbitrage constraints based on bid and ask prices of CDO tranches. To reduce the noise a new class of distributions is introduced. A case study shows that this approach has a stable performance. The MATLAB code is provided.

2 - Risk Classification Approach through Convex Optimization

Vladimir Bugera, Kammerdiner Consulting, 16031 N 31st Ave, Phoenix, AZ, 85053, United States of America, vladimir@bugera.com, Stan Uryasev

We consider an optimization approach for multi-class classification. The optimization problem is formulated as minimization of a penalty function built with quadratic separating functions. It is reduced to linear programming. We enhance the optimization problem with various constraints to adjust model flexibility and to avoid data overfitting. We apply this approach to evaluate risks in several financial applications, and compare our methodology with conventional techniques.

3 - Entropy Approach for Calibrating Probabilistic Distributions

Konstantin Kalinchenko, University of Florida, Gainesville, FL 32611, kalinchenko@ufl.edu, Stan Uryasev

We are using entropy approach for calibrating probabilistic distributions. The first problem is related to estimating return distributions of a portfolio based on information from analysts. The second problem is from medical area where we are estimating the risk (probability) of cesarean section.

Thursday, 1:15pm - 2:45pm

■ ThB01

Marriott - Chicago A

Allocations and Scheduling

Cluster: Approximation Algorithms

Invited Session

Chair: Cliff Stein, Columbia University, 326 S W Mudd Building, 500 W. 120th Street, New York, NY, 10027, cliff@ieor.columbia.edu

1 - Allocating Goods to Maximize Fairness

Julia Chuzhoy, TTI, 6045 S. Kenwood Ave., Chicago, United States of America, cjulia@tti-c.org, Deeparnab Chakrabarty, Sanjeev Khanna

In the Max-Min Allocation problem, the input consists of a set of agents, a set of items and utilities u(A,i) of agent A for item i. The goal is to allocate items to the agents, maximizing the minimum utility of any agent. The utility of an agent is the sum of its utilities for items it receives. We show new approximation algorithms for the problem, and in particular provide poly-logarithmic approximation in quasi-polynomial time.

2 - Primal-dual Algorithm for Maximum Budgeted Allocation

Deeparnab Chakrabarty, Post-doctoral Fellow, University of Waterloo, 200 University Ave W, Waterloo, ON, N2L2C9, Canada, deeparnab@gmail.com

In the maximum budgeted allocation (MBA) problem, we are given a set of indivisible items and agents bidding on them. Each agent has a budget over which she will not pay. The goal is to allocate the items to maximize revenue. We state a natural linear programming relaxation for the problem and then show a primal-dual algorithm achieving a $3/4$-factor matching the integrality gap of the relaxation. This is the best known approximation for the problem to date.

3 - Scheduling to Minimize Average Response Time

Cliff Stein, Columbia University, 326 S W Mudd Building, 500 W. 120th Street, New York, NY, 10027, cliff@ieor.columbia.edu

Consider the non-preemptive scheduling problem on one machine and a set of jobs that arrive at different times and have different processing times. The objective is to minimize the average response time. We give new approximation algorithms for this, and related scheduling problems, using resource augmentation. The main technical contribution is a new integer programming formulation and leads to the first constant factor approximations using constant factor faster machines.

■ ThB02

Marriott - Chicago B

Equilibrium and Variational Inequality Problems

Cluster: Complementarity Problems and Variational Inequalities

Invited Session

Chair: Michael Hintermueller, Professor, Humboldt-Universitaet zu Berlin, Department of Mathematics, Unter den Linden 6, Berlin, 10099, Germany, hint@math.hu-berlin.de

1 - A Regularization/semi-smooth-Newton Method for Solving a Cahn-Hilliard Type Problem

Moulay Hicham Tber, Doctor, University of Graz, Department of Mathematics, Paulustorgasse 15, Graz, 8010, Austria, moulay.tber@uni-graz.at, Michael Hinze, Michael Hintermueller

A Cahn-Hilliard model is considered. The governing system is discretised in time using a semi-implicit scheme. the resulting time-discrete system is formulated as an optimal control problem with constraints on the control. To solve the optimal control problem, we propose a function space algorithm which combines a regularization method to deal with the constraints on the control and a semi-smooth Newton method to solve the optimality systems for the regularized sub-problems.

2 - An Analysis of M-stationary Points to an Electricity Spot Market EPEC

Thomas Surowiec, PhD Student, Humboldt-University of Berlin, Department of Mathematics, Unter den Linden 6, Berlin, 10099, Germany, surowiec@math.hu-berlin.de, Rene Henrion, Jiri Outrata

We present a type of solution analysis for equilibrium problems with equilibrium constraints (EPEC). The analysis centers on the disambiguation of M-stationarity conditions, leaving them void of multivalued objects. Conducting this analysis requires a verification of the stability properties of certain multifunctions and constraint qualifications. Depending on the model parameters, this is done in a variety ways, e.g., via a new calmness result for a class of a non-polyhedral multifunctions.

3 - Nonsmooth Newton Multigrid Methods for Constrained and Nonlinear Minimization Problems

Carsten Gräser, PhD Student, Freie Universität Berlin, Fachbereich Mathematik und Informatik, Arnimallee 6, Berlin, 14195, Germany, graeser@math.fu-berlin.de

Nonsmooth Newton methods turned out to be an efficient approach to deal with inequality constrained minimization problems. Unfortunately they often lack an inexact global convergence theory. We present a class of nonsmooth Newton methods that can be globalized using the problem inherent energy - even in the case of very inexact solution of the linear subproblems. Using linear multigrid methods for these subproblems a globally convergent overall nonlinear multigrid method is obtained that performs comparable to multigrid methods for linear problems. Since the presented approach incorporates inequality constraints in terms of nonsmooth nonlinear functionals it directly extends to various other nonsmooth minimization problems.

■ ThB03

Marriott - Chicago C

Decomposition Methods for Models of Energy Markets

Cluster: Optimization in Energy Systems

Invited Session

Chair: David Fuller, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, dfuller@engmail.uwaterloo.ca

1 - Subproblem Approximation in Dantzig-Wolfe Decomposition of Variational Inequality Problems

David Fuller, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, dfuller@engmail.uwaterloo.ca, William Chung

The talk outlines the extension of Dantzig-Wolfe decomposition from pure optimization problems to variational inequality (VI) problems. Several ways to approximate the subproblem can produce better proposals, while retaining the theoretical convergence properties. Illustrations are given for a model of Canadian energy markets.

2 - Decomposition and Approximation Algorithms for an Equilibrium Model in Electricity Markets

Emre Celebi, PhD Candidate, University of Waterloo, 200 University Ave. West, Waterloo, ON, N2L 3G1, Canada, ecelebi@engmail.uwaterloo.ca, David Fuller

An equilibrium model in time-of-use electricity markets with linearized DC network constraints is examined. We sought computationally efficient decomposition algorithms for this model and used approximations to reduce the computational effort. These algorithms and approximations are applied to large-scale realistic test models.

3 - Solving Stochastic Complementarity Problems with Benders Method

Steve Gabriel, Associate Professor, University of Maryland, Dept Civil Environ Eng, 1143 Glenn L Martin Hall, College Park, MD, 20742, United States of America, sgabriel@umd.edu, David Fuller

In this talk we present a new version of Benders method customized to solve stochastic complementarity problems but based on an earlier decomposition strategy of Fuller and Chung. We provide both the theory as well as numerical experiments that justify the approach.

■ ThB04

Marriott - Denver

Combinatorial Optimization H

Contributed Session

Chair: Yuichiro Miyamoto, Sophia University, Kioicho 7-1, Chiyodaku, Tokyo, Japan, miyamoto@sophia.ac.jp

1 - An Improved Algorithm for Finding Minimum Cycle Bases in Undirected Graphs

Edoardo Amaldi, DEI, Politecnico di Milano, Piazza L. da Vinci 32, Milano, 20133, Italy, amaldi@elet.polimi.it, Claudio Iuliano, Romeo Rizzi

Given an undirected graph G with a nonnegative weight on each edge, we wish to find a basis B of the cycle space of G of minimum total weight, where the weight of B is the sum of the weights of all the cycles in B. We present an efficient $O(m^{2n})$ hybrid algorithm in which only a substantially reduced set of candidate cycles, the so-called isometric cycles, is considered, and report some computational results.

2 - Integer Programming Formulations for Graph Partitioning

Matthias Peinhardt, Otto-von-Guericke University Magdeburg, Universitatsplatz 2, Faculty of Mathematics (FMA/IMO), Magdeburg, D-39106, Germany, matthias.peinhardt@ovgu.de

Graph Partitioning is an important optimization problem incorporating many diverse applications. In the past several Integer Programming formulations have been proposed. We compare these formulations experimentally with an emphasis on a formulation that has been dismissed in the past because of its inherent symmetry, albeit its advantage to directly deal with sparse graphs. To circumvent the problems arising from model symmetry we propose several approaches, and evaluate them.

3 - Levelwise Mesh Sparsification for Point-to-Point Shortest Path Queries

Yuichiro Miyamoto, Sophia University, Kioicho 7-1, Chiyodaku, Tokyo, Japan, miyamoto@sophia.ac.jp, Takeaki Uno, Mikio Kubo

We propose the levelwise mesh sparsification method that allows fast point-to-point queries in networks using preprocessed data. In our method, several sparse networks are obtained by preprocessing the original network, and the shortest path problem is solved by finding the shortest path in these sparse networks. Computational experiments on real world data show the efficiency in terms of computational time and memory efficiency. The advantage is that it uses only a small amount of memory.

■ ThB05

Marriott - Houston

Combinatorial Optimization L

Contributed Session

Chair: Ilya Safro, Postdoc, Argonne National Laboratory, Mathematics and CS Division, 9700 S Cass, Lemont, IL, 60439, United States of America, safro@mcs.anl.gov

1 - A Satisfiability Approach to Combinatorial Optimization Problems

Andrei Horbach, University of Kiel, Olshausenstr.,40, Kiel, 24098, Germany, horbach@bwl.uni-kiel.de

We solve combinatorial optimization problems by applying extended SAT techniques. Our approach allows us to efficiently solve several problems of combinatorial optimization, e.g. the Resource Constrained Project Scheduling Problem and real-world scheduling problems of sports leagues. We discuss the bottlenecks of this approach and possibilities to improve it.

2 - Combinatorial Optimization for Flat Panel Displays

Andreas Karrenbauer, EPFL, Institute of Mathematics, Station 8, Lausanne, 1015, Switzerland, andreas.karrenbauer@epfl.ch

We use methods from Combinatorial Optimization, i.e. flows and matchings, to improve modern flat panel displays. That is, we reduce the addressing time and thereby also power consumption and degradation effects. To this end, we model the addressing of the pixels as combinatorial matrix decomposition problems. We show NP-hardness and conditions under which polynomial algorithms exist. We derive fully combinatorial approximation algorithms, which are currently implemented by a chip manufacturer.

3 - Multilevel Algorithms for Combinatorial Optimization Problems

Ilya Safro, Postdoc, Argonne National Laboratory, Mathematics and CS division, 9700 S Cass, Lemont, IL, 60439, United States of America, safro@mcs.anl.gov

Linear ordering and partitioning problems appear in many practical applications. We present a general framework of linear multilevel heuristic algorithms and demonstrate (including numerical results) how its parts can be used for minimizing: linear arrangement, bandwidth, partitioning, etc. We introduce a notion of algebraic distance of an edge and show how to use endpoints neighborhood connectivity in Algebraic Multigrid schemes for graphs. Joint work with: A. Brandt, C. Chevalier and D. Ron.

■ ThB06

Marriott - Kansas City

Applications of Conic Programming in Random Linear and Integer Programs

Cluster: Conic Programming

Invited Session

Chair: Karthik Natarajan, City University of Hong Kong, Department of Management Science, Hong Kong, Hong Kong - PRC, knataraj@cityu.edu.hk

1 - Product Line Design with Interdependent Products

Vinit Kumar, National University of Singapore, 1 Business Link, BIZ 1 Building, Kent Ridge, 117592, Singapore, vinitkmishra@gmail.com, Chung-Piaw Teo, Hua Tao, Karthik Natarajan

We develop a discrete choice model termed as the Cross Moment Model (CMM) based on Semidefinite programming. This choice model is parsimonious in that it uses only the mean and covariance information of the utility functions. We use this model to solve a “flexible packaging design problem” confronting a local service parts supplier and compare the results with the results obtained by MNL.

2 - Mixed Zero-one Linear Programs Under Uncertainty: A Completely Positive Representation

Karthik Natarajan, City University of Hong Kong, Department of Management Science, Hong Kong, Hong Kong - PRC, knataraj@cityu.edu.hk, Chung-Piaw Teo, Zheng Zhichao

We develop a cross moment model based on completely positive programs for mixed 0-1 linear programs under uncertainty. The model captures mean-covariance information and works for mixed 0-1 linear programs. This extends Burer’s model from a deterministic to a stochastic setting. The practicality of the model is explored in an order statistics and project management setting. The generality of the model opens up an interesting dimension for research in stochastic discrete optimization models.

3 - Basis Partition of the Space of Linear Programs Through a Differential Equation

Zhao Gongyun, National Univ. of Singapore, Department of Mathematics, Singapore, Singapore, matzgy@nus.edu.sg

A linear program (LP) is associated with an optimal basis. The space of linear programs (SLP) can be partitioned into a finite number of sets, each consisting of all LPs with a common basis. If the partition of SLP can be characterized, we can solve infinitely many LPs in closed form. A tool for characterizing the partition of SLP is an ode M’=h(M), where M is a projection matrix. Any LP defines a projection matrix, starting from which the solution of M’=h(M) converges to a limit projection matrix which can determine the basis of the LP. With the help of M’=h(M), it is promising to discover full characterization of the partition of SLP. We will present some properties found so far. Full structure of SLP is still awaiting an exploration.

■ ThB07

Marriott - Chicago D

Integer and Mixed Integer Programming H

Contributed Session

Chair: Adewale Faparusi, Texas A&M University, 5005 Coachmans Carriage Terrace, Glen Allen, VA, 23059, United States of America, afaparusi@tamu.edu

1 - Chebyshev Center Based Column Generation

Jinil Han, Ph.D. Student, KAIST, 335 Gwahangno, Yuseong-gu, Department of Industrial and Systems Eng, Daejeon, 305-701, Korea, Republic of, hji@kaist.ac.kr, Sungsoo Park, Chungmok Lee

Classical column generation often shows desperately slow convergence. Recently, many acceleration techniques are proposed. We propose Chebyshev center based column generation. In this method, the Chebyshev center is used for centering dual solutions within dual polyhedron. The Chebyshev center can be obtained by solving a linear program, so that our method can be applied with small modification of the classical column generation scheme. Numerical experiments show the effectiveness of our method.

2 - Handling Manufacturing Restrictions in Sheet Metal Design by Mixed Integer Programming

Ute Guenther, TU Darmstadt, Schlossgartenstrasse 7, Darmstadt, 64289, Germany, uguenther@mathematik.tu-darmstadt.de, Alexander Martin

We investigate a network design problem where the task is to find a directed Steiner tree with additional constraints, e.g. on the diameter. We study the underlying polyhedron and present facet-defining inequalities representing connectivity constraints. The study is motivated by an application from engineering, namely how to find design plans for branched sheet metal structures. To include all manufacturing restrictions while maintaining reasonable running time we use branch-and-cut approaches.

3 - Heuristic Solutions for the Fixed Charge Network Flow Problem

Adewale Faparusi, Texas A&M University, 5005 Coachmans Carriage Terrace, Glen Allen, VA, 23059, United States of America, afaparusi@tamu.edu

The Fixed Charge Network Flow Problem (FCNFP) is known to be NP-hard. It has many practical applications and includes the Steiner tree problem, uncapacitated lot-sizing problems, and the fixed charge transportation problem as special cases Although many exact methods have been developed to solve the FCNFP, in generality their computational requirements are exponentially related to the size of the problem. Modifications to improve existing heuristic algorithms are proposed.

■ ThB08

Marriott - Chicago E

Branch-and-Price II

Cluster: Integer and Mixed Integer Programming

Invited Session

Chair: Marco Luebbecke, TU Berlin, Institute of Mathematics, Strasse des 17. Juni 136, Berlin, 10623, Germany, m.luebbecke@math.tu-berlin.de

1 - The Fixed Charge Shortest Path Problem

Martin Savelsbergh, Professor, Georgia Tech School of Industrial and Systems Engineering, 765 Ferst Drive NW, Atlanta, GA, 30332, United States of America, mwps@isye.gatech.edu, George Nemhauser, Faramroze Engineer, Jin-Hwa Song

Consider a network in which each arc has a fixed cost, an interval specifying the flow that can be sent along the arc, and a per-unit cost for sending flow along the arc. For each node, there is a maximum flow that can accumulate along a path before reaching the node. The fixed charge shortest path problem (FCSPP) seeks to find a minimum-cost path from a source to a sink. We develop an innovative DP algorithm for FCSPP. FCSSP arises frequently in branch-and-price algorithms.

2 - Exact Reoptimization Algorithms for the Control of Elevator Groups

Benjamin Hiller, Zuse Institute Berlin, Takustr. 7, Berlin, Germany, hiller@zib.de, Torsten Klug, Andreas Tuchscherer

The task of an elevator control is to schedule the elevators of a group such that small average and maximal waiting and travel times for the passengers are obtained. We present exact reoptimization algorithms for this problem. A reoptimization algorithm computes a new optimal schedule for the elevator group each time a new passenger arrives. Our algorithms use column generation techniques and are, to the best of our knowledge, the first exact reoptimization algorithms for a group of elevators. We use our algorithms to compare the potential performance that can be achieved for conventional (ie up/down buttons) and two variants of destination call systems, where a passenger enters his destination floor when calling an elevator.

3 - A Branch-and-price Algorithm for Clusterwise Linear Regression

Yan Jiang, PhD Candidate, Northwestern Universtiy, 2145 Sheridan Road, Room C210, Evanston, IL, 60208, United States of America, jiangyan1984@gmail.com, Diego Klabjan

We present a branch-and-price algorithm for performing clusterwise linear regression. The clusterwise linear regression problem is to find clusters such that the overall sum of squared errors in regression within the clusters is minimal.The proposed algorithm is applied in the retail promotion planning to group products according to their seasonal effects. The pricing problem is a specialized MIP, which is shown to be NP-complete.

■ ThB09

Marriott - Chicago F

General-purpose Techniques for Solving MIPS

Cluster: Integer and Mixed Integer Programming

Invited Session

Chair: Santanu Dey, Université Catholique de Louvain, 1348 Louvain-la-Neuve, Belgium, Santanu.Dey@uclouvain.be

1 - A Counterexample to a Conjecture of Gomory and Johnson

Amitabh Basu, Carnegie Mellon University, 5000 Forbes Avenue, A19B, Posner Hall, Pittsburgh, PA, 15213, United States of America, abasu1@andrew.cmu.edu, Michele Conforti, Gerard Cornuejols, Giacomo Zambelli

In Mathematical Programming 2003, Gomory and Johnson conjecture that the facets of the infinite group problem are always generated by piecewise linear functions. In this paper we give an example showing that the Gomory-Johnson conjecture is false.

2 - Basis Reduction and the Complexity of Branch-and-bound

Gabor Pataki, Universtiy of North Carolina-Chapel Hill, Department of Statistics and Operations, Chapel Hill, United States of America, gabor@unc.edu, Mustafa Tural

Branch-and-bound is a classical method to solve integer programming feasibility problems. On the theoretical side, it is considered inefficient: it can take an exponential number of nodes to prove the infeasibility of a simple integer program. Here we show that branch-and-bound is theoretically efficient, if we apply a basis reduction based transformation to the constraint matrix. We prove that if the coefficients of the problem are drawn from {1, ..., M} for a sufficiently large M, then for almost all such instances the reformulated problem solves at the rootnode. Besides giving an analysis of branch-and-bound, our main result generalizes a result of Furst and Kannan on the solvability of subset sum problems.

3 - Hybrid Branching

Timo Berthold, ZIB / Matheon, Takustr. 7, Berlin, 14195, Germany, berthold@zib.de, Tobias Achterberg

The question how to split a problem into subproblems (branching) is in the core of any branch-and-bound algorithm. Branching on individual variables is very common in CP, MIP, and SAT. The rules, however, which variable to choose for branching, differ significantly. In this talk, we present hybrid branching, which combines selection rules from these three fields. Hybrid branching outperforms state-of-the-art MIP branching rules on general MIP benchmark sets.

■ ThB10

Marriott - Chicago G

Algorithms and Applications of Global Optimization for Nonlinear Programming Problems

Cluster: Global Optimization

Invited Session

Chair: Ernesto G. Birgin, University of São Paulo, Institute of Mathematics and Statistics, Rua do Matão, 1010, São Paulo, SP, 05508-090, Brazil, egbirgin@ime.usp.br

1 - Solving Convex Multiplicative Programs in the Outcome Space

Paulo A. V. Ferreira, Associate Professor, University of Campinas, Electrical and Computer Engineering, Av. Albert Einstein, 400, Campinas, SP, 13083852, Brazil, valente@dt.fee.unicamp.br, Rúbia M. Oliveira

A convex analysis approach for the global optimization of convex multiplicative problems in the outcome space is proposed. Algorithms for two important classes of convex multiplicative programs - the minimization of a product of convex functions and the minimization of a finite sum of products of two convex functions over a convex set - are detailed and numerically investigated. Global minima for these two classes of nonconvex programs are obtained by solving, respectively, a sequence of quasi-concave problems by vertex enumeration, and a sequence of indefinite quadratic problems by constraint enumeration. Extensions for other classes of convex multiplicative programs are also reported.

2 - A Branch-and-bound Algorithm for a Location Problem under Distance and Size-sensitive Demands

Luis Merca Fernandes, Professor, Polytechnic Institute of Tomar and Institute of Telecommunications, Quinta do Contador - Estrada da Serra, Tomar, 2300-313, Portugal, luism@ipt.pt, Joaquim Judice, Antonio Pais Antunes, Hanif D. Sherali

We discuss a discrete location model for finding the number, location, and size of facilities to maximize a demand function that is related to the size of the facilities and the distance between them. The model also assumes that the facilities must satisfy a threshold level of demand. We present a mixed-integer nonlinear programming (MINLP) formulation, and design a novel branch-bound algorithm that is proven to converge to a global optimum. Some numerical results are reported based on a GAMS/MINOS implementation to illustrate the efficacy of the proposed algorithm.

3 - Augmented Lagrangians for Global Minimization of NLP Problems

Ernesto G. Birgin, University of São Paulo, Institute of Mathematics and Statistics, Rua do Matão, 1010, São Paulo, SP, 05508-090, Brazil, egbirgin@ime.usp.br, Christodoulos Floudas, Jose Mario Martinez

A novel global optimization method based on an Augmented Lagrangian framework is introduced for continuous constrained nonlinear optimization problems. At each outer iteration the method requires the epsilon-global minimization of the Augmented Lagrangian with simple constraints. Global convergence to an epsilon-global minimizer of the original problem is proved. The subproblems are solved using the alphaBB method. Numerical experiments are presented.

■ ThB11

Marriott - Chicago H

Robust Optimization, Sparse Solutions and Signal Reconstruction

Cluster: Robust Optimization

Invited Session

Chair: Constatine Caramanis, University of Texas, Mail Code, C0806, Austin, TX, 78712, cmcaram@ece.utexas.edu

1 - Thresholded Basis Pursuit: Support Recovery for Sparse and Approximately Sparse Signals

Venkatesh Saligrama, Professor, Boston University, Boston, MA, United States of America, srv@bu.edu, Manqi Zhao

We present a linear programming solution for support recovery of sparse signals from randomly projected noisy measurements. Our proof technique is based on perturbation of the noiseless l1 problem. Consequently, the maximum achievable sparsity level in the noisy problem is comparable to that of the noiseless problem. Our result offers a sharp characterization in that neither the SNR nor the sparsity ratio can be significantly improved.

2 - Robust Regression and Lasso

Huan Xu, University of Texas, Mail Code, C0806, Austin, TX, 78712, xuhuan@cim.mcgill.ca, Constatine Caramanis, Shie Mannor

We first show that the well-known Lasso is a special case of robust regression, thus providing an interpretation of Lasso from a robust optimization perspective. By showing some generalizations, we provide a new methodology for designing regression algorithms. In addition to obtaining new formulations, we directly to show sparsity properties of Lasso, and prove a general consistency result for robust regression problems, including Lasso, from a unified robustness perspective.

3 - Compressed Sensing of Positive Signals with Minimal Expansion

Alex Dimakis, Assistant Professor, University of Southern California, Los Angeles, CA, United States of America, adim@eecs.berkeley.edu, Weiyu Xu, Amin Khajehnejad, Babak Hassibi

We investigate the sparse recovery problem of reconstructing a high-dimensional non-negative sparse vector from lower dimensional linear measurements. While initial work focused on dense measurement matrices, such as those arising from Gaussian ensembles, sparse measurement schemes have been constructed recently, using the adjacency matrices of expander graphs. These constructions are crucial in applications, such as DNA microarrays and sensor networks, where dense measurements are not practically feasible. Furthermore, they often lead to recovery algorithms much more efficient than ℓ_1 minimization. However, to date, constructions based on expanders have required very high expansion coefficients which can potentially make the construction of such graphs difficult and the size of the recoverable sets small. We construct sparse measurement matrices for the recovery of non-negative vectors, using perturbations of adjacency matrices of expander graphs with much smaller expansion coefficients. We present a necessary and sufficient condition for ℓ_1 optimization to successfully recover the unknown vector and obtain expressions for the recovery threshold. We further show that the minimal expansion we use is necessary for any graph for which sparse recovery is possible and that therefore our construction is tight. We finally present a novel recovery algorithm that exploits expansion and is much faster than ℓ_1 optimization. We determine theoretical guarantees about the sparsity level of the recoverable vectors for this algorithm and compare it to existing schemes in the literature.

■ ThB12

Marriott - Los Angeles

PDE-Related Optimization in Image Processing

Cluster: PDE-constrained Optimization

Invited Session

Chair: Wotao Yin, Assistant Professor, Rice University, Department of Computational and Applied, 3086 Duncan Hall, Houston, TX, 77251, United States of America, wotao.yin@rice.edu

1 - A Hybrid Method of Bregman Iterations and PDEs for Sparse Deconvolution

Bin Dong, UCLA, UCLA Mathematics Department, Box 951555, Los Angeles, 90095, United States of America, bdong@math.ucla.edu, Yu Mao, Stanley Osher

We consider a combination of Bregman distance based methods with some specially designed PDEs for sparse deconvolution problems, e.g. deblurring of sparse spikes. The underlying optimization model is the standard L1 minimization with linear equality constraint, where the linear system corresponds to some convolution operator. The PDE is designed as a natural plug-in to the linearized Bregman iterations [Darbon and Osher 2007; Yin et. al. 2008; Osher et. al. 2008] and Bregman iterations [Yin et. al. 2008], and greatly improves the convergence speed for sparse deconvolution problems. Some applications of sparse deconvolutions are also considered.

2 - Simple Compressive Algorithms for Parallel Many-core Architectures

Jerome Darbon, UCLA, Mathematics Department, Los Angeles, United States of America, jerome@math.ucla.edu

We consider the recovery of signal via compressive sensing where the signal itself or its gradient are assumed to be sparse. This amounts to solve a l1 or a Total Variation minimization problem. We propose minimization algorithms specifically designed to take advantage of shared memory, vectorized, parallel and many-core microprocessors such as the Cell processor, new generation Graphics Processing Units (GPUs) and standard vectorized multi-core processors (e.g. standard CPUs).

3 - Heat Source Identification Based on L1 Optimization

Yingying Li, Graduate Student, University of California, Los Angeles, 1953 Overland Ave Apt 9, Los Angeles, CA, 90025, United States of America, yingyingli@math.ucla.edu, Stanley Osher, Richard Tsai

We consider inverting the heat equation, which is the problem of recovering the initial condition from given point-value samples at a fixed time or samples at multiple observation times. The initial condition assumed to be sparse. We show that with this assumption, the problem is effectively solved using L1 optimization methods.

■ ThB13

Marriott - Miami

Optimization Applications in Energy and Environmental Problems

Cluster: Optimization in Energy Systems
Invited Session

Chair: Shi-Jie Deng, Associate Professor, Georgia Institute of Technology, 765 Ferst Drive, ISyE, Atlanta, GA, 30332, United States of America, deng@isye.gatech.edu

1 - Modeling the Impacts of Plug-in Hybrid Electric Vehicles on Electric Power Systems

Ramteen Sioshansi, Assistant Professor, The Ohio State University, Integrated Systems Engineering, 1971 Neil Avenue, Columbus, OH, 43215, United States of America, sioshansi.1@osu.edu

We discuss the use of detailed unit commitment and vehicle models to simulate the impacts of plug-in hybrid electric vehicles (PHEVs) on electric power systems. Our analysis shows that if the power system has flexibility in when PHEVs can be recharged (e.g. commuters specify only that their vehicles must be recharged the following morning), PHEV charging can be timed to drastically improve generation efficiency. We also discuss some computational issues and extensions of the model.

2 - Effects of Permits Allocation on Emissions Leakage and Distribution of Future Generating Capacity

Yihsu Chen, University of California, Merced, 5200 N. Lake Rd, Merced, CA, 95343, United States of America, yihsu.chen@ucmerced.edu, Andrew Liu

We examine the effects of emissions permits allocation schemes on the extent of the emission leakage and distribution of future generating capacity in power sector. We consider three emissions trading programs (e.g., source-, load-based and first-seller) and two allocation approaches. Whereas grandfather separates future permits allocation from today's decisions, the output-based approach links the awarded permits s to today's output. The latter effectively subsidizes suppliers,Äô production costs, encourages more output and elevates permits prices. The results indicate that domestic power price could increase when per unit emissions subsidy is high. Polluting facilities would migrate to locations that are not subject to emissions cap.

3 - Efficient Frontier of Demand Response and Supply Resources

Shi-Jie Deng, Associate Professor, Georgia Institute of Technology, 765 Ferst Drive, ISyE, Atlanta, GA, 30332, United States of America, deng@isye.gatech.edu, Li Xu

This paper investigates an efficient frontier framework for an LSE to evaluate the role of DR programs in achieving a desirable tradeoff between profit and risk. We propose a model to obtain an optimal portfolio, consisting of load resources such as DR contracts, spot energy and forward energy contracts, which minimizes the risks or maximizes the utilities of LSEs subject to certain expected profit target.

■ ThB14

Marriott - Scottsdale

Game Theory B

Contributed Session

Chair: Bo Chen, Professor, University of Warwick, Gibbet Hill Road, Coventry, CV4 7AL, United Kingdom, b.chen@warwick.ac.uk

1 - Minimum Coloring Games and Population Monotonic Allocation Schemes

Herbert Hamers, Tilburg University, P.O. Box 90153, Tilburg, 5000 LE, Netherlands, h.j.m.hamers@uvt.nl, Silvia Miquel, Henk Norde

A minimum coloring game is defined on a graph in which the value of a coalition equals the chromatic number of the sub-graph spanned by the vertices corresponding to this coalition. Deng, Ibaraki and Nagamochi (2000) showed that minimum coloring games are totally balanced if and only if the underlying graph of the game is perfect.Okamoto (2003) proved that minimum coloring games are submodular if and only if the underlying graph of the game is complete multipartite.This paper shows the existence of a population monotonic allocation scheme (PMAS) of a minimum coloring game if and only if the underlying graphs of the game has neither P4 nor 2K2 as induced sub-graph.

2 - The Optimal Timing of Prearranged Paired Kidney Exchanges

Murat Kurt, PhD Candidate, University of Pittsburgh, 3700 O'Hara Street, 1048 Benedum Hall, Pittsburgh, PA, 15261, United States of America, muk7@pitt.edu, M. Utku Unver, Mark S. Roberts, Andrew J. Schaefer

Paired kidney exchanges (PKE) alleviate the shortage in the supply of kidneys for transplantation. We consider the transplant timing in a PKE and formulate the resulting problem as a non-zero sum stochastic game. We present necessary and sufficient conditions to characterize the stationary equilibria of this game. We bring the equilibrium selection into focus and characterize the welfare maximizing equilibrium as an optimal solution to an MIP. We present numerical results based on clinical data.

3 - Equilibria in Load Balancing Games

Bo Chen, Professor, University of Warwick, Gibbet Hill Road, Coventry, CV4 7AL, United Kingdom, b.chen@warwick.ac.uk

A Nash equilibrium (NE) in a multi-agent game is a strategy profile that is resilient to unilateral deviations. A strong equilibrium (SE) is one that is stable against coordinated deviations of any coalition. We show that, in the load balancing games, NEs approximate SEs in the sense that the benefit of each member of any coalition from coordinated deviations is well limited. Furthermore, we show that an easily recognizable special subset of NEs exhibit even better approximation of SEs.

■ ThB15

Gleacher Center - 100

PDE Constrained Optimization Under Uncertainty

Cluster: Stochastic Optimization
Invited Session

Chair: Ruediger Schultz, University of Duisburg Essen, Department of Mathematics, Lotharstr 65, D-47048 Duisburg, D-47048, Germany, schultz@math.uni-duisburg.de

1 - Aerodynamic Shape Optimization under Uncertainty

Claudia Schillings, University of Trier, FB 4 - Department of Mathematics, Trier, 54286, Germany, claudia.schillings@uni-trier.de, Volker Schulz

In this talk,we aim at an improvement of existing simulation and optimization technology,so that uncertainties are identified,quantized and included in the optimization procedure.Beside the scalar valued uncertainties in the flight conditions we consider the shape itself as an uncertainty and apply a Karhunen-Loeve expansion to approximate the probability space.To overcome the curse of dimensionality an adaptively refined sparse grid is used in order to compute statistics of the solution.

2 - Shape Optimization under Uncertainty via the SIMP-Method

Claudia Stangl, University of Duisburg-Essen, Department of Mathematics, Lotharstr 65, Duisburg, D-47048, Germany, claudia.stangl@uni-duisburg-essen.de

We consider shape optimization of elastic materials under random loading. A two-stage stochastic programming approach is compared to optimization with respect to the mean load. Via the SIMP-method(solid isotropic material with penalization) a non-linear optimization problem in finite dimension arises. Computational results highlighting the role of nonanticipativity conclude the talk.

3 - Risk Averse Shape Optimization by Level Set Methods

Martin Pach, University of Duisburg Essen, Department of Mathematics, Lotharstr 65, Duisburg, D-47048, Germany, pach@math.uni-duisburg.de

For shape optimization of elastic structures under random volume and surface forces we present a framework inspired by two-stage stochastic programming. We extend the risk neutral stochcastic optimization perspective by considering risk averse models involving the expected excess and the excess probability. Numerical results for a descent method using level set methods and topological derivatives are presented.

■ ThB16

Gleacher Center - 200

Stochastic Optimization E

Contributed Session

Chair: Sethuraman Sankaran, Postdoctoral Fellow, UCSD, 467 EBU II, UCSD, San Diego, CA, 92122-0411, United States of America, sesankar@ucsd.edu

1 - Convex Polynomial Approximation on Evaluating the First Order Gradient

Lijian Chen, Assistant Professor, University of Louisville, 5241 Craigs Creek Dr, Louisville, KY, 40241, United States of America, lijian.chen@louisville.edu, Tito Homem-de-Mello

We use the remarkable properties of the Bernstein polynomial to evaluate a convex function's gradient by approximating it with convex polynomial. The function is not necessarily to be differentiable. When the function is hard to evaluate, we will estimate the function by the simulated data. The necessary degree is provided for a given accuracy. The application of this method could be large scale stochastic convex programming on logistics, revenue management, and supply chain management.

2 - Convex Approximations of Problems with First-order Stochastic Dominance Constraints

Ebru Angun, Doctor, Galatasaray University, Ciragan Cad. Ortakoy, Istanbul, 34357, Turkey, eangun3@isye.gatech.edu, Alexander Shapiro

We consider optimization problems with first-order stochastic dominance constraints, which can be formulated as continuum of probabilistic constraints. It is well-known that probabilistic constraints may lead to nonconvex feasible regions. After discretization and adding new variables, our aim is to obtain a relaxation through second-order stochastic dominance constraints and a conservative approximation through Bernstein approximations, both of which result in convex optimization problems.

3 - A Stochastic Constrained Optimization Technique using Derivative-free Pattern Search and Collocation

Sethuraman Sankaran, Postdoctoral Fellow, UCSD, 467 EBU II, UCSD, San Diego, CA, 92122-0411, United States of America, sesankar@ucsd.edu, Alison Marsden

We present a mathematical technique for constrained stochastic optimization problems. We employ the sparse-grid stochastic collocation technique for tackling the random dimensions. The Surrogate Management Framework with Mesh Adaptive Direct Search polling strategy and kriging interpolation is employed. Convergence proofs will be discussed in detail. This approach is tested on numerous engineering problems such as thermal and solid mechanics problems with probabilistic reliability constraints.

■ ThB17

Gleacher Center - 204

Logistics and Transportation D

Contributed Session

Chair: Changhyun Kwon, Assistant Professor, University at Buffalo, SUNY, Dept. of Industrial & Systems Engineering, Buffalo, NY, 14260, United States of America, chkwon@buffalo.edu

1 - Applying Nonlinear Programming and Complementarity Models to Crude Oil Scheduling

João Lauro Faco', Professor, Federal University of Rio de Janeiro, Av. Athos da Silveira Ramos, 274, Departamento de CiÍncia da Computação, Rio de Janeiro, 21941-916, Brazil, jldfaco@gmail.com, Adilson Elias Xavier, Fabio Fagundez

Scheduling problems can be modeled as mixed-integer problems, featuring discrete and continuous constraints. The first group relates to enumerative or logical decisions ("choose A to feed B"), while the second to limitations like "maximum storage of A is 500 m3". We model a crude scheduling problem as an NLP with continuous variables only, by substituting discrete constraints by complementarity ones. This strategy is applied to known instances and solved by the GRG method. Results are compared.

2 - Bynary Programming Applied to System of Waste Collection Routes

Javier Arias Osorio, Professor, Universidad Industrial de Santander, Calle 9a. Carrera 27, Bucaramanga, Sa, 57, Colombia, jearias@uis.edu.co, Astrid Johana Reyes Pita

The aim is to optimize the design of waste collection routes the process of waste collection generated by the production and processing of nickel mining at Cerro Matoso S.A through the use of a binary programming model and validate the results. The business waste collection consider the dynamic elements of itself waste generation in a continuous manner and available for collection at any time, this involves the company network that includes 67 points of collection.

3 - Joint Toll Pricing for Hazardous Material Transport and Regular Traffic

Changhyun Kwon, Assistant Professor, University at Buffalo, SUNY, Dept of Industrial & Systems Engineering, Buffalo, NY, 14260, United States of America, chkwon@buffalo.edu, Yingying Kang, Rajan Batta

We consider a joint toll pricing model both for hazardous material transport trucks and regular traffic vehicles. While considering the behavior of networks users induced by tolls, we seek a toll policy that minimizes the total risk. We assume the risk of incidents on an arc is dependent on the number of regular traffic vehicles as well as the number of hazardous material transport trucks. We study mathematical properties of the model and suggest a numerical method.

■ ThB18

Gleacher Center - 206

Reformulation Techniques in Mixed-Integer Nonlinear Programming

Cluster: Nonlinear Mixed Integer Programming

Invited Session

Chair: Leo Liberti, Doctor, Ecole Polytechnique, LIX, Ecole Polytechnique, Palaiseau, 91128, France, leoliberti@gmail.com

Co-Chair: Giacomo Nannicini, Ecole Polytechnique, LIX, Ecole Polytechnique, Palaiseau, 91128, France, giacomon@lix.polytechnique.fr

1 - Valid Inequalities, Separation, and Convex Hulls for Multilinear Functions

Andrew Miller, Universite de Bordeaux 1, INRIA Bordeaux Sud-Ouest, Bordeaux, France, andrew.miller@math.u-bordeaux1.fr, Pietro Belotti, Mahdi Namazifar

We study convex envelopes for a product of variables that have lower and upper bounds, and which is itself bounded. (Since spatial branch-and-bound solvers use polyhedral relaxations of such sets to compute bounds, having tight relaxations can improve performance.) For two variables, the well-known McCormick inequalities define the convex hull for an unbounded product. For a bounded product, we define valid linear inequalities that support as many points of the convex hull as possible. Though uncountably infinite in number, these inequalities can be separated for exactly in polynomial time. We also discuss extensions of such results to products of more than two variables, considering both convex hull descriptions and separation.

2 - Parameter Estimation for Polynomial Discrete Dynamical Systems

Sandro Bosio, Postdoctoral Fellow, Otto-von-Guericke University Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, bosio@mail.math.uni-magdeburg.de, Steffen Borchers, Philipp Rumschinski, Utz-Uwe Haus, Robert Weismantel, Rolf Findeisen

Given a discrete dynamical system and some experimental output measurements (given as sets, accounting for errors and disturbances), the goal of parameter estimation is to outer-approximate the set of system parameters consistent with the measurements (if any). We describe a parameter estimation framework for polynomial systems based on quadratic reformulation and semidefinite relaxation. Based on this, we also discuss a graph approach that allows to model simple experimental design problems.

■ ThB19

Gleacher Center - 208

Nonlinear Mixed Integer Programming E

Contributed Session

Chair: Neng Fan, University of Florida, 303 Weil Hall, P.O. Box 116595, Gainesville, FL, 32603, United States of America, andynfan@ufl.edu

1 - On Well-posedness of Vector Convex Optimization Problems

Matteo Rocca, Professor, University of Insubria, via Monte Generoso, 71, Department of Economics, Varese, Italy, matteo.rocca@uninsubria.it, Giovanni P. Crespi, Melania Papalia

In this talk we investigate well posedness properties of convex and quasiconvex vector functions. In particular, in a finite dimensional setting, we show that vector optimization problems with quasiconvex objective function are well posed. Then we observe that similarly to the scalar case such a result does not hold in an infinite dimensional setting. Anyway, we show that in this case, well posedness of a convex optimization problem is a generic property, extending a result known for scalar optimization problems.

2 - A Mixed Integer Convexity Result with an Application to an M/M/s Queueing System

Emre Tokgoz, University of Oklahoma, 202 W. Boyd, Room 116H, Norman, OK, 73019, United States of America, Hillel Kumin

In this paper, we develop a general convexity result for functions with n integer and m real variables by defining a new Hessian matrix for these functions. The result is applied to the optimization of an M/M/s queueing system in which the design parameters are the number of servers and the service rate.

3 - Integer Programming of Biclustering Based on Graph Models

Neng Fan, University of Florida, 303 Weil Hall, P.O. Box 116595, Gainesville, FL, 32603, United States of America, andynfan@ufl.edu

In this paper, biclustering of a data matrix is studied based on graph partitioning models. Several integer programming models are established to realize the clustering under different definitions of cut. The relaxation forms of the IP models include linear programming, semidefinite programming, quadratic programming and spectral methods.

■ ThB20

Gleacher Center - 300

Numerical Methods for Nonlinear Optimization

Cluster: Nonlinear Programming
Invited Session

Chair: Ya-xiang Yuan, Professor, Chinese Academy of Sciences (CAS), Institute of Computational Mathematics, Zhong Guan Cun Donglu 55, Beijing, 100190, China, yyx@lsec.cc.ac.cn

1 - Solving Distance Geometry Problem via Successive Subspace Optimization

Zhijun Wu, Professor, Iowa State University, 370 Carver Hall, Ames, IA, 50011, United States of America, zhijun@iastate.edu

A distance geometry problem can be formulated as a problem for solving a nonlinear system of equations. The problem is difficult to solve and has great computational challenges. Here we describe a method for the solution of the problem by successively identifying a subsystem of equations that can be solved independently. The whole problem can then be solved by iteratively solving a sequence of subsystems, which can be done relatively efficiently using a nonlinear least squares method.

2 - An Affine-scaling Algorithm for Nonlinear Optimization with Continous Knapsack Constraints

Hongchao Zhang, Professor, Louisiana State University, Department of Mathematics, Baton Rouge, LA, 70803, United States of America, hozhang@math.lsu.edu, William Hager

A gradient based affine-scaling algorithm for continuous knapsack constraints will be presented. This algorithm has the property that each iterate lies in the interior of the feasible set and is more suitable for large dimensional optimization problems where the Hessian of the objective function is a large, dense, and possibly ill-conditioned matrix. Some theoretical properties, especially the local linear convergence of the algorithm will be discussed. Some numerical results will be also reported.

3 - Using Approximate Secant Equations in Multilevel Unconstrained Optimization

Vincent Malmedy, Research Fellow F.R.S.-FNRS, University of Namur (FUNDP), Rempart de la Vierge 8, Namur, 5000, Belgium, vincent.malmedy@fundp.ac.be, Philippe Toint, Serge Gratton

The properties of multilevel optimization problems can be used to define approximate secant equations, which describe the second-order behavior of the objective function. We introduce a quasi-Newton method (with a line search) and a nonlinear conjugate gradient method that both take advantage of this new second-order information, and present numerical experiments.

■ ThB21

Gleacher Center - 304

Algorithms for Network Design

Cluster: Telecommunications and Networks
Invited Session

Chair: Stavros Kolliopoulos, National & Kapodistrian University of Athens, Department of Informatics, Panepistimiopolis, Ilissia, Athens, 157 84, Greece, sgk@di.uoa.gr

1 - Energy-efficient Communication in Ad Hoc Wireless Networks

Ioannis Caragiannis, University of Patras, Dept. of Computer Eng. and Informatics, Univesity of Patras, Rio, 26500, Greece, caragian@ceid.upatras.gr

In ad hoc wireless networks, the establishment of typical communication patterns like broadcasting, multicasting, and group communication is strongly related to energy consumption. Since energy is a scarce resource, corresponding minimum energy communication problems arise. We consider a series of such problems on two suitable combinatorial models for wireless ad hoc networks with omni-directional and directional antennas and present related approximation algorithms and hardness results.

2 - Network Discovery and Verification

Alex Hall, Google Switzerland, alex.hall@gmail.com

We consider the problem of discovering the edges and non-edges of a network using a minimum number of queries. This is motivated by the common approach of combining local measurements in order to obtain maps of the Internet or other dynamically growing networks. We give an overview of results obtained in this area in recent years (complexity, inapproximability, lower bounds, and approximation algorithms). We will have a closer look at approximate discovery of random graphs.

3 - Beating Simplex for Fractional Packing and Covering Linear Programs

Neal Young, University of California, Riverside, Dept of Computer Science and Engineering, Riverside, CA, 92521, United States of America, neal@cs.ucr.edu, Christos Koufogiannakis

We describe an approximation algorithm for linear programs with non-negative coefficients. Given a constraint matrix with n non-zeros, r rows, and c columns, the algorithm computes primal and dual solutions whose costs are within a factor of 1+epsilon of optimal in time O((r+c)log(n)/epsilon^2 + n). For dense problems (with r,c=O(sqrt(n))) this is linear in the input size, even as epsilon tends to zero. Previous Lagrangian-relaxation algorithms take at least Omega(n log(n)/epsilon^2) time. The Simplex algorithm typically takes at least Omega(n min(r,c)) time. (This extends work by Grigoriadis and Khachiyan for approximately solving 2-player zero-sum games in sub-linear time.)

■ ThB22

Gleacher Center - 306

Implementations, Software B

Contributed Session

Chair: Marcus Oswald, University of Heidelberg, Im Neuenheimer Feld 368, Heidelberg, 69120, Germany, Marcus.Oswald@Informatik.uni-heidelberg.de

1 - Expression Graphs for Use in Optimization Algorithms

David M. Gay, Sandia National Labs, P.O. Box 5800, MS 1318, Albuquerque, NM, 87185-1318, United States of America, dmgay@sandia.gov

Expression graphs provide a representation of algebraic functions that is convenient for manipulation. Uses include classification (e.g., linear, quadratic, convex), structure discovery (e.g., sparsity), preparation for evaluation (e.g., simplifications), numerical evaluations, derivative computations, bound computations, and bound propagations (e.g., for “presolve”). I will review some experience with expression graphs made available by AMPL and discuss some recent work on bound computations.

2 - Supporting Software for Practice of Mathematical Programming

Hiroshige Dan, Assistant Professor, Kansai University, 3-3-35, Yamate-cho, Suita-shi, Osaka, 564-8680, Japan, dan@kansai-u.ac.jp, Shin-ya Nomura

Application of mathematical programming to real-world problems consists of three steps; (i) formulating a mathematical model, (ii) solving the model to obtain a solution, and (iii) examining the computed solution. We have developed software called DEMP (Development Environment for Mathematical Programming) that supports these steps comprehensively. DEMP has been implemented as a plug-in for Eclipse, which is one of the most popular Integrated Development Environment (IDE).

3 - Computations of GTSP-Polyhedra

Marcus Oswald, University of Heidelberg, Im Neuenheimer Feld 368, Heidelberg, 69120, Germany, Marcus.Oswald@Informatik.uni-heidelberg.de, David Buettner, Gerhard Reinelt, Dirk Oliver Theis

The Symmetric TSP asks for a minimum length Hamilton cycle in a complete graph. The Graphical Traveling Salesman Problem (GTSP) is defined analogously to the STSP, except that it allows to visit nodes and/or traverse edges more than once. The GTSP-Polyhedron on n nodes, GTSP(n), is equal to the convex hull of all incidence vectors of edge multi-sets of spanning closed walks. We present a parallelized algorithm computing outer descriptions of GTSP-Polyhedra and show computational results.

■ ThB23

Gleacher Center - 308

Fast Gradient Algorithms for Nuclear Norm and Compressive Sensing Optimization

Cluster: Sparse Optimization
Invited Session

Chair: Kim-Chuan Toh, National University of Singapore, 2 Science Drive 2, Department of Mathematics, Singapore, SG, 117543, Singapore, mattohkc@nus.edu.sg

1 - Redundancy, Sparsity, and Algorithm

Zuowei Shen, Professor, National University of Singapore, Department of Mathematics, NUS, 2 Science Drive 2, Singapore, 117543, Singapore, matzuows@nus.edu.sg

Efficient algorithms in image restoration and data recovery are derived by exploring sparse approximations of the underlying solutions by redundant systems. Several algorithms and numerical simulation results for image restoration, compressed sensing, and matrix completion will be presented in this talk.

2 - An Accelerated Proximal Gradient Algorithm for Nuclear Norm Regularized Least Squares Problems

Kim-Chuan Toh, National University of Singapore, 2 Science Drive 2, Department of Mathematics, Singapore, SG, 117543, Singapore, mattohkc@nus.edu.sg, Sangwoon Yun

We consider a nuclear norm regularized linear least squares problem. An accelerated proximal gradient algorithm, which terminates in $O(1/\sqrt{\epsilon})$ iterations with an ϵ-optimal solution, is proposed for the problem considered. We report numerical results for solving large-scale randomly generated matrix completion (MC) problems. The results suggest that our algorithm is efficient and robust. In particular, we are able to solve random MC problems with matrix dimensions up to $10^5\times 10^5$ each in less than 10 minutes on a modest PC.

3 - Fast Algorithms for Nonconvex Compressive Sensing

Rick Chartrand, Los Alamos National Laboratory, Theoretical Division, MS B284, Los Alamos, NM, 87545, United States of America, rickc@lanl.gov

Recent work has shown that replacing the l^1 objective function in compressive sensing with the nonconvex l^p objective with $p < 1$ provides many benefits. Reconstruction becomes possible with many fewer measurements, while being more robust to noise and signal nonsparsity. Although the resulting nonconvex optimization problem has many local minima, simple algorithms have been very effective at finding the global minimum and recovering sparse signals. In this talk, we show how a recent convex optimization algorithm using operator splitting and Bregman iteration can be extended to the setting of nonconvex compressive sensing. The result is mathematically interesting and computationally very fast for many applications.

■ ThB25

Gleacher Center - 404

Penalty Methods and Critical Points of Lipschitz Functions

Cluster: Variational Analysis
Invited Session

Chair: Boris Mordukhovich, Wayne State University, Dept. of Mathematics, 1150 Faculty Admin Bldg, Detroit, MI, 48202, aa1086@wayne.edu

1 - Mathematical Programs with Vanishing Constraints

Tim Hoheisel, PhD, University of Wuerzburg, Institute of Mathematics, Am Hubland, 97074 Wuerzburg, Germany, hoheisel@mathematik.uni-wuerzburg.de, Christian Kanzow, Wolfgang Achtziger

We consider a new class of constrained optimization problems called ‘mathematical programs with vanishing constraints’ (MPVCs), which have important applications , e.g., in the field of topology optimization. One of the major difficulties of these kind of problems arises from the fact that most of the prominent constraint qualifications are likely to be violated and hence, the Karush-Kuhn-Tucker conditions do no longer provide necessary optimality conditions. Thus, the talk will present more problem-tailored constraint qualifications and stationarity concepts and discuss their relationships. Based on these new concepts, numerical algorithms for the solution of MPVCs, using smoothing and regularization ideas, are investigated.

2 - Exact Penalty in Constrained Optimization and Critical Points of Lipschitz Functions

Alexander Zaslavski, Professor, Technion Israel Institute of Technology, Haifa, Israel, ajzasl@techunix.technion.ac.il

We use the penalty approach to study constrained minimization problems in infinite-dimensional Asplund spaces. A penalty function is said to have the exact penalty property if there is a penalty coefficient for which a solution of an unconstrained penalized problem is a solution of the corresponding constrained problem. We establish a simple sufficient condition for exact penalty property using the notion of the Mordukhovich basic subdifferential.

3 - Identifying Global Solutions of Classes of Hard Non-convex Optimization Problems

Vaithilingam Jeyakumar, Professor, University of New South Wales, Department of Applied Mathematics, Sydney, Australia, v.jeyakumar@unsw.edu.au

Due to the absence of convexity, constrained global optimization problems such as quadratically constrained quadratic optimization problems, 0/1 quadratic optimization problems and fractional quadratic optimization problems provide classes of intrinsically hard optimization problems for the development of global optimality conditions and duality theory. Yet, they are important optimization models that often arise in numerous applications. I will provide examples of successful quadratic approximation approaches using under/over-estimators to establishing Lagrangian based global optimality conditions for classes of non-convex optimization problems.

■ ThB28

Gleacher Center - 600

Approximation Methods and Proximal Algorithms

Cluster: Nonsmooth and Convex Optimization
Invited Session

Chair: Felipe Alvarez, Associate Professor, University of Chile, Santiago, 8370448, Chile, falvarez@dim.uchile.cl

1 - Interior Proximal Algorithm with Variable Metric for SOCP: Application to Structural Optimization

Hector Ramirez C., Universidad de Chile, Chile, hramirez@dim.uchile.cl, Julio Lopez, Felipe Alvarez

In this work, we propose an inexact interior proximal type algorithm for solving convex second-order cone programs. The proposed algorithm uses a distance variable metric, which is induced by a class of positive definite matrices, and an appropriate choice of regularization parameter. This choice ensures the well-definedness of the proximal algorithm and forces the iterates to belong to the interior of the feasible set. Computational results applied to structural optimization are presented.

2 - Primal Convergence of Hybrid Algorithms Coupled with Approximation Methods in Convex Optimization

Miguel Carrasco, Universidad de los Andes, Chile, migucarr@gmail.com

The aim of this talk is to present some theorical results on the convergence of the Hybrid Algorithms. The motivation for introducing these algorithms is to find the minimum of a function f approximated by a sequence of functions f_k. The main assumption will be the existence of an absolute continuous optimal path with finite length. We will prove the convergence of these algorithms to a solution of our minimization problem. To conclude, we shall give some numerical illustrations.

3 - Alternating Proximal Algorithms and Hierarchical Selection of Optima in Games, Control and PDE’s

Juan Peypouquet, UTFSM, Av Espa 1680, Valparaiso, Chile, juan.peypouquet@usm.cl, Hady Attouch, Marc-Olivier Czarnecki

We study an alternating diagonal proximal point algorithm: at each iteration a first step uses the resolvent corresponding to a maximal monotone operator and a second step to the subdifferential of a proper closed function weighted by an increasing parameter. The resulting sequence of iterates and - under less restrictive conditions - their averages converge weakly to a point with special properties. The results enable us to solve constrained or bilevel optimization problems. This method is applied to best response dynamics with cost to change, optimal control problems and domain decomposition for partial differential equations.

Thursday, 3:15pm - 4:45pm

■ ThC01

Marriott - Chicago A

Approximation Algorithms C

Contributed Session

Chair: Leonid Faybusovich, Professor, University of Notre Dame, Department of Mathematics, 255 Hurley Hall, Notre Dame, IN, 46556, United States of America, leonid.faybusovich.1@nd.edu

1 - Fault Tolerant Facility Location: 1.724-approximation Based on Randomized Dependent Rounding

Jaroslaw Byrka, EPFL, MA B1 527, Station 8, Lausanne, ch-1015, Switzerland, jaroslaw.byrka@epfl.ch, Aravind Srinivasan, Chaitanya Swamy

We give a new LP-rounding 1.724-approximation algorithm for the metric Fault-Tolerant Uncapacitated Facility Location problem. This improves on the previously best known 2.076-approximation algorithm of Shmoys and Swamy. Our work applies a dependent-rounding technique in the domain of facility location. The analysis of our algorithm benefits from, and extends, methods developed for Uncapacitated Facility Location; it also helps uncover new properties of the dependent-rounding approach.

2 - An Algorithm for a Maximum Density Subset Problem Based on Approximate Binary Search

Satoshi Takahashi, Master Course Student, University of Tsukuba, 1-1-1, Tennoudai, Tsukuba, 305-8577, Japan, takahashi2007@e-activity.org, Maiko Shigeno, Mingchao Zhang

In our research, we treat a maximum density subset problem defined on a set-system, and verify appropriateness of our problem in community selection problems. Also, we present an algorithm for solving our problem based on approximate binary search. Furthermore, we discuss that the framework of our algorithm can be applied to max mean cut problems.

3 - Jordan-algebraic Framework for Randomization Technique in Optimization

Leonid Faybusovich, Professor, University of Notre Dame, Department of Mathematics, 255 Hurley Hall, Notre Dame, IN, 46556, United States of America, leonid.faybusovich.1@nd.edu

We describe a very general framework for randomization technique in optimization. The major technique is based on new measure concentration inequalities on products on manifolds of nonnegative elements of fixed rank. Various concrete applications and stochastic modeling technique are discussed.

■ ThC02

Marriott - Chicago B

Algorithms for Variational Inequalities and Related Problems II

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: Andreas Fischer, TU Dresden, Institute of Numerical Mathematics, Dresden, 01062, Germany, Andreas.Fischer@tu-dresden.de

1 - Stabilized Newton-type Method for Variational Problems

Damian Fernandez, UNICAMP - IMECC, Rua Sergio Buarque de Holanda, 651, Campinas, SP, 13083-859, Brazil, dfernan@impa.br, Mikhail Solodov

The stabilized sequential quadratic programming algorithm (sSQP) had been developed to guarantee fast convergence for degenerate optimization problems. Superlinear convergence of sSQP had been previously established under the strong second-order sufficient condition for optimality (without any constraint qualification assumptions). We prove the superlinear convergence assuming only the usual second-order sufficient condition. In addition, our analysis is carried out to variational problems.

2 - A New Line Search Inexact Restoration Approach for Nonlinear Programming

Andreas Fischer, TU Dresden, Institute of Numerical Mathematics, Dresden, 01062, Germany, Andreas.Fischer@tu-dresden.de, Ana Friedlander

A new inexact restoration approach is presented. It simplifies the restoration principle by Martinez and Pilotta. After the restoration step the new iterate is obtained by means of a single line search on an approximate tangent direction. All accumulation points generated by the algorithm are proved to satisfy a necessary optimality condition. In addition, the regularity condition that is usually needed in the restoration step is weakened. To some extent this also enables the application of the new approach to programs with complementarity constraints.

3 - Sequential Optimality Conditions

Gabriel Haeser, PhD Student, State University of Campinas, Department of Applied Mathematics, Campinas, SP, 6065, Brazil, ghaeser@ime.unicamp.br, Jose Mario Martinez, Roberto Andreani

We present new optimality conditions related to the Aproximate Gradient Projection condition (AGP). When there is an extra set of linear constraints, we define a linear-AGP condition and prove relations with CPLD and KKT conditions. The CPLD is a new constraint qualification strictly weaker than MFCQ and CRCQ. Similar results are obtained when there is an extra set of convex constraints. We provide some further generalizations and relations to an inexact restoration algorithm.

■ ThC03

Marriott - Chicago C

Supply Function and Bilateral Contract Models of Oligopoly Electricity Markets

Cluster: Optimization in Energy Systems
Invited Session

Chair: Ross Baldick, The University of Texas at Austin, Department of Electrical and Computer En, Engineering Science Building ENS 502, Austin, TX, 78712, United States of America, Ross.Baldick@engr.utexas.edu

1 - Contract Design and Behavioral Co-ordination in Oligopolies

Fernando Oliveira, ESSEC Business School, Avenue Bernard Hirsch - BP 50105, CEDEX, France, oliveira@essec.fr, Carlos Ruiz, Antonio J. Conejo

In this article, we present a multi-player model of the relationship between forward and spot markets in oligopolies, in the context of bilateral trading. We analyze how different types of contract and market structure interact to influence the behavior of firms and market-efficiency.

2 - A Stability Analysis of the Supply Function Equilibrium in Electricity Markets

Lin Xu, University of Texas at Austin, The University of Texas at Austin, 1 University Station C0803, Austin, TX, 78712, United States of America, linxu@mail.utexas.edu, Ross Baldick

The supply function equilibrium model is a close-to-reality model in electricity markets, but theoretically there exists a continuum of equilibria, which limits its predictive value. We do a stability analysis to refine the equilibria, considering piecewise polynomial function perturbations. As shown in an example, the stable supply function set shrinks as the order of the polynomial function increases, and stable equilibria are likely to exist for practically reasonable perturbation functions.

3 - Mixed-strategy Equilibria in Discriminatory Divisible-good Auctions

Andy Philpott, Professor, University of Auckland, Private Bag 92019, Auckland, AL, 1025, New Zealand, a.philpott@auckland.ac.nz, Par Holmberg, Eddie Anderson

Auctions of divisible-goods occur in a number of settings, the most well-known being electricity pool-markets. There are two common payment mechanisms for these auctions, one where a uniform price is paid to all suppliers, and an alternative that adopts a discriminatory, or pay-as-bid, price. Under the assumptions that demand is uncertain and costs are common knowledge, we study supply-function equilibria in the pay-as-bid auction using the concept of market-distribution functions. We show that pure-strategy Nash equilibria typically do not exist in this setting, and derive mixed-strategy equilibria of various types.

ThC04

Marriott - Denver

Submodular Function Maximization II

Cluster: Combinatorial Optimization
Invited Session

Chair: Andreas Schulz, Massachusetts Institute of Technology, E53-357, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States of America, schulz@mit.edu

1 - Maximizing Non-monotone Submodular Functions Over Matroid and Knapsack Constraints

Viswanath Nagarajan, Carnegie Mellon University, 5000 Forbes Ave, Pittsburgh, PA, 15213, United States of America, viswa@cmu.edu, Jon Lee, Maxim Sviridenko, Vahab Mirrokni

Submodular function maximization is a central problem in combinatorial optimization generalizing several problems such as Max-Cut in graphs/hypergraphs, maximum entropy sampling, and maximum facility location. We study the problems of maximizing any non-negative submodular function subject to multiple matroid or knapsack constraints. For any fixed k, we give a [1/(k+2+1/k)]-approximation under k matroid constraints, and a 1/5-approximation under k knapsack constraints. Our algorithms are based on local search, and assume only a value-oracle access to the submodular function. Previously, results were known only for the special case of monotone submodular functions.

2 - Submodular Maximization Over Multiple Matroids via Generalized Exchange Properties

Maxim Sviridenko, IBM TJ Watson Research Center, P.O. Box 218, Yorktown Heights, NY, United States of America, sviri@us.ibm.com, Jon Lee, Jan Vondrak

Submodular-function maximization is a central problem in combinatorial optimization, generalizing many important NP-hard problems including Max Cut in digraphs, graphs and hypergraphs, certain constraint satisfaction problems, maximum-entropy sampling, and maximum facility-location problems. Our main result is that for any k>=2 and any epsilon>0, there is a natural local-search algorithm which has approximation guarantee of 1/(k+epsilon) for the problem of maximizing a monotone submodular function subject to k matroid constraints. This improves a 1/(k+1)-approximation of Nemhauser, Wolsey and Fisher [1978] obtained more than 30 years ago. Also, our analysis can be applied to the problem of maximizing a linear objective function and even a general non-monotone submodular function subject to k matroid constraints. We show that in these cases the approximation guarantees of our algorithms are 1/(k-1+epsilon) and 1/(k+1+1/k+epsilon), respectively.

3 - Submodular Approximation: Sampling-based Algorithms and Lower Bounds

Zoya Svitkina, University of Alberta, Department of Computing Science, Edmonton, AB, Canada, Zoya.Svitkina@UAlberta.ca, Lisa Fleischer

We introduce several generalizations of classical computer science problems obtained by replacing simpler objective functions with general submodular functions. The new problems include submodular load balancing, submodular sparsest cut, and submodular function minimization with cardinality lower bound. We establish tight upper and lower bounds for the approximability of these problems with a polynomial number of queries to a function-value oracle.

ThC05

Marriott - Houston

Combinatorial Optimization M

Contributed Session

Chair: Asaf Shupo, AVP; Quant Opera Assoc Cust Strategies Mgr, MBNA Ottawa, Bank of America, 1600 James Naismith Drive, Ottawa, ON, K1B 5N8, Canada, asaf.shupo@mbna.com

1 - Bounded Fractionality of Multiflow Feasibility Problem for K3+K3 and Other Maximization Problems

Hiroshi Hirai, Assistant Professor, RIMS, Kyoto University, Kyoto 606-850, Kyoto, Japan, hirai@kurims.kyoto-u.ac.jp

We consider the multiflow feasibility problem whose demand graph is the vertex-disjoint union of two triangles. We show that under the Euler condition this problem has a 1/12-integral solution or no solution. This solves a conjecture raised by Karzanov, and completes the classification of the demand graphs having bounded fractionality. We also prove the existence of a 1/12-integral optimal solution for a larger class of multiflow maximization problems.

2 - Madonna Travels: the k-Arc Recovery Robust Shortest Path Problem

Christina Puhl, Technische Universitat Berlin, Strasse des 17. Juni 136, Berlin, 10623, Germany, puhl@math.tu-berlin.de

Recoverable robustness (RR) is a concept to avoid over-conservatism in robust optimization by allowing a limited recovery after the full data is revealed. We consider the setting of a RR shortest path problem, in which the arc costs are subject to uncertainty. As recovery at most k arcs of a chosen path can be altered. For most scenario sets the problem is strongly NP-complete and inapproximable. A polynomial algorithm is presented for interval scenarios and k being part of the input.

3 - Using Large-scale Minimum-cost Flow Problem in Optimal Marketing Segmentation

Asaf Shupo, AVP; Quant Opera Assoc Cust Strategies Mgr, MBNA Ottawa, Bank of America, 1600 James Naismith Drive, Ottawa, ON, K1B 5N8, Canada, asaf.shupo@mbna.com

The purpose of this paper is to report a very large minimum-cost flow (MCF) problem arising in the marketing segmentation, and to present an implementation of MCF for its solution. Some of the problems are very large up to 6,447,649 nodes and 57,046,031 arcs. Current work is being performed in optimal marketing segmentation problem arising at Bank of America. The optimal solution ensures that the separation of customers towards all the products available maximizes the marketing return.

ThC06

Marriott - Kansas City

SDP and Its Applications

Cluster: Conic Programming
Invited Session

Chair: Masakazu Kojima, Tokyo Institute of Technology, Dept. of Math & Comp Sci, 2-12-1-W8-29 Oh-Okayama Meguro, Tokyo, Japan, kojima@is.titech.ac.jp

Co-Chair: Sunyoung Kim, Professor, Ewha W. University, 11-1 Dahyun dong, Seoul, 120-750, Korea, Republic of, skim@ewha.ac.kr

1 - Nonlinear SDPs by Primal-dual Interior Point Method - Global and Superlinear Convergence

Hiroshi Yamashita, Mathematical Systems Inc., 2-4-3, Shinjuku, Shinjuku-ku, Tokyo, Japan, hy@msi.co.jp, Hiroshi Yabe, Kouhei Harada

We present a class of primal-dual interior point methods for nonlinear semidefinite programming problems. The methods are based on Newton-like method for modified KKT conditions. We apply scaling to the modified complementarity equation, and obtain general expression of search directions which include HRVW/KSH/M and NT in linear SDP. We discuss merit functions that include primal-only function and primal-dual function. We also discuss search algorithms that include line search and trust region. We show that AHO direction has superlinear convergence property under appropriate conditions, and that HRVW/KSH/M and NT directions have two step superlinear convergence under similar conditions. Finally, a few numerical examples will be shown.

2 - Most Tensor Problems are NP Hard

Lek-Heng Lim, Morrey Assistant Professor, University of California, Berkeley, 873 Evans Hall, Berkeley, CA, 94720-3840, United States of America, lekheng@math.berkeley.edu, Christopher Hillar

We show that tensor analogues of many problems that are readily computable in the matrix (i.e. 2-tensor) case are NP hard in both the traditional Cook-Karp-Levin sense and the Blum-Shub-Smale sense, making SDP relaxation an attractive, if not inevitable, alternative. The problems include: computing a best rank-1 approximation, the singular values/vectors, or the spectral norm of a 3-tensor; computing the eigenvalues/vectors of a symmetric 3-tensor; determining the feasibility of a system of bilinear equations or solving such a system in either an exact or least-squares sense. These extend Hastad's result on the NP-hardness of computing tensor rank to other natural tensor problems.

3 - Duality in the Positive Semidefinite Matrix Completion and Its Application to SDPs

Masakazu Kojima, Tokyo Institute of Technology, Dept. of Math & Comp Sci, 2-12-1-W8-29 Oh-Okayama Meguro, Tokyo, Japan, kojima@is.titech.ac.jp

We present a necessary and sufficient condition for a sparse and symmetric matrix A to be positive semidefinite as a dual approach of the positive semidefinite matrix completion method. Here we assume that the sparsity pattern of A is characterized with a chordal graph G(N,E). The ith row or ith column of A corresponds to the node i in N, and nonzero (i,j)th element of A to the edge (i,j) in E. We also discuss how the condition can be utilized for exploiting the sparsity of linear and nonlinear SDPs.

ThC07

Marriott - Chicago D

Integer and Mixed Integer Programming I

Contributed Session

Chair: David Warme, Member of Technical Staff, Group W, Inc., 8315 Lee Highway, Suite 303, Fairfax, VA, 22031, United States of America, David@Warme.net

1 - Convex Reformulations for Integer Quadratic Programs

Amelie Lambert, PhD Student, CEDRIC-CNAM, 292 Rue Saint Martin, Paris, 75003, France, amelie.lambert@cnam.fr, Alain Billionnet, Sourour Elloumi

Let (QP) be an integer quadratic program that consists in minimizing a quadratic function subject to linear constraints. To solve (QP), we reformulate it into an equivalent program with a convex objective function, and we use a Mixed Integer Quadratic Programming solver. This reformulation, called IQCR, is optimal in a certain sense from the continuous relaxation bound point of view. It is deduced from the solution of a SDP relaxation of (QP). Computational experiments are reported.

2 - Primal Heuristic for Integer Linear Programming with Automated Aggregations

Jakub Marecek, The University of Nottingham, School of Computer Science, Jubilee Campus, Nottingham, NG81BB, United Kingdom, jxm@cs.nott.ac.uk, Edmund K. Burke, Andrew J. Parkes

The heuristic has three stages. First, we aggregate: Variables are partitioned into min. number of singletons and support sets of constraints forcing convex combinations of binary variables to less than or equal to one. Second, we solve the aggregated instance. Finally, we extend this solution to the original instance. Notice the first stage can provide a lower bound and a feasible solution can be guaranteed to exist at the third stage, if at all. This works well for instances from scheduling.

3 - Planning and Scheduling of Combat Air Patrol Missions in the STORM Military Campaign Simulation

David Warme, Member of Technical Staff, Group W, Inc., 8315 Lee Highway, Suite 303, Fairfax, VA, 22031, United States of America, David@Warme.net

The objective of Combat Air Patrol (CAP) missions is to occupy and control regions of airspace continuously over a time interval, subject to range, endurance and resource constraints. We present an algorithm to plan and schedule CAP missions using 3 distinct formulations (2 MIPs and 1 LP). Two heuristics and certain cuts obtain solutions that are almost always optimal within 5-10 CPU seconds. The application is STORM, a stochastic discrete-event campaign simulation used by the US military.

ThC08

Marriott - Chicago E

Decomposition Methods for Integer Programming

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Matthew Galati, Optimization Interface Lead, SAS Institute, Philadelphia Regional Office, Suite 201, 1400 Morris Drive, Chesterbrook, PA, 19087, United States of America, Matthew.Galati@sas.com

1 - Lagrangean Relaxation Decomposes a Stochastic Mining Problem

Monique Guignard-Spielberg, Professor, University of Pennsylvania, OPIM Department, Philadelphia, PA, 19104, United States of America, guignard_monique@yahoo.fr, Felipe Carvallo, Laureano Escudero, Andres Weintraub

We consider a stochastic integer optimization problem based upon planning ore extraction in a Chilean copper mine, with uncertain future copper prices. One typical instance has 858,750 constraints and 635,750 variables (with 494,350 0-1). We use Lagrangean relaxation to decompose the problem into one subproblem per scenario, and use a "lazy Lagrangean heuristic" to get feasible solutions. The Lagrangean dual is solved with the volume algorithm. We will concentrate on the algorithmic approach.

2 - A Fast Column Generation Algorithm for the Regionalization Problems

John Raffensperger, Senior Lecturer, University of Canterbury, Dept. of Management, Private Bag 4800, Christchurch, 8140, New Zealand, john.raffensperger@canterbury.ac.nz

I give a new algorithm for the regionalization problem —finding boundaries for political or operational reasons, and ecological connectivity. Past work shows this problem is hard. The method decomposes the problem into a subproblem and master. The subproblem is solved with a customised Kruskal's algorithm to find forests of connected regions. After this, the master is solved to optimality. Solution times appear to be orders of magnitude faster than anything else reported in the literature.

3 - Benders Decomposition Based on an Interior Point Cutting Plane Method and Branch-and-cut

Joe Naoum-Sawaya, University of Waterloo, Department of Management Sciences, 200 University Ave. West, Waterloo, ON, N2L3G1, Canada, jnaoumsa@uwaterloo.ca, Samir Elhedhli

We present the novel integration of the Analytic Center Cutting Plane Method (ACCPM) in Benders decomposition. Unlike the classical Benders decomposition where cuts are generated using extreme points, Benders cuts are generated from a central point of the master problem. A branch-and-cut approach is used to implement the ACCPM based Benders decomposition. Computational results on the capacitated facility location problem show that our algorithm outperforms the classical Benders decomposition.

ThC09

Marriott - Chicago F

Models and Cutting Planes for Mixed-integer Programming

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Ismael de Farias, Texas Tech, Department of Industrial Engineering, Lubbock, TX, United States of America, ismael.de-farias@ttu.edu

1 - On an Intersection of Mixing Sets

Simge Kucukyavuz, Ohio State University, 1971 Neil Ave, Columbus, OH, United States of America, kucukyavuz.2@osu.edu

We consider the intersection of multiple mixing sets with common binary variables arising in the deterministic equivalent of mathematical programs with chance constraints. We propose a "blending" procedure that gives strong valid inequalities for the intersection of mixing sets. We also describe a relationship between the blending coefficients and the p-efficient points defined for chance-constrained programs.

2 - Solving Nonlinear Engineering Problem with Piecewise-linear Approximation Techniques

Armin Fuegenschuh, Zuse Institut Berlin (ZIB), Takustrasse 7, Berlin, 14195, Germany, fuegenschuh@zib.de

Several real-world optimization and control problems, in particular in engineering applications, consist of both nonlinear continuous phenomena and discrete decisions. In order to find proven global optimal solutions, one possible way is to model such problems as linear mixed-integer programs, for which effective solvers are available. However, one has to approximate the nonlinearities using only linear constraints and mixed-integer variables. In this talk we outline such approximation techniques. Thereafter we discuss applications to different industrial problems, such as the optimal control of airplanes under free-flight conditions, or the optimal separation of substances in process engineering, and present numerical results.

3 - Valid Inequalities for a Piecewise Linear Objective with Knapsack and Cardinality Constraints

Tallys Yunes, University of Miami, School of Business Administration, Coral Gables, FL, 33124-8237, United States of America, tallys@miami.edu, Ismael de Farias

We study the problem of maximizing a nonlinear function that can be approximated by a sum of separable continuous piecewise linear functions. The variables are constrained by a knapsack constraint and by a cardinality constraint stating that at most K of them can be positive. Cardinality constraints have applications in many fields, including finance and bio-informatics. We propose a family of valid inequalities for this problem and discuss computational experiments.

■ ThC10

Marriott - Chicago G

Exact and Heuristic Techniques for MINLP

Cluster: Global Optimization
Invited Session

Chair: Pietro Belotti, Visiting Professor, Lehigh University, 200 W Packer Ave, Bethlehem, PA, 18015, United States of America, belotti@lehigh.edu

1 - An Algorithmic Framework for Separable Non-convex MINLP

Claudia D'Ambrosio, DEIS, University of Bologna, viale Risorgimento 2, Bologna, 40136, Italy, c.dambrosio@unibo.it, Andreas Waechter, Jon Lee

We propose an algorithm to globally solve separable non-convex MINLPs. We define a convex MINLP relaxation approximating via linear relaxation the concave subintervals of each non-convex univariate function. These and the convex subintervals are glued together using binary variables. Then we get an upper bound fixing the integer variables and locally solving the obtained non-convex NLP. We finally refine our convex MINLP relaxation. Experiments on different classes of instances are presented.

2 - Inequalities from Strong Branching Information for Mixed Integer Nonlinear Programs

Mustafa Kilinc, University of Wisconsin, Mechanical Engineering Bldg, 1513 University Avenue, Madison, WI, 53706, kilinc@wisc.edu, Jeff Linderoth, James Luedtke, Andrew Miller

Strong Branching is an effective branching technique that can significantly reduce the size of branch-and-bound tree for Mixed Integer Nonlinear Programs (MINLP)s. We will demonstrate how to effectively use "discarded" information from strong branching to create disjunctive cutting planes in a linearization-based solver for convex MINLPs. Computational results reveal that the tree size can be effectively reduced using these inequalities.

3 - Feasibility Pump Based Heuristics for Mixed Integer Nonlinear Programs

Kumar Abhishek, United Airlines, 1002 N Plum Grove Road, Apt 314, Schaumburg, IL, 60173, United States of America, kua3@lehigh.edu, Sven Leyffer, Jeff Linderoth

We explore three heuristics for finding feasible points for MINLPs based on the feasibility pump. The first approach alternates between rounding and solving an NLP. The second approach extends the feasibility pump of Bonami et. al., and solves an MILP iteratively instead of rounding. Finally, our third approach integrates the feasibility pump within an LP/NLP-based branch-and-cut framework. We present detailed numerical results to demonstrate the effectiveness of these heuristics.

■ ThC11

Marriott - Chicago H

Robust Optimization and Applications

Cluster: Robust Optimization
Invited Session

Chair: Georgia Perakis, MIT, 50 Memorial Drive, Cambridge, MA, United States of America, georgiap@mit.edu

1 - Dynamic Pricing Through Scenario Based Optimization

Ruben Lobel, PhD Candidate, MIT, 77 Massachusetts Ave, Bldg. E40-149, Cambridge, MA, 02139, United States of America, rlobel@mit.edu, Georgia Perakis

We consider a robust approach to the dynamic pricing problem, with fixed inventory and uncertain demand. Our goal is to find approximate closed-loop pricing policies for different types of robust objective. We introduce a scenario based optimization approach that can solve the problem to an arbitrary level of robustness, based on the number of scenarios used. We will show how this methodology can be used either with historical data or by randomly sampling data points.

2 - Models for Minimax Stochastic Linear Optimization Problems with Risk Aversion

Xuan Vinh Doan, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States of America, vanxuan@MIT.EDU, Dimitris Bertsimas, Karthik Natarajan, Chung-Piaw Teo

We study the minimax stochastic linear optimization problems with assumption that probability distribution of random parameters belongs to a distribution class specified by first and second moments. We show that the model is tractable for problems with random objective and some special problems with random right-hand side. We provide explicit worst-case distributions in these cases. We compare the performance of minimax solutions with data-driven solutions under contaminated distributions. Applications include a production-transportation problem and a single facility minimax distance problem. Computational results show that minimax solutions hedge against worst-case distributions and provide lower variability in cost than data-driven ones.

3 - Robust Supply Chain Management with Expected Shortfall Constraints

Garud Iyengar, Columbia University, 500W 120th Street, New York, United States of America, garud@ieor.columbia.edu

The robust optimization based approximations available in the literature typically control the probability of constraint violation. They do not control the degree of constraint violation. We propose a new formulation that allows the decision-maker to control both the probability and expected value of constraint violation. We show how to construct tractable approximations for this new formulation. The methodology can be used for both bounded and unbounded uncertain parameters. We apply this methodology to problems in inventory management and contract selection.

■ ThC12

Marriott - Los Angeles

PDE Constrained Optimization Problems in Finance

Cluster: PDE-constrained Optimization
Invited Session

Chair: Ekkehard Sachs, Universitat Trier, Trier, 54286, Germany, sachs@uni-trier.de

1 - A Reduced Basis for Option Pricing

Nicolas Lantos, PhD Student, LJLL (Paris 6) & Natixis CS, 175, rue du Chevaleret, Paris, 75013, France, lantos@ann.jussieu.fr, Rama Cont, Olivier Pironneau

Galerkin methods approximate solution of PIDE on a finite basis of functions. The choice of this basis is driven by: the numerical efficiency of the basis' computation and the suitability of its asymptotic behavior. We introduce a one dimensional reduced basis designed on the Black-Scholes solution. Preliminary results for a call option show that less than twenty basis are needed to obtain a reliable accuracy. This methodology can be applied to any payoff that has a (semi-) closed form.

2 - Valuation of Options and Calibration under Finite Activity Jump-diffusion Models

Jari Toivanen, Stanford University, Stanford, United States of America, toivanen@stanford.edu

We consider finite activity jump-diffusion models like Merton's and Kou's model. Implicit finite difference discretizations lead to sequence of linear (complementarity) problems with full matrices. We describe rapidly converging iterations requiring solutions of problems with tridiagonal matrices. We formulate the calibration of the model parameters as a nonlinear least squares problem. We study the efficient iterative solution of these ill conditioned problems.

3 - Calibration of Local Volatility Models

Andre Lörx, Dipl.-Math. oec., Universität Trier, Trier, 54286, Germany, Ekkehard Sachs

In this talk we review techniques used in practice for the calibration of the local volatility model which is an extension of the Black-Scholes model for option pricing. We compare the advantages of various approaches like quadratic programming, Dupire's equation and the adjoint approach for a least squares formulation.

■ ThC13

Marriott - Miami

Energy Models Using Stochastic MIPs

Cluster: Optimization in Energy Systems
Invited Session

Chair: Javier Salmeron, Naval Postgraduate School, 1411 Cunningham Road, Monterey, United States of America, jsalmero@nps.edu

1 - A Scenario Tree-based Decomposition of Multistage Stochastic Mixed-Integer Problems in Power Supply

Debora Mahlke, TU Darmstadt, Schlossgartenstrasse 7, Darmstadt, 64289, Germany, mahlke@mathematik.tu-darmstadt.de, Andrea Zelmer, Alexander Martin

We consider a multistage stochastic mixed-integer model, where uncertainty is described by a scenario tree. To solve this block-structured problem, we present a decomposition approach based on splitting the scenario tree into subtrees. Solving the decoupled subproblems, a branch-and-bound algorithm is used to ensure feasibility. As an application, we present a power generation problem with fluctuating wind power supply, investigating the use of energy storages to balance supply and demand.

2 - Optimizing a Coupled Network Design Problem Involving Multiple Energy Carriers

Andrea Zelmer, TU Darmstadt, Schlossgartenstr. 7, Darmstadt, 64289, Germany, zelmer@mathematik.tu-darmstadt.de, Debora Mahlke, Alexander Martin

We present a network design problem where single energy carrier networks are coupled by cogeneration plants. Modeling the physical properties results in a complex mixed-integer nonlinear problem. The nonlinearities are approximated by piecewise linear functions yielding a mixed-integer linear problem. Investigating subpolyhedra regarding semicontinuous variables provides cutting planes which are used in a branch-and-cut approach. This algorithm is enhanced by an approximate-and-fix heuristic.

3 - Worst-case Interdiction, and Defense, of Large-scale Electric Power Grids

Javier Salmeron, Naval Postgraduate School, 1411 Cunningham Road, Monterey, United States of America, jsalmero@nps.edu, Kevin Wood, Ross Baldick

We generalize Benders decomposition to maximize a non-concave function and solve a bilevel electric power interdiction problem to identify a worst-case attack: a set of components, limited by interdiction resource, whose destruction maximizes disruption. The subproblem solves a set of DC optimal power-flow models for various states of repair and a load-duration curve. We also show how defensive resources can be emplaced to minimize disruption. Test problems describe regional U.S. power grids.

■ ThC14

Marriott - Scottsdale

Game Theory C

Contributed Session

Chair: Nayat Horozoglu, Research Student, London School of Economics and Political Science, Houghton Street, WC2A 2AE, London, United Kingdom, n.horozoglu@lse.ac.uk

1 - A Framework to Turn Approximation Algorithms into Truthful Cost Sharing Mechanisms

Janina Brenner, TU Berlin, Institut fuer Mathematik, Sekr. MA 5-1, Strasse des 17. Juni 136, Berlin, 10623, Germany, brenner@math.tu-berlin.de, Guido Schaefer

We present a general framework for turning any c-approximation algorithm into a c-budget balanced weakly group-strategyproof cost sharing mechanism. The mechanisms we derive with this technique beat the best possible budget balance factors of Moulin mechanisms for several scheduling and network design problems, and achieve the first constant budget balance and social cost approximation factors for completion time scheduling. Our framework also works for competitive online algorithms.

2 - How Hard is it to Find Extreme Nash Equilibria in Network Congestion Games?

Johannes Hatzl, Graz University of Technology, Steyrergasse 30, Department of Optimization and Discrete, Graz, 8010, Austria, hatzl@opt.math.tu-graz.ac.at, Elisabeth Gassner, Gerhard Woeginger, Heike Sperber, Sven Krumke

We study the complexity of finding extreme pure Nash equilibria in symmetric (unweighted) network congestion games. In our context best and worst equilibria are those with minimum respectively maximum makespan. On series-parallel graphs a worst Nash equilibrium can be found by a Greedy approach while finding a best equilibrium is NP-hard. For a fixed number of users we give a pseudo-polynomial algorithm to find the best equilibrium in series-parallel networks. For general network topologies also finding a worst equilibrium is NP-hard.

3 - Shortest Path Tree Games In Wireless Multi-hop Networks (WMNs)

Nayat Horozoglu, Research Student, London School of Economics and Political Science, Houghton Street, WC2A 2AE, London, United Kingdom, n.horozoglu@lse.ac.uk, Katerina Papadaki

A WMN is composed of a root node that provides connectivity to the Internet to a number of users, where users can relay information for other users. If all the users cooperate, they can use their shortest path tree to route the information. Given the shortest path cost of all transmissions, the users need to find a mutually satisfactory cost allocation. We formulate the problem as a cooperative game, derive structural properties of the game, and investigate possible cost allocation concepts.

■ ThC15

Gleacher Center - 100

Stochastic Integer Programming

Cluster: Stochastic Optimization

Invited Session

Chair: Maarten van der Vlerk, University of Groningen, P.O. Box 800, Groningen, 9700 AV, Netherlands, m.h.van.der.vlerk@rug.nl

1 - Cutting Plane Methods for Stochastic Programs with Dominance Constraints Induced by Linear Recourse

Dimitri Drapkin, University of Duisburg-Essen, Lotharstr 65, Duisburg, D-47048, Germany, dimitri.drapkin@googlemail.com

We consider optimization problems whose constraints involve stochastic order relations between decision-dependent random variables and fixed random benchmarks. The decision-dependent random variables are given by the total costs arising in two-stage stochastic programs with linear recourse. With finite probability spaces, we propose a cutting plane algorithm for this class of problems, enabling decomposition into single-scenario subproblems. We conclude with computational results indicating that our method is favourable over the application of general-purpose mixed-integer linear programming solvers.

2 - Two-stage Problems with Dominance Constraints - Closedness Property and a Decomposition Algorithm

Ralf Gollmer, Assistant, University of Duisburg-Essen, FB Mathematik, Forsthausweg 2, Duisburg, D-47057, Germany, ralf.gollmer@uni-due.de, Ruediger Schultz, Uwe Gotzes, Frederike Neise

For risk modeling in mixed-integer linear two-stage problems via first- and second-order stochastic dominance constraints closedness of the constraint set mapping and thus well-posedness of the problem is established. We propose a decomposition algorithm for the case of finite probability distributions and discuss some computational results for it.

3 - Multi-stage Stochastic Programming with Integer Variables and Endogeneous Uncertainty

Natashia Boland, Professor, University of Newcastle, School of Mathematical & Physical Scienc, Callaghan, 2308, Australia, natashia.boland@newcastle.edu.au

We consider the difficult case of multi-stage integer stochastic programming under endogenous uncertainty. We show that this uncertainty can be modelled naturally using integer variables. The resulting models have a large number of constraints which can be reduced using the scenario structure, even for quite general underlying probability distributions. These concepts are illustrated with an application in open-pit mine production scheduling.

■ ThC16

Gleacher Center - 200

Stochastic Optimization F

Contributed Session

Chair: Paul Boggs, Sandia National Laboratories, East Ave., Livermore, CA, 94551, United States of America, ptboggs@sandia.gov

1 - Optimal Maintenance Scheduling of Multicomponent Systems with Stochastic Life Limits

Adam Wojciechowski, PhD Student, Chalmers University of Technology, Department of Mathematical Sciences, Göteborg, 412 96, Sweden, wojcadam@chalmers.se, Michael Patriksson, Ann-Brith Strömberg

For many companies maintenance is viewed as a large source of cost, while it should rather be viewed as an investment in availability. Previously, little optimization has been performed on maintenance planning problems over a finite horizon. We focus on optimization of maintenance activities in multicomponent systems where each maintenance occasion generates a fixed cost. An integer linear programming model for opportunistic maintenance planning taking into account the uncertainty of component lives is presented, along with complexity and polyhedral analyses and preliminary numerical results.

2 - The Joint Hurdle-race Problem

Bernardo Pagnoncelli, Assistant Professor, Universidad Adolfo Ibanez, Diagonal Las Torres 2640 oficina 533C, Santiago, Chile, bernardokp@gmail.com, Steven Vanduffel

Consider an economic agent who needs to determine the current capital required to meet future obligations. Furthermore, for each period separately he needs to keep his capital above given thresholds, the hurdles, with high probability. We generalize the problem into a joint chance constrained problem assuming the decision maker has to pass the hurdles jointly. Using sample average approximation (SAA) we are able to obtain good candidate solution and bounds for the true optimal value.

3 - Optimal Allocation of Resources under Uncertainty Following an Anthrax Attack

Paul Boggs, Sandia National Laboratories, East Ave., Livermore, CA, 94551, United States of America, ptboggs@sandia.gov, David M. Gay, Jaideep Ray

The early stages of an anthrax attack will be characterized by much uncertainty. Almost nothing will be known about the extent, timing, size, and dose. Nor will emergency managers know how many cities were attacked and when subsequent targets were hit. In response to this situation, we have developed a way to assess the uncertainty in such a way that allows one to obtain a range of possible scenarios. We show how to use these possible scenarios to compute an optimal response.

■ ThC17

Gleacher Center - 204

Logistics and Transportation E

Contributed Session

Chair: Sergio Garcia Quiles, Universidad Carlos III, Avenida de la Universidad, 30, Leganos, Madrid, 28911, Spain, sergio.garcia@uc3m.es

1 - Distance-to-go Labels for Computing Shortest Paths in Large Road Networks

Hamish Waterer, University of Newcastle, School of Math & Physical Sciences, University of Newcastle, Callaghan NSW, 2308, Australia, hamish.waterer@newcastle.edu.au, Geoff Leyland

Preliminary results are presented of an investigation into computing shortest paths in real time when very limited information computed a priori can be stored. A single additional label on each arc is considered. These labels store the maximum distance from each arc to the end of any shortest path that uses the arc. Computational results show that these simple distance-to-go labels significantly improve the efficiency of Dijkstra's algorithm with the use of minimal additional storage.

2 - Dynamic Construction of Time-discretized Networks for Very Large Scale Operational Railway Planning

Frank Fischer, Chemnitz University of Technology, Fakultät für Mathematik, Chemnitz, 09107, Germany, frank.fischer@mathematik.tu-chemnitz.de, Christoph Helmberg

For the German railway network we search for a conflict free schedule for trains with given stopping intervals that observes sequence dependent headway times and station capacities. Our model uses time-discretized networks and configuration networks for the headway-constraints. The huge number of variables is handled by dynamic network generation within a combined Lagrangian relaxation and cutting plane approach. This is solved by a bundle method using primal aggregates for separation and rounding. Some promising results towards handling ten percent of the entire network are presented.

3 - Resolution of Large P-median Problems with a Column-and-row Generation Algorithm

Sergio Garcia Quiles, Universidad Carlos III, Avenida de la Universidad, 30, Leganos, Madrid, 28911, Spain, sergio.garcia@uc3m.es, Alfredo Mariin, Martine Labbe'

In the p-median location problem, a set of p medians must be located among a set of potential locations so that the total allocation cost of the non-medians to the medians be minimum. This presentation will show how very large problems (the largest of them, with more than ten thousand nodes) can be solved by using a formulation based on a set covering approach combined with a very particular column-and-row generation method.

■ ThC18

Gleacher Center - 206

Nonconvex Programming

Cluster: Nonlinear Mixed Integer Programming

Invited Session

Chair: Jon Lee, IBM TJ Watson Research Center, P.O. Box 218, Yorktown Heights, NY, 10598, United States of America, jonlee@us.ibm.com

1 - Extending a CIP Framework to Solve MINLPs

Stefan Vigerske, Humboldt-University, Department of Mathematics, Rudower Chaussee 25, 12489 Berlin-Adlers, Berlin, 10099, Germany, stefan@math.hu-berlin.de

We present extensions of the constraint integer programming framework SCIP for solving mixed-integer nonlinear programs. Nonlinear constraints (convex or nonconvex) are handled within an LP-based branch-and-cut algorithm by generating suitable linear relaxations and by domain propagation. The implementation is based on several other software packages, e.g., Couenne, CppAD, and Ipopt. Preliminary numerical results are presented.

2 - Projected Formulations for Non-convex Quadratically Constrained Programs

Anureet Saxena, Axioma Inc, 8800 Roswell Rd., Atlanta, GA, 30338, anureet@yahoo.com, Jon Lee, Pierre Bonami

A common way to produce a convex relaxation of a MIQCP is to lift the problem into a higher dimensional space by introducing additional variables to represent bilinear terms, and strengthening the resulting formulation using SDP constraint and disjunctive programming. In this paper, we study projection methods to build low-dimensional relaxations of MIQCP that capture the strength of these extended formulations.

3 - Strong Valid Inequalities for Orthogonal Disjunctions and Polynomial Covering Sets

Jean-Philippe Richard, University of Florida, Department of Industrial and Systems Eng, 303 Weil Hall, P.O. Box 116595, Gainesville, FL, 32611, richard@ise.ufl.edu, Mohit Tawarmalani, Kwanghun Chung

We propose a convexification tool to construct the convex hull of orthogonal disjunctive sets using convex extensions and disjunctive programming techniques. We describe a toolbox of results to verify the assumptions under which this tool can be employed. We then extend its applicability to nonconvex sets that are not naturally disjunctive. We illustrate the use of our results by developing convex hulls of certain polynomial covering sets and by reporting promising computational results.

■ ThC19

Gleacher Center - 208

Stochastic Optimization A

Contributed Session

Chair: Marc Letournel, PhD Student, LRI Graphcomb Staff, Universite d'Orsay, LRI bat 490, Orsay, 91405, France, letournl@lri.fr

1 - A 0-1 Stochastic Model for the Air Traffic Flow Management Problem

Celeste Pizarro, University Rey Juan Carlos, c/ Tulipan s/n, Madrid, Spain, celeste.pizarro@urjc.es, Laureano Escudero, Alba Agustaan, Antonio Alonso-Ayuso

We present a framework for solving large-scale multistage mixed 0-1 problems for the air traffic flow management problem with rerouting under uncentainty in the airport arrival and departures capacity, the air sector capacities and the flight demand. A scenario tree based scheme is used to represent the Deterministic Equivalent Model of the stochastic mixed 0-1 program with complete recourse.We propose the so-called Fix-and-Relax Coordination algorithm to solved it.

2 - A Branch-and-cut Framework for Stochastic Programming Problems under Endogenous Uncertainty

Christos Maravelias, Assistant Professor, University of Wisconsin - Madison, Chemical and Biological Engineering, 1415 Engineering Dr., Madison, WI, 53706, United States of America, maravelias@wisc.edu, Matthew Colvin

First, we exploit the structure of the problem to derive theoretical properties. We show that a large number of inequality nonanticipativity constraints (NACs) can be removed and others can be replaced by equalities, leading to smaller and tighter MIP models. We also develop a B&C method, where the tree search starts with a reduced MIP formulation where necessary NACs are added as needed, thus requiring all solutions to be examined before updating the bounds.

3 - Stochastic Knapsack Problem with Continuous Distributions

Marc Letournel, PhD Student, LRI Graphcomb Staff, Université d'Orsay, LRI bat 490, Orsay, 91405, France, letournl@lri.fr, Stefanie Kosuch, Abdel Lisser

We present and discuss a Stochastic Knapsack Problem with expectation constraint where the weights are assumed to be independently normally distributed. We present two methods to estimate the gradient of the constraint function in expectation: The first one is an approximate method that uses Finite Differences. The second method allows an exact estimation of the gradient via Integration by Parts. Numerical results of both methods are presented, compared and analyzed.

ThC20

Gleacher Center - 300

Trust Region Methods and Subproblems

Cluster: Nonlinear Programming
Invited Session

Chair: William Hager, University of Florida, P.O. Box 118105, Gainesville, FL, 32611, hager@math.ufl.edu

Co-Chair: Jennifer Erway, Wake Forest University, P.O. Box 7388, Winston Salem, NC, 27109, United States of America, erwayjb@wfu.edu

1 - Solving Large Nonlinear Least-squares Problems by Subspace Trust-region Methods

Margherita Porcelli, Universita' di Firenze, Viale Morgagni 67a, Firenze, 50134, Italy, porcelli@math.unifi.it, Nick Gould, Philippe Toint

Unconstrained nonlinear least-squares problems model many real applications and their solution forms basis of many methods for constrained optimization problems. We consider different subspace approaches for solving the trust-region subproblem arising at each iteration: methods based on nested subspaces associated with the Lanczos process and the low-dimensional subspaces minimization methods. The numerical performance of the two approaches is compared and numerical experiments with large problems from the CUTEr set are presented.

2 - A Stopping Criterion for Solving the SQP System in SSM

Ning Guo, Student, University of Florida, Department of Mathematics,, 358 Little Hall,University of Florida, Gainesville, FL, 32611, United States of America, guoning@ufl.edu, William Hager

SSM(sequential subspace method) is used in solving the trust region subproblem. The method and the algorithm will be briefly discussed. Inside each iteration, we obtain the SQP(sequential quadratic programming) iterate by solving the linear system generated by applying one step of Newton's method to the first-order optimality system. A stopping criterion is provided concerning how accurately the system should be solved to get an at least linear convergence for the non-degenerate case. Some Numerical results will be provided.

3 - An Exact Algorithm for Solving the Graph Partitioning Problem

Dzung Phan, University of Florida, 358 Little Hall, P.O. Box 118105, Gainesville, FL, 32611-8105, United States of America, dphan@ufl.edu, William Hager

In this talk, we present an exact algorithm for solving the node and edge weighted graph partitioning problem. The algorithm is based on a continuous quadratic formulation of the problem. Necessary and sufficient optimality conditions for a local minimizer of the quadratic program are introduced. These conditions relate the graph structure and the first-order optimality conditions at the given point. Lower bounds for the rectangular branch and bound algorithm are obtained by writing the objective function as the sum of a convex and a concave function and replacing the concave part by the best affine underestimator. Numerical results show that the proposed algorithm is highly competitive with state-of-the-art graph partitioning methods.

ThC21

Gleacher Center - 304

Network Design Optimization

Cluster: Telecommunications and Networks
Invited Session

Chair: Petra Mutzel, Professor Doctor, TU Dortmund, Computer Science LS11, Otto-Hahn-Str. 14, Dortmund, 44227, Germany, petra.mutzel@tu-dortmund.de

1 - A Branch-and-cut-and-price Algorithm for Vertex-biconnectivity Augmentation

Ivana Ljubic, University of Vienna, Bruennerstr. 72, Vienna, 1210, Austria, ivana.ljubic@univie.ac.at

Given a spanning subgraph of an edge-weighted graph, we search for the cheapest augmentation that makes it vertex-biconnected. We show that orienting the undirected graph does not help in improving the quality of lower bounds obtained by relaxing cut-based ILPs. We then develop a practically feasible branch-and-cut-and-price approach: Complete graphs with 400 nodes are solved to provable optimality, whereas for graphs with more than 2000 nodes, optimality gaps below 2% are reported.

2 - Dimensioning Multi-level Telecommunication Networks: Integer Programming Approaches

Maren Martens, Zuse Institute Berlin, Takustr. 7, Berlin, 14195, Germany, martens@zib.de, Andreas Bley

Modern telecommunication networks are structured hierarchically into access and metro areas and a core network: Users are connected to regional metro networks via access links, while the metro networks are connected through a core. Decisions when planning such structures target the choice of good (cost efficient) locations for metro and core nodes and the dimensioning of links such that all traffic demands can be routed. We present approaches that achieve exact solutions for such problems.

3 - Dual-based Local Search for the Connected Facility Location and Related Problems

S. (Raghu) Raghavan, University of Maryland, 4345 Van Munching Hall, College Park, MD, 20742, United States of America, raghavan@umd.edu, M. Gisela Bardossy

The connected facility location problem is an NP-complete problem that arises in the design of telecommunication and data networks where open facilities need to communicate with each other. We propose a dual-based local search heuristic that combines dual-ascent and local search that together yield strong lower and upper bounds to the optimal solution. Our procedure applies to a family of closely related problems (namely the Steiner tree-star (STS) problem, the general STS problem, and the rent-or-buy problem) that unite facility location decisions with connectivity requirements. We discuss computational experiments, which indicate that our heuristic is a very effective procedure that finds high quality solutions very rapidly.

ThC22

Gleacher Center - 306

Optimization in the Oil Industry and Mixed Energy Problems

Contributed Session

Chair: Luis Francisco Ferreira Senne, Petrobras, Av Republica do Chile, 65, sala 1902, Centro, Rio de Janeiro, RJ, 20031912, Brazil, luis_senne@yahoo.com.br

1 - A Decentralized Resilient Mixed-energy Infrastructure (L3) Model of America in the Next 40 Years

Jinxu Ding, Iowa State Univesity, Coover 2215, Ames, IA, 50011-3060, United States of America, jxding@iastate.edu, Arun Somani

The non-renewable energy infrastructure is highly-centralized and mainly depends on the crude-oil, natural gas and coal. This results in pollution and dependence on the foreign countries. And, the fossil energy will be used up in future. Thus, we propose the decentralized resilient mixed-energy infrastructure such that (1) Generate renewable energy locally; (2) Consume renewable energy locally; (3) Local people get benefits from new jobs, and clean energy. This can be summarized as L3 principle.

2 - Polynomial Penalty Functions Applied to Oil Production Optimization

Davood Shamsi, PhD Student, Stanford University, Terman Engineering Center, Room 373, 380 Panama Mall, Stanford, CA, 94305, United States of America, davood@stanford.edu, Dongdong Ge, David Echeverria Ciaurri, Yinyu Ye

In oil production optimization, one often needs to maximize the net present value of a reservoir subject to nonlinear constraints (e.g., maximum water injected rate). The introduction of polynomial penalty functions for constraint violation represents an novel strategy for controlling infeasibility. We show, for realistic examples, that the optimization paths associated to the use of penalty functions are smooth, and that the corresponding optimal solutions have acceptable quality in practice.

3 - Incorporation of Uncertainties in the Supply Plan of an Oil Company

Luis Francisco Ferreira Senne, Petrobras, Av Republica do Chile, 65, sala 1902, Centro, Rio de Janeiro, RJ, 20031912, Brazil, luis_senne@yahoo.com.br, Virgilio J. M. Ferreira Filho

To considerate uncertainty in the supply plan of an oil company stochastic programming techniques were employed. Eleven stochastic (two and multi-stage) recourse models were studied. Each of those models was compared with each other and with a deterministic one. To measure the impact of uncertainties in the plan some information were chosen to be watched. Different degrees of impact were associated to different kinds of uncertainty. The VSS as well as the computational effort were also analyzed.

■ ThC23

Gleacher Center - 308

Matrix Min-Rank and Matrix Completion Problems

Cluster: Sparse Optimization
Invited Session

Chair: Wotao Yin, Assistant Professor, Rice University, Department of Computational and Applied, 3086 Duncan Hall, Houston, TX, 77251, United States of America, wotao.yin@rice.edu

1 - A Singular Value Thresholding Algorithm for Matrix Completion

Jian-Feng Cai, CAM Assistant Adjunct Professor, Department of Mathematics, UCLA, 6363 Math Sciences Bldg, UCLA, Los Angeles, CA, 90095-1555, United States of America, caijf@hotmail.com, Emmanuel Candes, Zuowei Shen

We propose a simple and easy-to-implement algorithm to approximate the matrix with minimum nuclear norm among all matrices obeying a set of convex constraints. The algorithm is extremely efficient at addressing problems in which the optimal solution has low rank. We demonstrate that our approach is amenable to very large scale problems by recovering matrices of rank about 10 with nearly a billion unknowns from just about 0.4% of their sampled entries.

2 - Fixed Point and Bregman Iterative Methods for Matrix Rank Minimization

Shiqian Ma, Columbia University, 500 W. 120TH ST, Mudd, Department of IEOR, New York, NY, 10027, United States of America, sm2756@columbia.edu, Donald Goldfarb, Lifeng Chen

In this talk, we present and analyze fixed point and Bregman iterative algorithms for solving the nuclear norm minimization problem, which is a convex relaxation of matrix rank minimization problem. By using an approximate SVD procedure, we get a very fast, robust and powerful algorithm that can solve very large problems. Our numerical results on matrix completion problems demonstrate that this algorithm is much faster and provides much better recoverability than SDP solvers such as SDPT3.

3 - The Linearized Bregman Method

Wotao Yin, Assistant Professor, Rice University, Department of Computational and Applied, 3086 Duncan Hall, Houston, TX, 77251, United States of America, wotao.yin@rice.edu

The linearized Bregman method has been used in sparse optimization and matrix completion problems. This talk presents the history of the method, its theoretical properties, latest numerical enhancements, as well as its comparisons with other popular methods in sparse optimization. In particular, we show that the linearized Bregman method is equivalent to a gradient descent algorithm applied to a dual penalty formulatin, which has an interesting property of exact penalty.

■ ThC25

Gleacher Center - 404

Infinite Dimensional Variational Analysis and Applications

Cluster: Variational Analysis
Invited Session

Chair: Nguyen Mau Nam, University of Texas-Pan American, 1201 West University Drive, Edinburg, TX, 78539, nguyenmn@utpa.edu

1 - The Tangential Distance with its Applications

Bingwu Wang, Associate Professor, Eastern Michigan University, 504D Pray-Harrold building, EMU, Ypsilanti, MI, 48187, United States of America, bwang@emunix.emich.edu

The talk involves the tangential distance, which appears recently in variational analysis, and plays an important rule in deriving formulas regarding direct images. Some of these applications will be explored, as well as basic properties of the tangential distance. The talk is based on joint work with Boris Mordukhovich and Nguyen Mau Nam.

2 - Necessary and Sufficient Conditions of One-sided Lipschitz Mappings and Applications

Hoang Nguyen, Graduate Student, Wayne State University, Mathematics Dept. WSU 656 W.Kirby, 1150 F/A B, Detroit, MI, 48202, United States of America, ba2609@wayne.edu

This talk discusses the necessary and sufficient conditions of one-sided Lipschitz mappings defined on Hilbert spaces. The second part of the talk, we will discuss about the necessary optimality conditions of Bolza problem for one-sided Lipschitzian differential inclusions.

3 - Subdifferential of Suprimum and Infinimum of Infinite Functions and its to Infinite Optimization

Mehari Gebregziabher, GTA, Department of Mathematics, Wayne State University, 3905 Evaline, Hamtramck, MI, 48212, United States of America, aw9095@wayne.edu

In this paper a represntation for the basic subdifferential of suprimum of infinite Lipschitz continuous functions on reflesive space is obtained. A representation for subdifferential of infinimum of infinite continuous functions is also given provided that the infinimum is attainable in an open neighbourhood. As a result a representation for supperdifferentials and Clarke subdifferental is obtained. A necessary optimality condition for infinite optimization is also proved.

■ ThC28

Gleacher Center - 600

Nonsmooth, Linear and Robust Optimization

Cluster: Nonsmooth and Convex Optimization
Invited Session

Chair: Stephen Wright, Professor, University of Wisconsin-Madison, Computer Sciences, 1210 West Dayton Street, Madison, WI, 53706, United States of America, swright@cs.wisc.edu

1 - Constraint Reduction for Linear Programs in General Form

Meiyun He, University of Maryland, Department ECE and ISR, College Park, MD, 20742, United States of America, myheglqh@gmail.com, Andre Tits

Linear programs (LPs) in general form are readily recast into LPs in standard primal or dual form. The resulting "A"matrix has a sparsity structure that ought to be exploited at solution time. Constraint reduction techniques reduce the work per iteration when interior-point methods are used for solving standard-form LPs for which A has many more columns than rows. Here such techniques are applied to general-form LPs, tailored to exploit the sparsity structure of the transformed problem.

2 - Problem Geometry and Problem Robustness

Jorge Vera, Professor, Pontificia Universidad Catolica de Chile, Campus San Joaquin, Vicuna Mackenna 4860, Santiago, 7820436, Chile, jvera@ing.puc.cl

The geometry of a set has been shown to explain complexity properties of related convex optimization algorithms. It is a relevant question whether these properties influence sensitivity of optimal solutions with respect to changes in the data, in a similar way as with condition numbers. In this work we show some of those connections and address its potential implications for the computation of robust solutions. Robust solutions are protected from data variation, but the change in the robust solution with respect to nominal solutions is related to the robustness and well posedness of the problem itself. We show how feasible set geometry could be used as a way of measuring this robustness.

3 - Composite Optimization: Algorithm and Identification Properties

Stephen Wright, Professor, University of Wisconsin-Madison, Computer Sciences, 1210 West Dayton Street, Madison, WI, 53706, United States of America, swright@cs.wisc.edu, Adrian Lewis

We seek to minimize composite function of the form h(c(x)), where c is a smooth vector function and h is usually nonsmooth, possibly nonconvex, and possibly extended-valued. This paradigm encompasses many problems of current interest, including compressed sensing and matrix completion, as well as more established problems such as l-1 penalty formulations of nonlinear programming. We propose a method that is based on a linearization of c together with a smooth proximal penalty on the step, and analyze convergence of this method in the case of h prox-regular. We also discuss issues of identification in this setting, that are extensions of active constraint identification in nonlinear programming.

Friday, 10:00am - 11:30am

■ FA01

Marriott - Chicago A

Approximation Algorithms III

Cluster: Approximation Algorithms
Invited Session

Chair: Cliff Stein, Columbia University, 326 S W Mudd Building, 500 W. 120th Street, New York, NY, 10027, cliff@ieor.columbia.edu

1 - Differentially Private Approximation Algorithms

Kunal Talwar, Microsoft Research, Silicon Valley Campus, 1065 La Avenida, Mountain View, CA, 94043, United States of America, kunal@microsoft.com, Frank McSherry, Anupam Gupta, Katrina Ligett, Aaron Roth

We initiate a systematic study of algorithms for optimization problems in the framework of differential privacy, which formalizes the idea of protecting the privacy of individual input elements. We study the problems of vertex and set cover, min-cut, k-median, facility location, Steiner tree, and the recently introduced submodular maximization problem, Combinatorial Public Projects. For all these problems we give information theoretic lower bounds, and matching or nearly matching upper bounds.

2 - Unsplittable Flow in Paths and Trees and Column-Restricted Packing Integer Programs

Chandra Chekuri, University of Illinois at Urbana-Champaign, Dept of Computer Science, 201 N Goodwin Ave, Urbana, IL, 61801, United States of America, chekuri@cs.uiuc.edu

We consider the unsplittable flow problem (UFP). Most previous work on UFP has focused on the case where the maximum demand of the requests is no larger than the smallest edge capacity - referred to as the “no-bottleneck” assumption. We give a simple $O(\log^{2n})$ approximation for UFP on trees. Using our insights, we develop an LP relaxation for UFP on paths that has an integrality gap of $O(\log^{2n})$. We also discuss related problems on column-restricted packing integer programs (CPIPs)

3 - Multi-armed Bandits with Side Constraints

Kamesh Mungala, Assistant Professor, Duke University, Box 90129, Durham, NC, 27708, United States of America, kamesh@gmail.com, Sudipto Guha, Peng Shi

The stochastic multi-armed bandit (MAB) problem models the exploration exploitation tradeoff. For this problem, traditional index policies become sub-optimal in the presence of side-constraints, such as costs of switching between arms. In this talk, we will present a novel, simple, and general algorithmic technique for handling side-constraints, which yields policies that are not only constant factor approximations, but are also computationally just as efficient as index policies.

■ FA02

Marriott - Chicago B

Matrix Classes in LCP and Semidefinite LCP

Cluster: Complementarity Problems and Variational Inequalities
Invited Session

Chair: A Chandrashekaran, CSIR-SRF, Indian Institute of Technology Madras, Department of Mathematics, IIT”Madras, Chennai, TN, 600036, India, chandru1782@gmail.com

1 - New Characterizations of Row Sufficient Matrices

Richard Cottle, Professor Emeritus, Stanford University, Department of Mgt. Sci. & Engr., 380 Panama Mall, Stanford, CA, 94305, United States of America, rwc@stanford.edu, Sushil Verma, Ilan Adler

Using structural properties of certain matrix classes, we give new characterizations of RSU, the class of row sufficient matrices. We show that such matrices belong to Eaves’s class L. Asking what must be true of row sufficient L-matrices, we establish three new characterizations of RSU expressed in terms of the matrix classes L, E0, Q0, and the structural properties of sign-change invariance, completeness, and fullness. When coupled with the structural property of reflectiveness, these results give new characterizations of the class of sufficient matrices.

2 - P-matrix Generalized Linear Complementarity Problems with Matrices That Are Not Hidden K-matrices

Walter Morris, George Mason University, 4400 University Drive, Fairfax, VA, 22030, United States of America, wmorris@gmu.edu, Bernd Gaertner, Leo Ruest, Rahul Savani

The complexity analysis of some simple principal pivot algorithms for the (generalized) LCP (G,q) with a (vertical block) P-matrix G depends on the acyclicity of a certain directed graph associated with G and q. This graph is acyclic if the matrix G is a hidden K-matrix. We show that if G has 3 columns, there exists a vector q so that the digraph for LCP (G,q) contains a directed cycle iff G is in the interior of the set of (vertical block) matrices that are not hidden K-matrices.

3 - Some New Results in Semidefinite Linear Complementarity Problems

A Chandrashekaran, CSIR-SRF, Indian Institute of Technology Madras, Department of Mathematics, IIT Madras, Chennai, TN, 600036, India, chandru1782@gmail.com, T Parthasarathy, V Vetrivel

In this article we study the semimonotone type properties in the Semidefinite Linear Complementarity Problems(SDLCP’s) motivated by the semimonotone property in the Linear Complementarity problems(LCP’s). We introduce and prove some results on a semimonotone type property called P’_2 - property for SDLCP’s, similar to the already existing results in the LCP theory. Then we prove the equivalence of the P’_2 and P_2 - property for the Lyapunov and the double sided multiplicative transformations. We also study the implications of P’_2 properties on the P and Q - properties for the Lyapunov, Stein and double sided multiplicative transformations.

■ FA03

Marriott - Chicago C

Electricity Markets II

Cluster: Optimization in Energy Systems
Invited Session

Chair: Andres Ramos, Professor, Universidad Pontificia Comillas, Alberto Aguilera 23, Madrid, 28015, Spain, andres.ramos@upcomillas.es

1 - Formulation of the Economic Dispatch with a Complete and Novel Modeling of Technical Characteristics

Juan Carlos Morales, XM Expertos en Mercados, Calle 12 Sur # 18-168, Medellin, Colombia, jcmorales@XM.com.co, Carlos Mario Correa, Oscar Mauricio Carreão, Pablo Corredor

This article presents in detail a practical, efficient and novel Mixed Integer Linear Programming approach (MILP) to model a complete Unit Commitment (UC) problem with network linear constraints. In this paper the authors show a practical and efficient UC problem integrating into a mathematical model the technical characteristics of the power plants, the frequency reserve and the network constraints, with the primary objective of minimizing the operational costs of the system.

2 - Stochastic Dual Dynamic Programming Applied to Nonlinear Hydrothermal Models

Santiago Cerisola, Researcher, Universidad Pontificia Comillas, Alberto Aguilera 23, Madrid, 28015, Spain, santiago.cerisola@upcomillas.es, Jesus M. Latorre, Andres Ramos

We apply the SDDP decomposition to a nonlinear stochastic hydrothermal model where we model nonlinear water head effects and the nonlinear dependence between the reservoir head and the reservoir volume. We use the McCormick envelopes to approximate the nonlinear constraints that model the efficiency of the plant. We divide these constraints into smaller regions and use the McCormick envelopes for each region. Binary variables are used for this disjunctive programming approach which complicates the application of the decomposition method. We use a variant of the L-shaped method that enables the inclusion of binary variables into the subproblem and perform the stochastic decomposition method. A realistic large-scale case study is presented.

3 - Stochastic Programming Models for Optimal Bid Strategies in the Iberian Electricity Market

F.-Javier Heredia, Professor, Universitat Politècnica de Catalunya, North Campus-C5, Office 206, Jordi Girona, 1-3, Barcelona, 08034, Spain, f.javier.heredia@upc.edu, Cristina Corchero

The day-ahead market is not only the main physical energy market of Portugal and Spain in terms of the amount of traded energy, but also the mechanism through which other energy products, as bilateral (BC) and physical futures (FC) contracts, are integrated into the Iberian Electricity Market (MIBEL) energy production system. We propose stochastic programming models that give both the optimal bidding and BC and FC nomination strategy for a price-taker generation company in the MIBEL. Implementation details and some first computational experiences for small real cases are presented.

■ FA04

Marriott - Denver

Combinatorial Optimization I

Contributed Session

Chair: Quentin Botton, PhD, Universite Catholique de Louvain - Louvain School of Management, Place des Doyens, 1, Louvain-la-Neuve, 1348, Belgium, quentin.botton@uclouvain.be

1 - Matching Structure of Symmetric Bipartite Graphs and a Generalization of Polya's Problem

Naonori Kakimura, University of Tokyo, 7-3-1, Hongo, Bunkyo-ku, Tokyo, 1138656, Japan, kakimura@mist.i.u-tokyo.ac.jp

A bipartite graph is called symmetric if it has symmetry of reflecting two vertex sets. This talk discusses matching structure of symmetric bipartite graphs. We first apply the Dulmage-Mendelsohn decomposition to symmetric bipartite graphs. The resulting components, which are matching-covered, turn out to have symmetry. We then decompose a matching-covered symmetric bipartite graph via an ear decomposition. We show an ear decomposition can retain symmetry by adding at most two paths. As an application of these decompositions to combinatorial matrix theory, we introduce a generalization of Polya's problem to rectangular matrices. We show this problem can be solved in polynomial time, and give a characterization in terms of excluded minors.

2 - On a Minimal Linear Description of the Stable Set Polytope of Quasi-line Graphs

Gianpaolo Oriolo, Università degli studi di Roma Tor Vergata, Via del Politecnico 1, Roma, Italy, oriolo@disp.uniroma2.it, Gautier Stauffer

A linear description of the stable set polytope STAB(G) of quasi-line graphs was recently given by Eisenbrand, Oriolo, Stauffer and Ventura. Quasi-line graphs generalize line-graphs and so their stable set polytope is a generalization of the matching polytope. In the talk we address the question of a (minimal) linear description of STAB(G) for quasi-line graphs. Recall that a minimal set of inequalities describing the matching polytope is a celebrated result by Edmonds and Pulleyblank.

3 - Properties of a Layered Extended Graph Formulation for Designing K-Edge(Arc) Disjoint L-paths

Quentin Botton, PhD, Universite Catholique de Louvain - Louvain School of Management, Place des Doyens, 1, Louvain-la-Neuve, 1348, Belgium, quentin.botton@uclouvain.be, Luis Gouveia, Bernard Fortz

In this paper, we propose an extended formulation for the K-Arc(Edge)-Disjoint Hop-Constrained Network Design Problem in the single commodity case. We formulate some interesting properties and we prove that our formulation provides a complete description of the polyhedron when L<=3 and for any value of K for the Arc-Disjoint case. We propose some new valid inequalities for the Edge-Disjoint case and we illustrate the quality of the lower bound when L>3 through some numerical results.

■ FA06

Marriott - Kansas City

Theory and Applications of Conic Programming Problems

Cluster: Conic Programming

Invited Session

Chair: Hayato Waki, The University of Electro-Communications, Chofu-gaoka 1-5-1 West Building 4, 311, Chofu-shi, Tokyo, Japan, Tokyo, 182-8585, Japan, hayato.waki@jsb.cs.uec.ac.jp

1 - ESDP Relaxation of Sensor Network Localization: Analysis, Extensions and Algorithm

Ting Kei Pong, Graduate Student, University of Washington, Department of Mathematics, Box 354350, Seattle, United States of America, tkpong@math.washington.edu, Paul Tseng

Recently Wang, Zheng, Boyd, and Ye proposed an edge-based SDP (ESDP) as a further relaxation of the SDP relaxation of the sensor network localization problem. We show that zero trace necessarily certifies position accuracy in ESDP interior solutions, provided that measured distances are noiseless. We then propose a robust version of ESDP to handle noise and a fast distributed algorithm for its solution.

2 - Facial Reduction Algorithm and Conic Expansion Algorithm

Masakazu Muramatsu, The University of Electro-Communications, Chofu-gaoka 1-5-1 West Building 4, 311, Chofu-shi, Tokyo, Japan, Tokyo, Japan, muramatu@cs.uec.ac.jp, Hayato Waki

We first propose a facial reduction algorithm (FRA) for general conic linear programming, and prove some useful properties of the algorithm. Then we establish relationships between FRA and conic expansion algorithm (CEA, a.k.a. the dual regularization approach) by Luo, Sturm, and Zhang. In fact, CEA can be regarded as a dual of special case of FRA. We give some examples that FRA can provide finer sequence of regularizations than CEA.

3 - A Facial Reduction Algorithm for Semedefinite Programming Problems in Polynomial Optimization

Hayato Waki, The University of Electro-Communications, Chofu-gaoka 1-5-1 West Building 4, 311, Chofu-shi, Tokyo, Japan, Tokyo, 182-8585, Japan, hayato.waki@jsb.cs.uec.ac.jp, Masakazu Muramatsu

Kojima et al. (2005) proposed a method that eliminates redundant monomials for all SOS representations of a given polynomial. In this talk, we reveal a relationship between the elimination method and Facial Reduction Algorithm (FRA) proposed by Bowrein and Wolkowicz (1980), and show that the elimination method not only reduces the size of the SDP problem of finding an SOS representation of the given polynomial but also improves the numerical stability. We also present some examples that the elimination method performs well.

■ FA07

Marriott - Chicago D

Integer and Mixed Integer Programming J

Contributed Session

Chair: Illya Hicks, Associate Professor, Rice University, 6100 Main St. - MS 134, Houston, TX, 77005-1892, United States of America, ivhicks@rice.edu

1 - Experiments with Two-row Cuts

Pierre Bonami, CNRS, Aix Marseille Université, 163 Avenue de Luminy, Marseille, France, pierre.bonami@lif.univ-mrs.fr, Gerard Cornuejols, Francois Margot, Amitabh Basu

Most of the cutting plane algorithms implemented in current state of the art solvers rely on cuts that can be derived from a single equation. A natural idea to build more efficient cutting plane algorithms is to use cuts which need more than one equation to be derived. Recently there has been a lot of interest in cutting planes generated from two rows of the optimal simplex tableau. For example, it has been shown that there exist examples of integer programs for which a single cut generated from two rows can dominates the split closure by an arbitrary amount. Motivated by these theoretical results, we study computationaly the effect of adding these cutting planes on a set of problems from the MIPLIB library.

2 - Fast Lower Bounds for the Capacitated Arc Routing Problem

Rafael Martinelli, Pontificia Universidade Catolica do Rio de Janeiro, Rua Marques de Sao Vicente, 225 - RDC, Departamento de Informatica, Gavea, Rio de Janeiro, 22453-900, Brazil, rmartinelli@inf.puc-rio.br, Marcus Poggi

We devise a dual ascent algorithm for the Capacitated Arc Routing Problem (CARP) based on the formulation proposed by Belenguer and Benavent. Although this approach may not yield the best possible bounds, it allows a very fast computation. The main difficulty is to select active primal cuts, associated to dual variables, that allow reaching high quality dual bounds. We discuss how to find these cuts and show that the resulting algorithm consistently finds strong lower bounds.

3 - Integer Programming Techniques for General Branchwidth

Illya Hicks, Associate Professor, Rice University, 6100 Main St. - MS 134, Houston, TX, 77005-1892, United States of America, ivhicks@rice.edu

In this talk, we consider the problem of computing the branchwidth and optimal branch decomposition of a symmetric submodular function, the general branchwidth problem. General branchwidth encompasses graphic, hypergraphic, and matroidal branchwidth, as well as carvingwidth and rankwidth. We present the first integer programming model for this general branchwidth problem and offer preliminary computational results for solving our model.

■ FA08

Marriott - Chicago E

Trends in Mixed Integer Programming X

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Robert Weismantel, Professor, Otto-von-Guericke University Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, weismant@mail.math.uni-magdeburg.de

Co-Chair: Andrea Lodi, DEIS, University of Bologna, Viale Risorgimento, 2, Bologna, 40136, Italy, andrea.lodi@unibo.it

1 - Properties of Integer Feasibility on a Simplex

Karen Aardal, Professor, Delft University of Technology, Mekelweg 4, Delft, 2628 CD, Netherlands, Karen.Aardal@cwi.nl, Laurence Wolsey

We give a non-trivial upper bound on the number of nodes needed to solve the integer feasibility problem on a simplex after it has been reformulated using the Aardal-Hurkens-Lenstra lattice reformulation.

2 - Revival of Vertex Enumeration

Leen Stougie, Professor Doctor, Vrije Universiteit & CWI Amsterdam, De Boelelaan 1105, Amsterdam, 1085HV, Netherlands, lstougie@feweb.vu.nl, Vicente Acuna

The complexity of enumerating vertices of bounded polyhedra is a long standing open problem. Khachiyan et al. (2005) give a negative answer for (unbounded) polyhedra. Research in this field is attracting new attention by the study of metabolic networks. Our new results are a) it is NP-hard to decide if a vertex exists with 2 prespecified coordinates in its support, b) enumerating vertices having 1 specific coordinate in their support cannot be done with polynomial delay unless P=NP.

3 - Smallest Compact Formulation for the Permutahedron

Michel Goemans, MIT, Department of Mathematics, Cambridge, MA, 02139, United States of America, goemans@math.mit.edu

We give an extended formulation of the permutahedron (convex hull of all permutations on n elements) with O(n log(n)) variables and O(n log (n)) constraints. We also show that no smaller compact formulation exists (up to constant factors). This answers a question of Alberto Caprara. The results easily generalize to variants of the permutahedron.

■ FA09

Marriott - Chicago F

Branch-and-Price III

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Marco Luebbecke, TU Berlin, Institute of mathematics, Strasse des 17. Juni 136, Berlin, 10623, Germany, m.luebbecke@math.tu-berlin.de

1 - The Column Generation Improvement Heuristic (CGI) and its Consequences

Marcus Poggi, Pontificia Universidade Catolica do Rio de Janeiro, Rua Marques de Sao Vicente, 225 - RDC, Departamento de Informatica, Gavea, Rio de Janeiro, 22451-900, Brazil, poggi@inf.puc-rio.br

One may propose column generation formulations for combinatorial problems where the pricing subproblem turns out to be another, although identical sometimes, instance of the original problem. When it is not, we point out that finding a profitable new solution for the subproblem implies an improvement on the current (LP) solution. We discuss this instance repetition behavior over applications of CGI to routing problems (TSP, TDTSP) and nonlinear 0-1 programs (UBQP, MAX-CUT, MAX-CLIQUE). We explore the consequences of this embedded instance transformation in branch-and-price approaches where problem solutions are associated to single columns. Uniting implications on variables coming from different related instances is the current challenge.

2 - An All-integer Column Generation Methodology for Set Partitioning Problems

Elina Ronnberg, Linkoping University, Department of Mathematics, Division of Optimization, Linkoping, SE-58183, Sweden, elron@mai.liu.se, Torbjorn Larsson

The set partitioning polytope has the quasi-integrality property, that enables the use of simplex pivot based methods for moving between integer solutions associated with linear programming bases. In our methodology each intermediate solution to a restricted master problem is feasible, integer, and associated with simplex multipliers. A subproblem is designed to produce columns that maintain integrality when pivoted into the basis. Criteria for verifying optimality are presented.

3 - Cutting in Branch-and-cut-and-price Algorithms

Simon Spoorendonk, DTU Management Engineering, Produktionstorvet, Building 426, Kgs. Lyngby, 2800, Denmark, spoo@man.dtu.dk, Guy Desaulniers, Jacques Desrosiers

Given a Dantzig-Wolfe decomposition of an integer program, this talk presents a general framework for formulating, on the original formulation, valid inequalities derived on an equivalent master problem. It is possible to model these inequalities by adding new variables and constraints to the original formulation. We show how the additional inequalities may give rise to an augmented sub-problem. Examples on how to apply this framework are given for the vehicle routing problem with time windows.

■ FA10

Marriott - Chicago G

Global Optimization of Differential Equations

Cluster: Global Optimization
Invited Session

Chair: Paul Barton, Lammot du Pont Professor, MIT, Room 66-464, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States of America, pib@mit.edu

1 - Global Optimization of Nonlinear Programs with Partial Differential Equations Embedded

Alexander Mitsos, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Department of Mechanical Engineering, Cambridge, MA, 02139, mitsos@mit.edu

A methodology for global optimization with algorithms embedded is summarized [1]. It relies on McCormick relaxations [2] and their subgradient propagation. Algorithms with a fixed number of iterations are considered. Parameter estimation problems with ordinary and partial differential equations are presented. The approach proposed has drastically smaller number of optimization variables in the lower bounding scheme compared to existing global optimization methods. Reference: [1] A. Mitsos, B. Chachuat and P. I. Barton. McCormick-Based Relaxations of Algorithms. SIOPT, in press. [2] G. P. McCormick. Computability of global solutions to factorable nonconvex programs: Part I. Convex underestimating problems. Math. Progr., 10(2):147-175, 1976.

2 - A Discretize-then-relax Approach for Convex/Concave Relaxation of the Solutions of Parametric ODEs

Benoit Chachuat, Assistant Professor, McMaster University, Department of Chemical Engineering, 1280 Main Street West, Hamilton, ON, L8S 4L7, Canada, benoit@mcmaster.ca, Ali M. Sahlodin

The ability to construct tight convex and concave relaxations for the solutions of parametric ODEs is pivotal to deterministic global optimization methods for nonconvex dynamic optimization. The emphasis so far has been on constructing an auxiliary system of ODEs that describes convex/concave bounds of the parametric solutions, pointwise in the independent variable, thereby following a relax-then-discretize approach. This paper presents a novel discretize-then-relax approach to construct tight convex/concave bounds that are guaranteed to enclose the parametric solutions. Our procedure builds upon interval-based techniques implemented in state-of-the-art validated ODE solvers such as VNODE-LP, and applies to a wide class of parametric ODEs.

3 - Bounding Trajectories for Nonlinear ODEs: Application to Global Optimization

Mark Stadtherr, University of Notre Dame, Department of Chem. & Biomolecular Eng., 182 Fitzpatrick Hall, Notre Dame, IN, 46556, markst@nd.edu, Yao Zhao, Youdong Lin

Recent developments in the solution of interval-valued initial value problems for systems of nonlinear ordinary differential equations are reviewed. These techniques provide mathematically and computationally guaranteed bounds on the state trajectories. Applications to global optimization problems involving nonlinear dynamic systems are described.

■ FA11

Marriott - Chicago H

Robust Optimization A

Contributed Session

Chair: Dick den Hertog, Tilburg University, P.O. Box 90153, Tilburg, Netherlands, D.denHertog@uvt.nl

1 - Linear Recovery Robust Programs

Sebastian Stiller, MATHEON, Institut für Mathematik, TU Berlin, Berlin, 10623, Germany, stiller@math.tu-berlin.de

The concept of recoverable robustness has been invented to overcome the conservatism of robust optimization. We treat the case of linear recovery which is similar to a 2-stage stochastic program, where the second stage cost is the maximum over a restricted scenario set. We give efficient algorithms and a tight polyhedral analysis of coincidental covering, i.e., that solutions are recoverable also for scenarios outside the given scenario set. The method is superior to classical approaches in particular for disturbed right-hand side vectors and in case many or all rows are affected by disturbances. In a study on delay resistant train platforming with real-world data this general method has outperformed special purpose methods by 25%.

2 - Robust Estimation: Case of Regression by Minimum Sum of Absolute Errors

John F Wellington, Indiana University Kokomo, 2300 S. Washington Street, P. O. Box 9003, Kokomo, IN, 46904, United States of America, jfwellin@iuk.edu, Stephen A. Lewis

We look upon estimation of the parameters of the single equation multiple linear regression model as an optimization problem and address its solution under the criterion of minimum sum of absolute errors (MSAE). We report a post-optimality analysis that allows evaluation of the sensitivity of the MSAE solution to simultaneous variations in the technical or left-hand side (LHS) coefficients of the linear programming formulation of the MSAE problem.

3 - Robust Optimization with Uncertainty Regions Based on Phi-divergence

Dick den Hertog, Tilburg University, P.O. Box 90153, Tilburg, Netherlands, D.denHertog@uvt.nl, Aharon Ben-Tal, Anja De Waegenaere, Bertrand Melenberg

We focus on robust linear optimization with uncertainty regions defined by phi-divergence distance measures (e.g. chi-squared, Hellinger). Such uncertainty arise in a natural way if the uncertain parameters depend on an unknown probability distribution and goodness-of-fit tests are used. We show that the robust counterpart of a linear optimization problem with "phi-divergence" uncertainty is tractable. We also apply the theory to expected utility functions; in particular to the newsboy problem.

■ FA12

Marriott - Los Angeles

Industrial Applications of PDE-Constrained Optimization

Cluster: PDE-constrained Optimization
Invited Session

Chair: Amr El-Bakry, ExxonMobil Research & Engineering Company, 1545 Route 22 East, Annandale, NJ, 08801, United States of America, amr.s.el-bakry@exxonmobil.com

1 - A Multi-model Approach to Simulation Based Optimization

Natalia Alexandrov, NASA Langley Research Center, Mail Stop 442, Hampton, VA, 22681-2199, United States of America, n.alexandrov@nasa.gov

We examine an approach to the design of complex systems governed by computationally intensive simulations. The problem may be viewed in terms of a multilevel formulation or a multilevel solution algorithm. The term multi-model refers to the use of several layers of models in representing a particular simulation at various stages of design or for the purposes of tractability. We investigate analytical and computational properties of the approach and examine a numerical demonstration.

2 - Adjoint Based Numerical Optimization of a Reservoir Waterflooding Problem

Klaus Wiegand, Senior Engineering Associate, ExxonMobil Upstream Research, Mercer Street, Houston, United States of America, klaus.d.wiegand@exxonmobil.com, Matthias Heinkenschloss, Amr El-Bakry

We present numerical algorithms to find optimal well rates for a reservoir waterflooding problem. First and second order optimality conditions are derived based on the Adjoint method. Results are presented for a shallow oil-water system that is simulated using two popular time discretization schemes.

3 - Dynamic Optimization for Plastic Sheet Production

Antonio Flores-Tlacuahuac, Professor, Universidad Iberoamericana, Prolongacion Paseo de la Reforma 880, Mexico df, 01219, Mexico, antonio.flores@uia.mx

The dynamic optimization of a heating and polymerization reaction process for plastic sheet production in a forced-circulated warm air reactor is addressed. The mathematical model is cast as a time dependent Partial Differential Equation system (PDEs). Our aim is to compute the warming air temperature as time function so to drive the plastic sheet temperature to its desired profile as soon as possible while meeting a set of process constraints.

■ FA14

Marriott - Scottsdale

PDE-constrained Optimization A

Contributed Session

Chair: Christian Brandenburg, TU Darmstadt, Schlossgartenstr. 7, Darmstadt, Germany, brandenburg@mathematik.tu-darmstadt.de

1 - Adaptive Multilevel SQP-Methods for PDE-constrained Optimization with Control Constraints

J. Carsten Ziems, Technische Universitaet Darmstadt, Schlossgartenstr. 7, Darmstadt, 64289, Germany, ziems@mathematik.tu-darmstadt.de, Stefan Ulbrich

We present an adaptive multilevel SQP-method for opt. problems governed by nonlinear PDEs with control constraints. Starting with a coarse discretization of the problem we combine a trust-region SQP-method with an implementable adaptive refinement strategy based on error estimators and a criticality measure. In the presence of parabolic PDE constraints the alg. also supports the use of independent discretizations for state and adjoint PDE. We prove global convergence and show numerical results.

2 - Discrete Adjoint Techniques for Flow Optimization Based on Parallel Large Eddy Simulation

Rolf Roth, Technische Universität Darmstadt, Schlossgartenstr. 7, Darmstadt, 64289, Germany, rroth@mathematik.tu-darmstadt.de, Stefan Ulbrich

We describe a systematic way to generate adjoint code by applying an efficient sparsity exploiting forward mode of AD to the original code. The result is a linear system for the adjoint that can be solved by taking advantage of the original code and the existing structure for multicore and multigrid. We applied this procedure to the parallel, block-structured, multigrid flow solver FASTEST, which uses LES and is written in Fortran. Numerical results of engineering applications will be presented.

3 - Shape Optimization for the Instationary Navier-Stokes Equations with Goal-oriented Adaptivity

Christian Brandenburg, TU Darmstadt, Schlossgartenstr. 7, Darmstadt, Germany, brandenburg@mathematik.tu-darmstadt.de, Florian Lindemann, Michael Ulbrich, Stefan Ulbrich

We present an adjoint approach for shape optimization in function spaces which is conveniently implementable in that it allows for the use of existing state and adjoint solvers on the current computational domain to obtain exact gradients. This approach is applied to the incompressible instationary Navier-Stokes equations in 2 and 3 space dimensions. Multilevel techniques are realized by using goal-oriented adaptivity w.r.t. to the drag objective functional. Numerical results will be given.

■ FA15

Gleacher Center - 100

Applications of Stochastic Complementarity Programs

Cluster: Stochastic Optimization
Invited Session

Chair: Asgeir Tomasgard, NTNU, Alfred Getz vei 3, Trondheim, 7491, Norway, Asgeir.Tomasgard@sintef.no

1 - Resale in Vertically Separated Markets: Profit and Consumer Surplus Implications

Adrian Werner, SINTEF, S.P. Andersens vei 5, Trondheim, 7491, Norway, AdrianTobias.Werner@sintef.no, Qiong Wang

Liberalizing industries with natural monopoly characteristics often leads to vertical separation. With high investment costs the upstream market remains monopolistic. Entrants purchase the upstream component for downstream resale. This potential competition may even help the incumbent's downstream subsidiary to improve profit but may raise end-user costs. We focus on two aspects: market power and demand uncertainty. Utilizing two-stage SMPECs, we discuss a case for natural gas transport.

2 - Capacity Booking in a Transportation Network with Stochastic Demand

Asgeir Tomasgard, NTNU, Alfred Getz vei 3, Trondheim, 7491, Norway, Asgeir.Tomasgard@sintef.no, Mette Bjorndal, Yves Smeers, Kjetil Midthun

We present an equilibrium model for transport booking in a gas transportation network. The booking regime is similar to the regime implemented in the North-Sea. The model looks at the challenges faced by the network operator in regulating such a system. There are some privileged players in the network, with access to a primary market for transportation capacity. The demand for capacity is stochastic when the booking in the primary market is done. There is also an open secondary market for transportation capacity where all players participate including a competitive fringe. This is modelled as a Generalized Nash Equilibrium using a stochastic complementarity problem.

3 - A Benders Decomposition Method for Discretely-Constrained MPEC

Yohan Shim, University of Maryland, College Park, 1173 Martin Hall, College Park, MD, 20742, United States of America, yshim@umd.edu, Marte Fodstad, Asgeir Tomasgard, Steve Gabriel

We present a new variant of Benders method combined with a domain decomposition heuristic to solve discretely-constrained mathematical programs with equilibrium constraints. These bi-level, integer-constrained problems are important for a variety of areas involving infrastructure planning (e.g., energy) although they are computationally challenging. We apply the proposed new method in the natural gas investment decisions under competitive operations and stochastic markets.

■ FA16

Gleacher Center - 200

Stochastic Optimization G

Contributed Session

Chair: Michael Chen, Post Doctoral Fellow, IBM, TJ Watson Research Center, York Town, NY, vancouver.michael@gmail.com

1 - Monte Carlo Methods for Risk Minimization Problems

Dali Zhang, PhD Student, University of Southampton, School of Mathematics, Southampton, SO17 1BJ, United Kingdom, zhangdl@soton.ac.uk, Huifu Xu

In the paper we consider a stochastic optimization model where the objective function is the variance of a random function and the constraint function is the expected value. Instead of using popular scenario tree methods, we apply the sample average approximation method to solve it. Under some mild conditions, we show that the statistical estimator of the optimal solution converges at an exponential rate. We apply the proposed model and the method to a portfolio management problem.

2 - Sparse Grid Scenario Generation and its Rate of Convergence

Michael Chen, Post Doctoral Fellow, IBM, TJ Watson Research Center, York Town, NY, United States of America, vancouver.michael@gmail.com, Sanjay Mehrotra

We adapt the sparse grid integration method for scenario generation in stochastic optimization. For problems with sufficient differntiability numerical results show that this method outperforms Monte-Carlo and QMC methods and it remains competetive for two-stage stochastic program. We present a rate of convergence analysis for this method.

3 - An Inexact Bundle Method for Two-stage Stochastic Linear Programming

Welington Oliveira, Federal University of Rio de Janeiro, P.O. Box 68511, Rio de Janeiro, 21941-972, Brazil, wlo@cos.ufrj.br, Claudia Sagastizabal, Susana Scheimberg

In order to represent accurately uncertainty, many applications of stochastic programming consider large scenario trees. However, a large number of scenarios makes the numerical solution too difficult to deal with. For the particular case of two-stage programs, we consider an inexact bundle method applied in a Benders-like decomposition framework. As shown by encouraging numerical experience, the inexact bundle method allows to skip subproblems solution while keeping controlled the accuracy error.

■ FA17

Gleacher Center - 204

Logistics and Transportation F

Contributed Session

Chair: Olivia Smith, University of Melbourne, Department of Mathematics and Statistics, University of Melbourne, Parkville, vi, 3052, Australia, omadill@ms.unimelb.edu.au

1 - Optimized Order Policies for Multi-echelon Spare-part Distribution Systems

Konrad Schade, Universität Bayreuth, Lehrstuhl Wirtschaftsmathematik, Universität Bayreuth 95440 Bayreuth, Bayreuth, Germany, konrad.schade@uni-bayreuth.de

Order policies are crucial in supply chain management. This talk is about finding cost-minimizing orderpoints within a multi-echelon inventory system that uses the (s,S)-strategy. The Guaranteed-Service-Model (GSM) provides such orderpoints under the assumption of reliable internal lead times and bounded total demand. We extend the GSM to a two-stage stochastic MILP to enable recourse actions. First computational results indicate that the value of the stochastic solution is substantial.

2 - Robust Airline Scheduling: Improving Schedule Robustness with Flight Re-timing and Aircraft Swapping

Sophie Dickson, The University of Melbourne, Dept of Maths & Stats, Parkville, 3010, Australia, sophiedickson@gmail.com, Natashia Boland

All plans go astray on the day; airline schedules are no exception. Flight delays often have knock-on effects that frustrate passengers and cost airlines money. Most schedules have slack time that helps reduce knock-on delays. We present new models that re-time flights and swap flights between aircraft in a schedule, redistributing the slack time to minimise knock-on effects. We discuss the models' properties, how parameters are set from real airline data, and results from numerical experiments.

3 - Weight Constrained Shortest Path Problems with Replenishment Arcs

Olivia Smith, University of Melbourne, Department of Mathematics and Statistics, University of Melbourne, Parkville, vi, 3052, Australia, omadill@ms.unimelb.edu.au, Natashia Boland, Hamish Waterer

In many contexts, such as airline scheduling, there is a need to find paths which satisfy weight constraints with replenishment. An example is airline crew pairing where we seek paths which reflect 2-5 days of flying. In this context, the crew can only work a set number of hours before they must have a long enough break to sleep. These long breaks are replenishment arcs. We consider the problem of finding weight feasible shortest paths in such a network.

■ FA18

Gleacher Center - 206

Dike Height Optimization in the Netherlands

Cluster: Nonlinear Mixed Integer Programming

Invited Session

Chair: Kees Roos, Professor, Delft University of Technology, Mekelweg 4, Delft, 2628 CD, Netherlands, c.roos@tudelft.nl

1 - A Numerical Method for the Control of Dike Levels in Continuous Time

Sander van der Pijl, Centrum Wiskunde & Informatica, Science Park 123, Amsterdam, 1098 XG, Netherlands, Sander.van.der.Pijl@cwi.nl

The optimal control of dike heights is a trade-off between the investment costs of dike increases and the expected costs due to flooding. The optimization problem is formulated in continuous time and leads to a so-called Hamilton-Jacobi-Bellman equation. It is a system of second order partial differential equations that need to be solved backward in time. This is achieved by combining a finite-difference ENO spacial discretization with a high-order TVD Runge-Kutta time integration method. As an example, the method is applied to compute the optimum control law for the dike heights of the island of Texel, that will be demonstrated.

2 - Computing Safe Dike Heights at Minimal Costs

Kees Roos, Professor, Delft University of Technology, Mekelweg 4, Delft, 2628 CD, Netherlands, c.roos@tudelft.nl, Dick den Hertog, Guoyong Gu

Safe dike heights are crucial for protecting life in the Netherlands and many other regions of the world. We discuss issues that arise when modeling the probability of floods, the expected damage and measures to prevent floods. Our aim is to minimize the sum of future investing costs and expected damage over a long period (of about 300 years). We present a mathematical optimization model and a dynamic programming model, as well as some computational results.

3 - A MINLP Approach for the Non-homogeneous Dike Height Optimization Problem

Ruud Brekelmans, Tilburg University, Warandelaan 2, P.O. Box 90153, Tilburg, 5000LE, Netherlands, r.c.m.brekelmans@uvt.nl, Kees Roos, Dick den Hertog

Dikes in the Netherlands protect a large part of the country against the water. After the serious flood in 1953 a cost-benefit model was developed by van Dantzig to determine optimal dike heights. Recently, Eijgenraam improved and extended van Dantzig's model, to update the dike investment plan. We show how Eijgenraam's approach can be extended to non-homogeneous dikes and model it as an MINLP problem. The goal is to minimize the sum of the expected loss of flooding and the costs of heightening the dikes. We also show a robust optimization approach that deals with the parameter uncertainty.

■ FA19

Gleacher Center - 208

Nonlinear Programming A

Contributed Session

Chair: Eiji Mizutani, NTUST, 43 Keelung Road, Section 4, Taipei, Taiwan - ROC, eiji@mail.ntust.edu.tw

1 - A Gauss-Newton Approach for Solving Constrained Optimization via Exact Penalty Functions

Ellen H. Fukuda, IME-USP, Rua Diogo Vaz, 370, apt. 111, Sao Paulo, 01527-020, Brazil, ellen.ime@gmail.com, Paulo J. S. Silva, Roberto Andreani

We propose a Gauss-Newton-type method for solving nonlinear programming problems with general constraints. It uses an extension of a continuous differentiable exact penalty function for variational inequalities, introduced recently by Andre and Silva, and based on the incorporation of a multiplier estimate in the classical augmented Lagrangian. With a less restrictive assumption, we prove exactness and convergence results. Preliminary numerical experiments are also presented.

2 - A Non-monotonic Method for Large-scale Non-negative Least Squares

Dongmin Kim, University of Texas at Austin, 1 University Station, C0500 Taylor Hall 2.124, Austin, TX, 78712, United States of America, dmkim@cs.utexas.edu, Suvrit Sra, Inderjit Dhillon

We present a method for large-scale non-negative least squares (NNLS) problem. In many applications in astronomy, chemometrics, medical sciences, and information retrieval non-negativity arise naturally, whereby the ordinary least-squares must be replaced by NNLS. Our method extends an unconstrained algorithm of Barzilai and Borwein to handle non-negativity constraints. In contrast to other methods based on BB, our algorithm does not curtail the non-monotonicity of the underlying BB method. Without line-search the BB method has been previously shown not to converge. However, by exploiting some properties of the NNLS objective and the simple constraints our algorithm is guaranteed to converge, despite the absence of line-search.

3 - Efficient Hessian Evaluations by Stagewise Backpropagation in Nonlinear Least Squares Problems

Eiji Mizutani, NTUST, 43 Keelung Road, Section 4, Taipei, Taiwan - ROC, eiji@mail.ntust.edu.tw, Stuart Dreyfus

We demonstrate a neural-network (NN) stagewise backpropagation procedure to evaluate the Hessian matrix H (of size n-by-n) "explicitly" in classical nonlinear least squares problems. A conventional wisdom is that the difference between the evaluation cost of H and that of the so-called Gauss-Newton Hessian is O(n-squared). In contrast, our stagewise procedure reduces it down to O(n-linear) when a given nonlinear model can be formatted as an NN-like layered structure.

■ FA20

Gleacher Center - 300

Large-Scale Nonlinear Optimization

Cluster: Nonlinear Programming
Invited Session

Chair: Jorge Nocedal, Professor, Northwestern University, EECS Dept, Evanston, IL, 60201, United States of America, nocedal@eecs.northwestern.edu

1 - On the Use of Piecewise Linear Models in Nonlinear Programming

Yuchen Wu, PhD Student, Northwestern University, 2145 Sheridan Rd., L375, Evanston, IL, 60208, United States of America, yuchen@northwestern.edu

This paper presents an algorithm for large-scale optimization that attempts to combine the best properties of sequential quadratic programming and sequential linear-quadratic programming methods. It consists of two phases. First, the algorithm constructs a piecewise linear approximation of a quadratic model of the Lagrangian and solves a linear programming problem to determine a working set. The second phase of the algorithm solves an equality constrained sub-problem whose goal is to accelerate convergence toward the solution. The paper studies the global and local convergence properties of the new algorithm and presents a set of numerical experiments to illustrate its practical performance.

2 - An Inequality Constrained Nonlinear Kalman-Bucy Smoother

James Burke, Professor, University of Washington, Box 354350, Seattle, WA, 98195, United States of America, burke@math.washington.edu, Gianluigi Pillonetto, Bradley Bell

Kalman-Bucy smoothers are used to estimate the state variables as a function of time in a system with stochastic dynamics and measurement noise. In this algorithm the number of numerical operations grows linearly with the number of time points. If other information is available, for example a bound on one of the state variables, it is often ignored because it does not fit into the standard Kalman-Bucy smoother algorithm. In this talk we show how an interior point approach to state constraints yields and algorithm whose number of operations also grows linearly with the number of time points by preserving the same decomposition obtained for the unconstrained Kalman-Bucy smoother.

3 - Trust Region Newton Krylov Methods for Nonlinear Systems

Richard Byrd, Professor, University of Colorado, Computer Science Dept., Boulder, CO, 80309, United States of America, richard@cs.colorado.edu, Daniel Crumly

It is well known that Newton's method with a line search can fail when applied to nonlinear systems of equations. The standard alternative is to use a trust region implementation, but this is not feasible for very large nonlinear systems, such as those arising in discretization of PDEs. We describe approximate trust region Newton methods for this problem that use Krylov subspace methods analogous to the Steihaug-Toint method that show promising results.

■ FA21

Gleacher Center - 304

Reliable Network Structures

Cluster: Telecommunications and Networks
Invited Session

Chair: Maren Martens, Zuse Institute Berlin, Takustr. 7, Berlin, 14195, Germany, martens@zib.de

1 - 2-InterConnected Facility Location

Markus Chimani, TU Dortmund, Otto-Hahn-Str 14, Dortmund, 44227, Germany, markus.chimani@cs.uni-dortmund.de, Maren Martens, Maria Kandyba

Connected facility location problems combine cost-efficient facility placement with the requirement to connect the facilities among each other. In telecommunication applications, these facilities often have to form a reliable core network to which we attach the clients, i.e., there have to be at least two disjoint paths within the core between every pair of facilities. We establish the problem class of 2-interConnected Facility Location and categorize its central variants. On the one hand we show NP-hardness of, e.g., approximations. On the other hand we show constructive characterizations that allow feasibility checking, preprocessing, and heuristics. Finally, we show how to solve these problems to provable optimality in practice.

2 - Developing Ring-based Network Structures Allowing Interring Traffic

Silvia Schwarze, University of Hamburg, Von-Melle-Park 5, Hamburg, 20146, Germany, schwarze@econ.uni-hamburg.de, Marco Caserta, Stefan Voss

One approach to ensure reliability in telecommunication networks is to enforce 1+1 protection. That is, for each origin-destination pair, two node-disjoint paths have to be established, an approach which is naturally ensured by rings. We are focusing on the construction of ring-based networks where interring traffic is possible at transit nodes. Given restrictions on ring size in terms of length and number of nodes, we address the question of finding minimum cost network structures, when costs arise at edges (ring kilometres) and nodes (transit traffic). We present results from a real-world case study.

3 - Survivable Two-layer Network Design

Andreas Bley, TU Berlin / Matheon, Strafle des 17. Juni 136, Berlin, D, 10623, Germany, bley@math.tu-berlin.de, Sebastian Orlowski, Christian Raack, Roland Wessaely, Arie M.C.A. Koster

We present an integer programming approach for a survivable two-layer network design problem. This problem arises in the planning of optical communication networks, where traffic demands are routed in a network of logical links, which are paths in an underlying fiber network. We describe our model, reduction techniques and cutting planes, and specially tailored primal heuristics. Finally, we report computational results for realistic instances, which show the effectiveness of our techniques.

■ FA22

Gleacher Center - 306

COIN-OR Open-source Software for Mathematical Programming

Cluster: Implementations, Software
Invited Session

Chair: Robert Fourer, Professor, Northwestern University, Dept. of Industrial Eng & Mgmnt Sciences, 2145 Sheridan Road, Evanston, IL, 60208-3119, United States of America, 4er@iems.northwestern.edu

1 - COIN-OR Triennial Update

Robert Fourer, Professor, Northwestern University, Dept. of Industrial Eng & Mgmnt Sciences, 2145 Sheridan Road, Evanston, IL, 60208-3119, United States of America, 4er@iems.northwestern.edu

The Computational Infrastructure for Operations Research (COIN-OR) initiative was launched 9 years ago at ISMP 2000 to facilitate and encourage development of open software for computational math programming and other OR methods. There has since been considerable growth and development of the initiative, now managed by an independent nonprofit foundation. This update describes opportunities to make use of the initiative,Äôs projects and suggests ways to become part of the COIN-OR community.

2 - Bigger, Better, Faster: Update on World's Fastest Open-source MIP Solver

Laszlo Ladanyi, IBM, 1101 Kitchawan Road, Yorktown Heights, NY, 10598, United States of America, ladanyi@us.ibm.com, Robin Lougee-Heimer, John Forrest

COIN-OR Branch and Cut (Cbc) is the world's fastest open-source mixed-integer program solver. New heuristics, a 2x increase in preprocessing speed, and improved dynamic use of cutting planes have helped realize a significant speedup from version 2.0 (2007) to 2.3 (2008), reducing the geometric mean of time for solved problems by 55% and the problems unsolved within the time limit by 75% on the Mittelmann benchmarks. We survey the recent enhancements and ongoing efforts at further improvement.

3 - New CoinMP Release 1.5: A Simple Free C-API Windows DLL and Unix Solver Library (LP/MIP) based on COIN

Bjarni Kristjansson, President, Maximal Software, Inc., 2111 Wilson Boulevard, Suite 700, Arlington, VA, 22201, United States of America, bjarni@maximalsoftware.com

The COIN Open Source Initiative has become very popular in the recent years. To make life easier for users that simply want to solve models and not compile C++ applications, we have developed a standard C-API Windows DLL CoinMP.DLL that implements most of the functionality of CLP, CBC, and CGL. A Linux/Unix version using AutoMake is also available. We will also discuss how CoinMP is currently used with MPL, and how it plays a major role in the Free Development and the Free Academic programs for MPL.

■ FA23

Gleacher Center - 308

Sparse Optimization A

Contributed Session

Chair: Noam Goldberg, Rutgers University, 640 Bartholomew Rd, Piscataway, United States of America, ngoldberg@rutcor.rutgers.edu

1 - Dual Averaging Methods for Regularized Stochastic Learning and Online Optimization

Lin Xiao, Researcher, Microsoft Research, 1 Microsoft Way, Redmond, WA, 98052, United States of America, lin.xiao@microsoft.com

We consider regularized stochastic learning and online optimization problems, where the objective function is the sum of two convex terms: one is the loss function of the learning task, and the other is a simple regularization term such as 1-norm for sparsity. We develop extensions of Nesterov's dual averaging method that can explicitly exploit the regularization structure in an online setting. The method achieves the optimal convergence rate O(1/sqrt(t)) for general convex regularization, and a faster rate O(log(t)/t) for strongly convex regularization. Computational experiments confirms the effectiveness of the method for l1-regularized online learning.

2 - Rank-Sparsity Incoherence for Matrix Decomposition

Venkat Chandrasekaran, Massachusetts Institute of Technology, 77 Massachusetts Avenue, 32-D570, Cambridge, MA, 02139, United States of America, venkatc@mit.edu, Sujay Sanghavi, Pablo A. Parrilo, Alan S. Willsky

Suppose we are given a matrix that is formed by adding an unknown sparse matrix to an unknown low-rank matrix. Our goal is to decompose the given matrix into its sparse and low-rank components. Such a problem arises in a number of applications in model and system identification, but obtaining an exact solution is NP-hard in general. We consider a convex optimization formulation for the decomposition problem. We develop a notion of rank-sparsity incoherence - a condition under which matrices cannot be both sparse and low-rank - to characterize both fundamental identifiability as well as sufficient conditions for exact recovery using our method.

3 - Sparse Linear Combination of Data Classifiers Through Relaxed L0 Regularization

Noam Goldberg, Rutgers University, 640 Bartholomew Rd, Piscataway, United States of America, ngoldberg@rutcor.rutgers.edu, Jonathan Eckstein

We propose a discrete optimization approach to constructing binary classifiers using sparse linear combination of base classifiers. Instead of minimizing the sum of deviations from the margin with respect to a subset of the input data and an L1 penalty, we minimize the number of misclassified points subject to a generalized L0 penalty. We tighten the LP relaxation of the resulting MIP model with novel cutting planes, and approximately solve the model using a column and cut generation algorithm.

■ FA25

Gleacher Center - 404

Nonsmooth Dynamic Systems and Semi-algebraic Set-valued Maps

Cluster: Variational Analysis
Invited Session

Chair: Jim Zhu, Western Michigan University, 1903 W Michigan Avenue, Kalamazoo, MI, 49008, qiji.zhu@wmich.edu

1 - Generic Continuity of Semi-algebraic Set-valued Maps

C. H. Jeffrey Pang, Dr., Fields Institute, 222 College Street, Toronto, ON, M5T 3J1, Canada, cp229@cornell.edu, Aris Daniilidis

Functions appearing in practice, whether single-valued or set-valued, are often semi-algebraic. Using recent results in tame metric regularity due to Ioffe, we show that a semi-algebraic closed-valued set-valued map is strictly continuous outside a set of strictly smaller dimension than its domain, extending the stratification property of single-valued tame maps. We illustrate some applications of our result, and show a Sard type theorem for minimums for general functions.

2 - Equilibrium Problems on Hadamard Manifolds

Victoria Martìn-Márquez, PhD Student, Universidad de Sevilla, Sevilla, Spain, victoriam@us.es, Genaro López, Vittorio Colao

Several problems in optimization and variational analysis can be formulated as an equilibrium problem in the setting of linear spaces. Our aim is to develop an equilibrium theory in Hadamard manifolds, i. e. complete Riemannian manifolds of nonpositive curvature. In particular, firmly nonexpansive mappings, resolvents and Yosida approximations will be studied in order to approximate either singularities of monotone vector fields or equilibrium points in this setting.

3 - How Many Tricks Does a Variational Analysts Have?

Jim Zhu, Western Michigan University, 1903 W Michigan Avenue, Kalamazoo, MI, 49008, qiji.zhu@wmich.edu

It is said that even a great mathematician has only a few tricks. We will explain that many important tools in convex and nonsmooth analysis are different facets of two basic tricks of variational methods: a variational principle and a decoupling method. We will also discuss interesting directions in which one may need more.

Friday, 2:00pm - 3:30pm

■ FB01

Marriott - Chicago A

Linear Programming

Contributed Session

Chair: Fabio Tardella, Professor, University of Rome La Sapienza Via del C. Laurenziano, 9, Roma, 00161, Italy, fabio.tardella@uniroma1.it

1 - D-Wolfe Decompositions Putting in the Subproblem the Degenerated Constraints of a Linear Problem

Francois Soumis, Professor, Polytechnique, 2900 Chemin de la Tour, Montreal, H3C 3A7, Canada, francois.soumis@gerad.ca

We propose a new Dantzig-Wolfe decomposition based on the improved primal simplex algorithm (IPS). The original problem is partitioned automatically according to its deep algebraic structure rather than by the modeler. Experimental results on some degenerate instances (between 44 and 71%) show that the proposed algorithms yields computational times that are reduced by an average factor ranging between 3.32 and 13.16 compared to the primal simplex of CPLEX.

2 - Dual Face Algorithm for Linear Programming

Ping-Qi Pan, Professor, Southeast University, Dept. of Math., Southeast University, Nanjing, 210096, China, panpq@seu.edu.cn

The proposed algorithm proceeds from dual face to dual face, until reaching a dual optimal face along with a pair of dual and primal optimal solutions, compared with the simplex algorithm, which moves from vertex to vertex. In each iteration, it solves a single small triangular system, compared with four triangular systems handled by the simplex algorithm. We report preliminary but favorable computational results with a set of standard Netlib test problems.

3 - The Fundamental Theorem of Linear Programming: Extensions and Applications.

Fabio Tardella, Professor, University of Rome La Sapienza Via del C. Laurenziano, 9, Roma, 00161, Italy, fabio.tardella@uniroma1.it

We describe a common extension of the fundamental theorem of LP and of the Frank-Wolfe theorem for QP problems. We then show that several known and new results providing continuous formulations for discrete optimization problems can be easily derived and generalized with our result. Furthermore, we use our extension to obtain efficient algorithms and polynomiality results for some nonlinear problems with simple polyhedral constraints, like nonconvex (standard) QP.

■ FB02

Marriott - Chicago B

Applications of Discrete Optimization

Cluster: Discrete Optimization

Chair: Nikolas Tautenhahn, Universitaet Bayreuth, Lehrstuhl fuer Wirtschaftsmathematik, Bayreuth 95440, Germany, nikolas.tautenhahn@uni-bayreuth.de

1 - Conflict-free Univeristy Course Time and Room Scheduling

Tobias Kreisel, Universität Bayreuth, Lehrstuhl Wirtschaftsmathematik, Universitätsstraße 30, 95440 Bayreuth, Bayreuth, Germany, tobias.kreisel@uni-bayreuth.de

Our goal is a conflict-free schedule with respect to courses of study, i.e. two courses of any course of study must not clash. We approach the problem by means of linear integer programming techniques. To handle the inherently large scale decomposition methods are considered. Acceptance issues are addressed by having persons responsible review automatically generated schedules; based on their remarks new schedules are iteratively generated.

2 - Optimal Control of Opinion-forming Dynamics

Sascha Kurz, Research Assistant / PD Doctor, Universität Bayreuth, Universitätsstraße 30, Lehrstuhl für Wirtschaftsmathematik, Bayreuth 95440, Germany, sascha.kurz@uni-bayreuth.de

Affecting the opinion of a group of individuals is the key target of marketing or an election campaign. We assume that the opinions (modeled as real numbers) of the individuals evolve according to the discrete turn-based bounded-confidence model and consider the problem of placing opinions such that after r turns the number of individuals whose opinion is within a given range is maximized. For this problem both exact and heuristic algorithms will be presented.

3 - Fair Assignment of Voting Weights

Nikolas Tautenhahn,Universitaet Bayreuth, Lehrstuhl fuer Wirtschaftsmathematik, Bayreuth 95440, Germany, nikolas.tautenhahn@uni-bayreuth.de

Assume we have a board of n members who have integral voting weights and a quota q so that a proposal is accepted if the number of votes in favor of the proposal meets or exceeds q. Finding voting weights which resemble a fair power distribution (e.~g. Penrose's square-root law) according to some power index (e.~g. the Shapley-Shubik index) is accomplished by complete enumeration of a superclass of voting games. We characterize these discrete structures and enumerate them.

■ FB03

Marriott - Chicago C

Models for Electricity Optimization Under Uncertainty

Cluster: Optimization in Energy Systems
Invited Session

Chair: Paul Johnson, Research Associate, University of Manchester, Alan Turing Building, Oxford Road, Manchester, M13 9PL, United Kingdom, paul.johnson-2@manchester.ac.uk

1 - Numerical Ideas for Two-stage Stochastic Programs with Chance Constraints

Paul Bosch, Universidad Diego Portales, Facultad de Ingenierìa, Ave. Ejército 441, Santiago, Santiago, Chile, paul.bosch@udp.cl

Motivated by problems coming from planning and operational management in power generation companies, this work extents the traditional two-stage linear stochastic program by adding probabilistic constraints in the second stage where we consider that the level of production of energy is limited by the random level of permitted emission. We describe, under special assumptions, how this problem can be treated computationally. As the first idea, we will study the different convex conservative approximations of the chance constraints defined in second stage of our model, and using Monte Carlo simulation techniques for approximate the expectation function in the first stage by the average.

2 - Making Wind Power Tradable by Electricity Storage

Paul Johnson, Research Associate, University of Manchester, Alan Turing Building, Oxford Road, Manchester, M13 9PL, United Kingdom, paul.johnson-2@manchester.ac.uk

PDEs can model the continuous time dynamics of electricity price, a wind generator's output and a jointly operated energy store. We derive an optimal rule for the output rate to commit during the next hour, so as to maximize the expected joint NPV of wind power and storage over many operating days. Results can test the viability of storage, and optimise the joint design of the store, the wind generator(s) and their connection to the distribution system.

■ FB03

Marriott - Chicago C

Models for Electricity Optimization Under Uncertainty

Cluster: Optimization in Energy Systems
Invited Session

Chair: Paul Johnson, Research Associate, University of Manchester, Alan Turing Building, Oxford Road, Manchester, M13 9PL, United Kingdom, paul.johnson-2@manchester.ac.uk

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■ FB04

Marriott - Denver

Combinatorial Optimization K

Contributed Session

Chair: Pavlos Eirinakis, PhD Student, Athens University of Economics and Business, Department of Management Science and Technology, 76 Patission Str., Athens, 10434, Greece, peir@aueb.gr

1 - Sequencing and Scheduling in Coil Coating with Shuttles

Felix Koenig, TU Berlin, Strasse des 17. Juni 136, Berlin, Germany, fkoenig@math.TU-Berlin.DE, Wiebke Hohn, Marco Luebbecke, Rolf Moehring

Applying combinatorial optimization in real life yields cost savings delighting the industry. Beyond that, at the core of some applications also lies a pretty (sub)problem rejoicing the mathematician. In our application coils of sheet metal are coated with k layers out of hundreds of colors. Coils are stapled together to run through k coaters, and non-productive time occurs e.g. when the color in a coater needs to be changed. Some coaters have two parallel tanks, enabling either parallel colors or cleaning of one tank during production. We present our sequencing and scheduling scheme in use at the plant today, lower bounds proving solution quality, and problems in the edge-wise union of interval graphs as a pretty mathematical subproblem.

2 - On Eulerian Extension Problems and Their Application to Sequencing Problems

Wiebke Hohn, TU Berlin, Strasse des 17. Juni 136, Berlin, 10623, Germany, hoehn@math.TU-Berlin.DE, Tobias Jacobs, Nicole Megow

We introduce a new technique for solving several sequencing problems. We consider the Gilmore-Gomory type Traveling Salesman Problem and two variants of no-wait two-stage flowshop scheduling, the classical makespan minimization problem and a new problem arising in the multistage production process in steel manufacturing. Our technique is based on an intuitive interpretation of sequencing problems as Eulerian Extension Problems. This view reveals new structural insights and leads to elegant and simple algorithms and proofs for this ancient type of problems. As a major effect, we compute not only a single solution; instead, we represent the entire space of optimal solutions.

3 - Weighted Stable B-matchings and Their Implications to Supply Chain Networks

Pavlos Eirinakis, PhD Student, Athens University of Economics and Business, Department of Management Science and Technology, 76 Patission Str., Athens, 10434, Greece, peir@aueb.gr, Dimitris Magos, Ioannis Mourtos, Panagiotis Miliotis

The stable b-matching problem is usually defined in the context of a job market and asks for an assignment of workers to firms satisfying the quota of each agent and being stable with respect to given preference lists. In our current work, we present an $O(n^3(\log n)^2)$ algorithm for solving the minimum weight problem, which also applies to special optimality cases. Further, we explore the possibility of applying our work on a multi-sided Supply Chain Network configuration.

■ FB05

Marriott - Houston

Combinatorial Optimization R

Contributed Session

Chair: Luidi Simonetti, Institute of Computing (IC) - University of Campinas (UNICAMP), Caixa Postal 6176, Campinas, SP, 13083-970, Brazil, luidi@ic.unicamp.br

1 - An Exact Method for the Minimum Caterpillar Spanning Problem

Luidi Simonetti, Institute of Computing (IC) - University of Campinas (UNICAMP), Caixa Postal 6176, Campinas, SP, 13083-970, Brazil, luidi@ic.unicamp.br, Cid de Souza, Yuri Frota

A spanning caterpillar in a graph is a tree which has a path such that all vertices not in the path are leaves. In the Minimum Spanning Caterpillar Problem (MSCP) each edge has two costs: a path cost when it belongs to the path and a connection cost when it is incident to a leaf. The goal is to find a spanning caterpillar minimizing the sum of all path and connection costs. Here we formulate the MSCP as a minimum Steiner arborescence problem. This reduction is the basis for the development of an efficient branch-and-cut algorithm for the MSCP. Computational experiments carried out on modified instances from TSPLib 2.1 revealed that the new method is capable to solve to optimality MSCP instances with up to 300 nodes in reasonable time.

■ FB06

Marriott - Kansas City

Conic Programming Approaches to Combinatorial Problems

Cluster: Conic Programming

Invited Session

Chair: Etienne de Klerk, Tilburg University, P.O. Box 90153, Tilburg, 5000 LE, Netherlands, e.deklerk@uvt.nl

1 - Optimizing a Polyhedral-semidefinite Relaxation of Completely Positive Programs

Samuel Burer, University of Iowa, S346 Pappajohn Business Building, Iowa City, IA, 52242-1994, United States of America, samuel-burer@uiowa.edu

It has recently been shown that a large class of NP-hard quadratic minimization problems can be modeled as so-called "completely positive programs." A straightforward convex relaxation of this type of program, while theoretically tractable, is still expensive for interior-point methods. In this talk, we propose a decomposition technique to solve the relaxation, which also readily produces lower bounds on the NP-hard objective value. We illustrate effectiveness of the approach for quadratic box-constrained, quadratic assignment, and quadratic multiple knapsack problems. Further, for the box and knapsack cases, we incorporate the lower bounds within an efficient branch-and-bound implementation.

2 - The Difference Between 5 x 5 Doubly Nonnegative and Completely Positive Matrices

Mirjam Dur, University of Groningen, P.O. Box 407, Groningen, 9700 AK, Netherlands, M.E.Dur@rug.nl, Samuel Burer, Kurt Anstreicher

The convex cone of completely positive (CPP) matrices and its dual cone of copositive matrices arise in several areas of applied mathematics, including optimization. Every CPP matrix is doubly nonnegative (DNN), i.e., positive semidefinite and component-wise nonnegative. Moreover, for n smaller than 5, every DNN matrix is CPP. We investigate the difference between 5 x 5 DNN and CPP matrices. We give a precise charaterization of how a 5 √ó 5 DNN matrix that is not CPP differs from a DNN matrix, and use this charaterization to show how to separate an extreme DNN matrix that is not CPP from the cone of CPP matrices.

3 - Conic Programming Formulations of the Traveling Salesman Problem

Etienne de Klerk, Tilburg University, P.O. Box 90153, Tilburg, 5000 LE, Netherlands, e.deklerk@uvt.nl, Dmitrii Pasechnik

The traveling salesman problem (TSP) is to find a Hamiltonian cycle of minimum weight in a weighted graph, and is arguably the most famous NP-hard problem in combinatorial optimization. We present a conic programming reformulation of TSP, by describing the convex hulls of association schemes, and applying the result to the association scheme of a Hamiltonian cycle (the so-called Lee scheme). The conic programming reformulation of TSP is related to the copositive programming reformulation of the more general quadratic assignment problem from: [Janez Povh, Franz Rendl: Copositive and Semidefinite Relaxations of the Quadratic Assignment Problem, to appear in Discrete Optimization, 2009].

■ FB07

Marriott - Chicago D

Integer and Mixed Integer Programming K

Contributed Session

Chair: Elvin Coban, Carnegie Mellon University, 5000 Forbes Avenue, Tepper School of Business, Pittsburgh, PA, 15213, United States of America, ecoban@andrew.cmu.edu

1 - New World of Discrimination – Do I Discover the New World as Same as Christopher Columbus

Shuichi Shinmura, Professor, Seikei Universtiy, 3-3-1 Kichijoji Kitamachi,Musashino-shi, Tokyo, Japan, shinmura@econ.seikei.ac.jp

Discrimination is very important in the science. It is approached from the statistics and mathematical programming such as SVM. Several discriminant models are developed by IP and LP. Especially, IP-OLDF based on minimum misclassification number criterion reveals new surprised facts about discrimination. It is evaluated by training data (four kinds of data sets) and evaluation data (100 sets of re-sampling data). LINGO models prove its robustness (generalization ability).

2 - On the Polyhedral Properties of a Discrete-time MIP Formulation for Production Planning

Konstantinos Papalamprou, PhD Student, London School of Economics and Political Science, Operational Research Group, London School of Economics,Houghton Str., London, WC2A 2AE, United Kingdom, k.papalamprou@lse.ac.uk, Christos Maravelias

We study the properties of the polyhedron defined by the constraints of a discrete-time mixed integer programming formulation for the production planning of chemical processes. This formulation is decomposed into two subproblems and polyhedral results regarding their linear programming relaxations are provided. Furthermore, we show how extensions of total unimodularity can be used. We are mainly concerned with k-regularity and we show how this property can be used in order to address large scale production planning problems. We are also focused on presenting special cases of this problem for which combinatorial algorithms can be applied.

3 - Single-machine Scheduling over Long Time Horizons by Logic-based Benders Decomposition

Elvin Coban, Carnegie Mellon University, 5000 Forbes Avenue, Tepper School of Business, Pittsburgh, PA, 15213, United States of America, ecoban@andrew.cmu.edu, John Hooker

We use logic-based Benders decomposition to minimize tardiness in single-facility scheduling problems with many jobs and long time horizons. Release dates and due dates are given. An MILP-based master problem allocates jobs to segments of the time horizon, and a constraint programming-based subproblem schedules the jobs in each segment. Computational results are reported on the success of decomposition for scaling up exact solution methods for problems of this kind.

■ FB08

Marriott - Chicago E

Trends in Mixed Integer Programming IX

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Andrea Lodi, DEIS, University of Bologna, Viale Risorgimento, 2, Bologna, 40136, Italy, andrea.lodi@unibo.it

Co-Chair: Robert Weismantel, Professor, Otto-von-Guericke University Magdeburg, Institute for Mathematical Optimization, Universitaetsplatz 2, Magdeburg, 39106, Germany, weismant@mail.math.uni-magdeburg.de

1 - A Study of MIP Branching Direction Heuristics

John Chinneck, Professor, Carleton University, Systems and Computer Engineering, 1125 Colonel By Drive, Ottawa, ON, K1S 5B6, Canada, chinneck@sce.carleton.ca, Jennifer Pryor

The branching direction heuristic used in a MIP solver has a significant impact on the solution speed. We report on an extensive empirical study of branching direction selection heuristics used in reaching the first integer-feasible solution. The conventional wisdom about branching up is examined, and a new method that performs well is introduced.

2 - An Extended Formulation for the Traveling Salesman Problem with Time Windows

Andrea Tramontani, DEIS, University of Bologna, Viale Risorgimento, 2, Bologna, 40136, Italy, andrea.tramontani@unibo.it, Sanjeeb Dash, Oktay Gunluk, Andrea Lodi

The Traveling Salesman Problem with Time Windows (TSPTW) is a well known generalization of the classical TSP where each node must be visited within a given time window. We present an extended integer linear programming formulation for TSPTW, based on a relaxed discretization of time windows. The proposed formulation yields strong lower bounds and leads to strong valid inequalities which can be efficiently separated within a classical branch-and-cut framework. The resulting branch-and-cut algorithm is tested on hard benchmark instances from the literature. The results show that the proposed formulation is effective in practice for tackling TSPTW. Interestingly, several unsolved benchmark instances are here solved for the first time.

3 - Computational Results on the Cunningham-Geelen Algorithm for Solving Integer Programs

Susan Margulies, Pfeiffer-VIGRE Post-doctoral Instructor, Rice University, Dept. of Computational and Applied Math, 6100 Main P.O. Box 1892, Houston, TX, 77251, United States of America, susan.margulies@rice.edu, Illya Hicks, Jing Ma

Consider the integer program max(c^Tx : Ax = b, x >= 0,) where A is non-negative and the column-matroid of A (denoted by M(A)) has constant branch width. Cunningham and Geelen introduce a pseudo-polynomial time algorithm for solving this integer program that takes a branch decomposition T of M(A) as input. We describe a heuristic for finding T and report on computation results of a C++ implementation of this algorithm, where the input branch decomposition T is produced by this heuristic.

■ FB09

Marriott - Chicago F

Branch-and-Price IV

Cluster: Integer and Mixed Integer Programming
Invited Session

Chair: Marco Luebbecke, TU Berlin, Institute of mathematics, Strasse des 17. Juni 136, Berlin, 10623, Germany, m.luebbecke@math.tu-berlin.de

1 - DECOMP: A Framework for Decomposition in Integer Programming

Matthew Galati, Optimization Interface Lead, SAS Institute, Philadelphia Regional Office, Suite 201, 1400 Morris Drive, Chesterbrook, PA, 19087, United States of America, Matthew.Galati@sas.com, Ted Ralphs

Decomposition techniques such as Lagrangian Relaxation and Dantzig-Wolfe decomposition are well-known methods of developing bounds for discrete optimization problems. We draw connections between these classical approaches and techniques based on dynamic cut generation. We discuss methods for integrating cut generation and decomposition in a number of different contexts and present DECOMP, an open-source framework that provides a uniform interface for implementation of these various techniques.

2 - Solving Steel Mill Slab Problems with Branch-and-Price

Stefan Heinz, Zuse Institute Berlin, Takustr, Berlin, Germany, heinz@zib.de, Thomas Schlechte, Ruediger Stephan

In this talk we introduce a branch-and-price approach for the steel mill slab problem which is problem 38 of the CSPLib. We show how this approach can be easily realized in the branch-and-price framework SCIP. Finally, we present computational results which prove that this method is superior to the previous approaches.

3 - Partial Path Column Generation for the ESPPRC

Mads Kehlet Jepsen, PhD Student, Technical University of Denmark, Produktionstorvet bygn. 424, Kgs. Lyngby, 2800, Denmark, mitzi@diku.dk, Bjorn Petersen

This talk introduces a decomposition of the Elementary Shortest Path Problem with Resource Constraints(ESPPRC), where the path is combined by smaller sub paths. We show computational result by comparing different approaches for the decomposition and compare the best of these with existing algorithms. We show that the algorithm for many instances outperforms a bidirectional labeling algorithm.

■ FB10

Marriott - Chicago G

Black-box Optimization of Expensive Functions with Many Variables and Many Nonlinear Constraints

Cluster: Global Optimization
Invited Session

Chair: Don Jones, General Motors, 3023 Sylvan Drive, Royal Oak, MI, 48073, don.jones@gm.com

1 - Radial Basis Function Algorithms for Large-scale Nonlinearly Constrained Black-box Optimization

Rommel Regis, Assistant Professor, Saint Joseph's University, Mathematics Department, 5600 City Avenue, Philadelphia, PA, 19131, United States of America, rregis@sju.edu

We develop derivative-free optimization algorithms that are suited for expensive black-box objective functions with many variables and many nonlinear black-box constraints. Our algorithms utilize radial basis function models to approximate the objective function and the black-box constraints and to identify promising function evaluation points for subsequent iterations. We present some numerical results on a black-box optimization problem in the automotive industry.

2 - Implementation of a One-stage EGO Algorithm

Nils-Hassan Quttineh, PhD Student, Mälardalen University, U3-269, Högskoleplan 1, Rosenhill, Västerås, 721 23, Sweden, nisse.quttineh@mdh.se, Kenneth Holmström

The original EGO algorithm finds a new point to sample in a two-stage process. First, the interpolation parameters are optimized with respect to already sampled points, then in a second step these estimated values are considered true in order to optimize the location of the new point. The use of estimated values introduces a source of error. Instead, in the One-Stage EGO algorithm, both parameter values and the location of a new point are optimized at once, removing the source of error. The new subproblem becomes more difficult, but eliminates the need of solving two subproblems. Difficulties in implementing a fast and robust One-Stage EGO algorithm in TOMLAB are discussed, especially the solution of the new subproblem.

3 - Enhancements to the Expected Improvement Criterion

Alexander Forrester, Lecturer, University of Southampton, School of Engineering Sciences, University Road, Southampton, SO17 1BJ, United Kingdom, Alexander.Forrester@soton.ac.uk, Don Jones

Optimization methods relying on kriging surrogate models often use the "expected improvement" criterion. Unfortunately, with sparse sampling (few points in many dimensions), the prediction error in the kriging models may be severely underestimated, resulting in an excessively local search. A modification of the standard method is presented which avoids the underestimation of error and thereby ensures bias towards global search.

■ FB11

Marriott - Chicago H

Robust Optimization B

Contributed Session

Chair: Jeff Linderoth, Associate Professor, University of Wisconsin-Madison, 1513 University Avenue, Madison, WI, 53706, United States of America, linderot@cae.wisc.edu

1 - Design Optimization Under Uncertainty Using Clouds

Martin Fuchs, CERFACS, 42 avenue Gaspard Coriolis, Toulouse, F-31057, France, martin.fuchs81@gmail.com

Bilevel design optimization problems with nonlinear black box objective functions constrained by mixed integer design choices arise naturally in uncertain real-world models. We represent uncertainties by a polyhedral cloud in the inner level which allows us to model incomplete information even in case of a large number of uncertain parameters. We propose a solution approach, highlight the difficulties and discuss how to overcome them.

2 - Robustness in Multi-objective Optimization Based on a User Perspective

Peter Lindroth, Chalmers University of Technology / Volvo 3P, Chalmers Tvargata 3, Gothenburg, SE-41296, Sweden, peter.lindroth@chalmers.se, Christoffer Cromvik

The question of robustness is essential for practical problems that are sensitive to small perturbations in the variables or the model parameters. We present a new definition of robustness of solutions to multi-objective optimization problems. The definition is based on an approximation of the underlying utility function for each decision maker. We show an efficient computational procedure to evaluate robustness, and we present numerical results for real-world problems.

■ FB12

Marriott - Los Angeles

Inverse Problems and Mathematical Imaging

Cluster: PDE-constrained Optimization
Invited Session

Chair: Eldad Haber, Emory University, 400 Dowman Drive, E414, 30322, United States of America, haber@mathcs.emory.edu

1 - Polynomial Time Algorithms for Clustering and Image Segmentation Problems

Dorit Hochbaum, Professor, UC Berkeley, Haas School of Business and, IEOR department Etcheverry Hall, Berkeley, Ca, 94720, United States of America, hochbaum@ieor.berkeley.edu

We address here a few clustering problems common in the image segmentation literature. We devise here the first known polynomial time algorithms solving optimally bi-criteria clustering problems including the ratio region problem, a variant of normalized cut, as well as a few other ratio problems in clustering and a model of the co-segmentation problem. The algorithms are efficient and combinatorial and are based on the use of an s,t-cut procedure as a subroutine.

2 - Constrained Sparse Poisson-intensity Reconstruction Algorithm for Compressive Imaging

Roummel Marcia, Duke University, 3424 CIEMAS, Durham, NC, 27708, United States of America, roummel@ee.duke.edu, Rebecca Willett, Zachary Harmany

The problem addressed in this talk is the estimation of a signal from data in a photon-limited compressed sensing (CS) context. The noise in this setting is not additive, zero-mean, Gaussian noise, and therefore, the conventional l2-l1 CS optimization approach will be ineffective. We recently developed photon-limited CS theory that uses a Poisson process to model the noise in this setting. The resulting optimization problem uses a negative log-likelihood objective function with non-negativity constraints (since photon intensities are naturally nonnegative). This talk explores computational methods for solving the constrained photon-limited CS problem.

3 - Nonsmooth Minimization with Spatially Adapted Regularization Parameter

Maria Rincon Camacho, PhD Student, University of Graz, Institute of Mathematics and Scientific, Heinrichstrasse 36, Graz, 8010, Austria, maria.rincon-camacho@uni-graz.at, Michael Hintermueller

A total variation (TV) model with a L1 fidelity term and a spatially adapted regularization parameter is presented in order to reconstruct images contaminated by impulse noise. This model intends to preserve small details while homogeneous features are still smooth. The regularization parameter is locally adapted according to a local mean estimator depending on the statistical characteristics of the noise. The solution of the L1-TV minimization problem is obtained by a superlinearly convergent algorithm based on Fenchel-duality and inexact semismooth Newton techniques, which is stable with respect to noise in the data. Numerical results justifying the advantage of such a regularization parameter choice rule are presented.

■ FB13

Marriott - Miami

Derivative-free and Simulation-based Optimization A

Contributed Session

Chair: Wolfgang Hess, Technische Universitaet Darmstadt, Fachbereich Mathematik, Schlossgartenstr. 7, Darmstadt, 64289, Germany, whess@mathematik.tu-darmstadt.de

1 - Shape Optimization Governed by the Linear Elasticity Equations

Wolfgang Hess, Technische Universitaet Darmstadt, Fachbereich Mathematik, Schlossgartenstr. 7, Darmstadt, 64289, Germany, whess@mathematik.tu-darmstadt.de, Stefan Ulbrich

Shape optimization can be applied to support the product development of profiles manufactured using sheet metal forming. We present an efficient multilevel SQP method for the nonconvex geometry optimization problems that arise in this context, though it is also suited for other design problems. We use detailed PDE-based models, e.g., 3D linear elasticity for stiffness optimization. Our algorithm employs nested iterations and uses a posteriori error estimators to generate adaptively refined meshes. Numerical results are presented.

■ FB14

Marriott - Scottsdale

Game Theory A

Contributed Session

Chair: G Ravindran, Head, SQC and OR Unit, Indian Statistical Institute Chennai Centre, Old No.110, New No.37, I Floor, Nelson Manickam Road, Aminjikarai, Chennai, TN, 600029, India, gravi@hotmail.com

1 - On Techniques to Solve Perfect Information Stochastic Games

G Ravindran, Head, SQC and OR Unit, Indian Statistical Institute Chennai Centre, Old No.110, New No.37, I Floor,, Nelson Manickam Road, Aminjikarai, Chennai, TN, 600029, India, gravi@hotmail.com, Nagarajan Krishnamurthy, T Parthasarathy

We discuss techniques to solve 2-player, Perfect Information Stochastic Games and some subclasses. We look at solving these games through Linear Complementarity Problem (LCP) formulations and Vertical LCP formulations. We also discuss feasibility of solving different Linear Programs (LP) simultaneously.

2 - On the Structure of Simple Stochastic Games and Algorithms to Solve Them

Nagarajan Krishnamurthy, PhD Student, Chennai Mathematical Institute, Plot H1, SIPCOT IT Park,, Padur PO, Siruseri., Kancheepuram District, TN, 603103, India, naga.research@gmail.com, T Parthasarathy, G Ravindran

We study the structure of Simple Stochastic Games (SSG) and propose new Linear Complementarity Problem (LCP) formulations. We analyze the structure of the underlying matrices in these formulations and discuss feasibility of solving them. We also discuss polynomial time algorithms to solve some subclasses of SSGs.

■ FB15

Gleacher Center - 100

Stochastic Programming

Cluster: Stochastic Optimization

Invited Session

Chair: Urmila Diwekar, President, Vishwamitra Research Institute, 368 56th Street, Clarendon Hills, IL, 60514, US Minor Outlying Islands, urmila@vri-custom.org

1 - A Novel Stochastic Programming Algorithm for Minimization of Fresh Water Consumption in Power Plants

Juan Salazar, Vishwamitra Research Institute, 368 56-th Street, Clarendon Hills, IL, 60514, United States of America, juan@vri-custom.org, Steven Zitney, Urmila Diwekar

Coal-fired power plants are widely recognized as major water consumers. Water consumption in thermoelectric generation is affected by uncertain variables like atmospheric conditions and power demand. Employment of a novel better optimization of nonlinear uncertain systems (BONUS) algorithm dramatically decreased the computational requirements of the stochastic optimization for this problem.

2 - Computational Experience of Solving Two-stage Stochastic Linear Programming Problems

Viktar Zviarovich, CARISMA, Brunel University, UB8 3PH, Uxbridge (Middlesex), United Kingdom, viktar.zviarovich@brunel.ac.uk, Gautam Mitra, Csaba Fabian, Francis Ellison

We present a computational study of two-stage SP models for a range of benchmark problems. We consider application of Simplex method and IPM to solve deterministic equivalent problems, Benders decomposition and two regularisation methods. The first method is experimental and has not been considered in the literature before. The second is based on the level decomposition of the expected recourse function by Fabian and Szoke. The scale-up properties and the performance profiles are presented.

3 - L-Shaped BONUS Algorithm for Large Scale Stochastic Nonlinear Programming Problem Solution

Yogendra Shastri, University of Illinois at Urbana-Champaign, Urbana-Champaign, IL, United States of America, yogendra@vri-custom.org, Urmila Diwekar

The class of stochastic nonlinear programming (SNLP) problems is important in optimization due to the presence of nonlinearity and uncertainty in many applications related to mathematical programming. This work proposes a new algorithm called L-shaped BONUS to solve the SNLP problems in a computationally efficient manner. The algorithm has been applied to solve various problems to illustrate the computational advantages.

■ FB16

Gleacher Center - 200

Stochastic Optimization H

Contributed Session

Chair: Yuntao Zhu, Assistant Professor, Arizona State University, P.O. Box 37100, Phoenix, AZ, 85069-7100, United States of America, yuntao.zhu@asu.edu

1 - Colorful Carathéodory Selections from Convex Hulls of Unions & Sumsets, for Variational Analysis

James E. Blevins, Uppsala University, Statistics Department (Ekonomikum), Box 513, Uppsala, 751 20, Sweden, James.Blevins@statistik.uu.se

Carathéodory's lemma was generalized for unions & sums (Bár·ny; Shapley Folkman). Algorithms for computing colourful Caratheodory (CC) selections are proposed; their polynomial time complexities proved. In Banach spaces of Rademacher type p>1, randomized methods for sparse convex approximation use CC selections. Whether convexified or not, the unions & sums of (nonconvex) setsósubdifferentials, epigraphs & levelsetsóconcern variational analysis, nonsmooth optimization & stochastic programming.

2 - Stochastic Semidefinite Programming under Uncertainty

Yuntao Zhu, Assistant Professor, Arizona State University, P.O. Box 37100, Phoenix, AZ, 85069-7100, United States of America, yuntao.zhu@asu.edu, K. A. Ariyawansa

In this talk we introduce a new stochastic optimization paradigm termed Stochastic Semidefinite Programming (SSDP). The formulation of SSDP is stressed as well as applications and solving algorithms.

■ FB17

Gleacher Center - 204

Logistics and Transportation G

Contributed Session

Chair: Mette Gamst, PhD Student, Technical University of Denmark, Produktionstorvet, Building 426, Room 58, Kgs. Lyngby, 2800, Denmark, gamst@man.dtu.dk

1 - A Heuristic Approach for the Team Orienteering Problem

Francisco Viana, MSc., PUC-Rio, Barata Ribeiro 502/509, Rio de Janeiro, Brazil, henrique.viana@gmail.com

The Team Orienteering Problem is a variant of the VRP. There is a set of points and a profit is collected for the visit of each point. A fleet is available to visit them. Then, the objective is construct a set of routes such that the total collected reward received from visiting a subset of the customers is maximized. The route length is restricted by a limit. This approach generates an initial solution by taboo search. After, the algorithm minimizes the smallest route to insert more customers.

2 - Models for Designing Trees with Node Dependent Costs

Pedro Moura, DEIO - CIO, Faculdade de Ciencias da Universidade de Lisboa, Campo Grande, Bloco C6 - Piso 4, Lisbon, 1749-016, Portugal, pmmoura@fc.ul.pt, Luis Gouveia

We discuss models for a variant of the classical Minimum Spanning Tree Problem and the Prize-Collecting Steiner Tree Problem where, besides the traditional costs/prizes in the objective function we include a concave modular cost function which depends on the degree value of each node in the solution. Computational results taken from instances with up to 100 nodes will be presented.

3 - An Exact Solution Approach for the Maximum Multicommodity K-splittable Flow Problem

Mette Gamst, PhD Student, Technical University of Denmark, Produktionstorvet, Building 426, Room 58, Kgs. Lyngby, 2800, Denmark, gamst@man.dtu.dk, Bjorn Petersen

This talk concerns the NP-hard Maximum Multicommodity k-splittable Flow Problem (MMCkFP) in which each commodity may use at most k paths between its origin and its destination. A new branch-and-cut-and-price algorithm is presented. The master problem is a two-index formulation of the MMCkFP and the pricing problem is the shortest path problem with forbidden paths. A new branching strategy forcing and forbidding the use of certain paths is developed. The new branch-and-cut-and-price algorithm is computationally evaluated and compared to results from the literature. The new algorithm shows very promising performance by outperforming existing algorithms for several instances.

FB18

Gleacher Center - 206

Dynamic Networks

Cluster: Nonlinear Mixed Integer Programming
Invited Session

Chair: Alexander Martin, Technische Universitaet Darmstadt, FB Mathematik, AG 7, Schlossgartenstr. 7, Darmstadt, D-64289, Germany, martin@mathematik.tu-darmstadt.de

1 - Discrete-Continuous Optimal Control with PDEs on Networks

Oliver Kolb, Technische Universitaet Darmstadt, Schlossgartenstr. 7, Darmstadt, Germany, Oliver.Kolb@gmx.net

This talk deals with the solution of discrete-continuous optimization problems for flow processes in gas and water supply networks. The aim is to run the network cost-efficiently whereas demands of consumers have to be satisfied. This results in a complex nonlinear mixed integer problem. We address this task with methods provided by discrete and continuous optimization. We present numerical simulation and optimization results based on our models.

2 - Adaptive Piecewise Linearization in MIP Optimization of PDE-constrained MINLPs

Antonio Morsi, Technische Universitaet Darmstadt, FB Mathematik, AG 7, Schlossgartenstr. 7, Darmstadt, D-64289, Germany, morsi@mathematik.tu-darmstadt.de, Oliver Kolb, Jens Lang, Bjoern Geissler, Alexander Martin

Adaptive grid refinement is an effective way to reduce the complexity of a problem while keeping the accuracy of the solution. We formulate a MIP model using piecewise linearizations (PWL) to represent nonlinearities in a discretized pde model. We show how to use an adaptive refinement strategy of the PWL to reduce the complexity of the solution process of this MIP based on error estimators. Applications of water and gas network optimization will reveal its practical benefits.

3 - MIP Relaxations of Nonconvex MINLPs by Piecewise Linear Approximation

Bjoern Geissler, Technische Universitaet Darmstadt, FB Mathematik, AG 7, Schlossgartenstr. 7, Darmstadt, D-64289, Germany, geissler@mathematik.tu-darmstadt.de, Antonio Morsi, Alexander Martin

We present a method for constructing arbitrary tight mixed integer linear relaxations of nonconvex MINLPs. Our method starts with constructing a piecewise linear approximation of the nonlinearities. Next, we use convex underestimators and concave overestimators to calculate upper bounds for the linearization error on each simplex. Finally, we use this information to build bounding volumes around the graphs of the nonlinear functions. These bounding volumes can be modeled in terms of mixed integer linear constraints by applying slightly modified versions of well-known MIP-techniques for piecewise linear functions.

FB20

Gleacher Center - 300

Nonlinear Programming D

Contributed Session

Chair: Darin Mohr, University of Iowa, 15 MacLean Hall, Iowa City, IA, 52242-1419, United States of America, dgmohr@math.uiowa.edu

1 - Hybrid Algorithms for Unconstrained Optimization Problems

Darin Mohr, University of Iowa, 15 MacLean Hall, Iowa City, IA, 52242-1419, United States of America, dgmohr@math.uiowa.edu

Quasi-Newton algorithms are widely used in unconstrained optimization while Runge-Kutta methods are widely used for the numerical integration of ODEs. In this work we consider hybrid algorithms combining low order implicit Runge-Kutta methods for gradient systems and quasi-Newton type updates of the Jacobian matrix such as the BFGS update.

FB21

Gleacher Center - 304

Incentives and Pricing

Cluster: Telecommunications and Networks
Invited Session

Chair: Rudolf Mueller, Maastricht University, Department of Quantitative Economics, Maastricht, Netherlands, R.Muller@KE.unimaas.nl

1 - Optimal Mechanism Design for Single Machine Scheduling

Marc Uetz, University of Twente, Applied Mathematics, P.O. Box 217, Enschede, 7500 AE, Netherlands, m.uetz@utwente.nl, Birgit Heydenreich, Debasis Mishra, Rudolf Mueller

Optimal mechanism design is concerned with coordinating the selfish behavior of noncooperative agents, while minimizing the total expected cost for the mechanism designer. We study optimal mechanisms in settings where job-agents compete for being processed on a single machine. We derive closed formulae for the one dimensional case, showing that the problem is solvable in polynomial time. We also discuss difficulties with the two dimensional case, suggesting that the problem might be hard.

2 - Characterizing Incentive Compatibility for Convex Valuations

Seyed Hossein Naeemi, Maastricht University, Department of Quantitative Economics, P.O. Box 616, Maastricht, 6200 MD, Netherlands, h.naeemi@maastrichtuniversity.nl, Andre Berger, Rudolf Mueller

We characterize implementability in dominant strategies of social choice functions when types are multi-dimensional, sets of outcomes are arbitrary, valuations for outcomes are convex functions in the type, and utilities are quasi-linear. We generalize a result by Archer and Kleinberg (2008) showing that for linear valuation functions on convex type domains monotonicity in combination with locally disappearing path-integrals on triangles are equivalent with implementability. Using our characterization, we generalize a theorem by Saks and Yu (2005), showing that for finite set of outcomes monotonicity alone is sufficient, to convex valuations. This provides a very short proof for the special case of linear valuations.

3 - Pricing in Networks

Martin Hoefer, RWTH Aachen University, Informatik I, Ahornstrasse 55, Aachen, D-52074, Germany, mhoefer@cs.rwth-aachen.de, Luciano Guala, Carmine Ventre, Piotr Krysta, Patrick Briest

We consider a general model for pricing in networks. A seller has to set revenue maximizing prices for a subset of network connections. Customers decide upon their purchase by efficiently optimizing a minimization problem such as MST or shortest path. We present a general approximation algorithm for revenue maximization in this model and improved results for special cases. We also consider the case, in which the optimization problem for customers is NP-hard and they use approximation algorithms.

■ FB25

Gleacher Center - 404

Proximal Point Methods and Infinite Dimensional Control

Cluster: Variational Analysis
Invited Session

Chair: Alexander Zaslavski, Professor, Technion Israel Institute of Technology, Haifa, Israel, ajzasl@techunix.technion.ac.il

1 - Exact Finite Approximations of Average-cost Countable Markov Decision Processes

Arie Leizarowitz, Professor, Technion-Israel Institute of Technology, Department of Mathematics, Israel, la@techunix.technion.ac.il, Adam Shwartz

We introduce an embedding of a countable Markov decision process which produces a finite Markov decision process. The embedded process has the same optimal cost, and shares dynamics of the original process within the approximating set. The embedded process can be used as an approximation which, being finite, is more convenient for computation and implementation.

2 - A Proximal Point Method in Nonreflexive Banach Spaces

Elena Resmerita, Johannes Kepler University, Institute of Industrial Mathematics, Linz, 4040, Austria, elena.resmerita@jku.at, Alfredo Iusem

We propose an inexact version of the proximal point method and study its properties in nonreflexive Banach spaces, both for the problem of minimizing convex functions and of finding zeroes of maximal monotone operators. Using surjectivity results for enlargements of maximal monotone operators, we prove existence of the iterates in both cases. Then we recover most of the convergence properties known to hold in reflexive and smooth Banach spaces for the convex optimization problem.

3 - Version of the Second Welfare Theorem for Welfare Economies with Public Goods

Aychiluhim Habte, Benedict College, 1600 Harden Street, Columbia, United States of America, habtea@benedict.edu, Boris Mordukhovich

In this paper we have considered nonconvex infnite dimensional welfare economic model with public goods and obtained necessary optimality conditions, a version of the second welfare theorem, in both approximate and exact forms. The approximate forms are expressed in terms of Fraµechet normal cone and the exact forms are expressed in terms of the basic normal cones. Our main tool from variational analysis is the so called extremalprinciple.