The 5th Sino-Japan Optimization Meeting

September 26-29, 2011

Beijing, China

http://lsec.cc.ac.cn/~sjom

The 5th Sino-Japan Optimization Meeting

September 26-29, 2011

Beijing, China

http://lsec.cc.ac.cn/~sjom

Information for Participants

Conference Site

Conference Site:	Si-Yuan Building, Academy of Mathematics and Systems Science (AMSS), Chinese Academy of Sciences (CAS)
Address:	No. 55, Zhong Guan Cun East Road, Hai Dian District, Beijing, CHINA

Reception & On-site Registration

Reception and on-site registration will take place simultaneously in two venues on September 25:

- September 25, 9:00-18:00, lobby of Jade Palace Hotel.
- September 25, 9:00-18:00, lobby of Institute of Computational Mathematics and Scientific/Engineering Computing (ICMSEC), AMSS, CAS.

If you are accommodated at Jade Palace, please register at the hotel; otherwise, please register at ICMSEC, AMSS, CAS. If you want to register at other time, please contact our conference secretary Ms. Ji-ping Wu.

Currency

Chinese currency is RMB. The current rate is about 6.38 RMB for 1 US dollar. The exchange of foreign currency can be done at the airport or the conference hotel (Jade Palace Hotel). Please keep the receipt of the exchange so that you can change back to your own currency if you have RMB left before you leave China.

From Jade Palace to AMSS

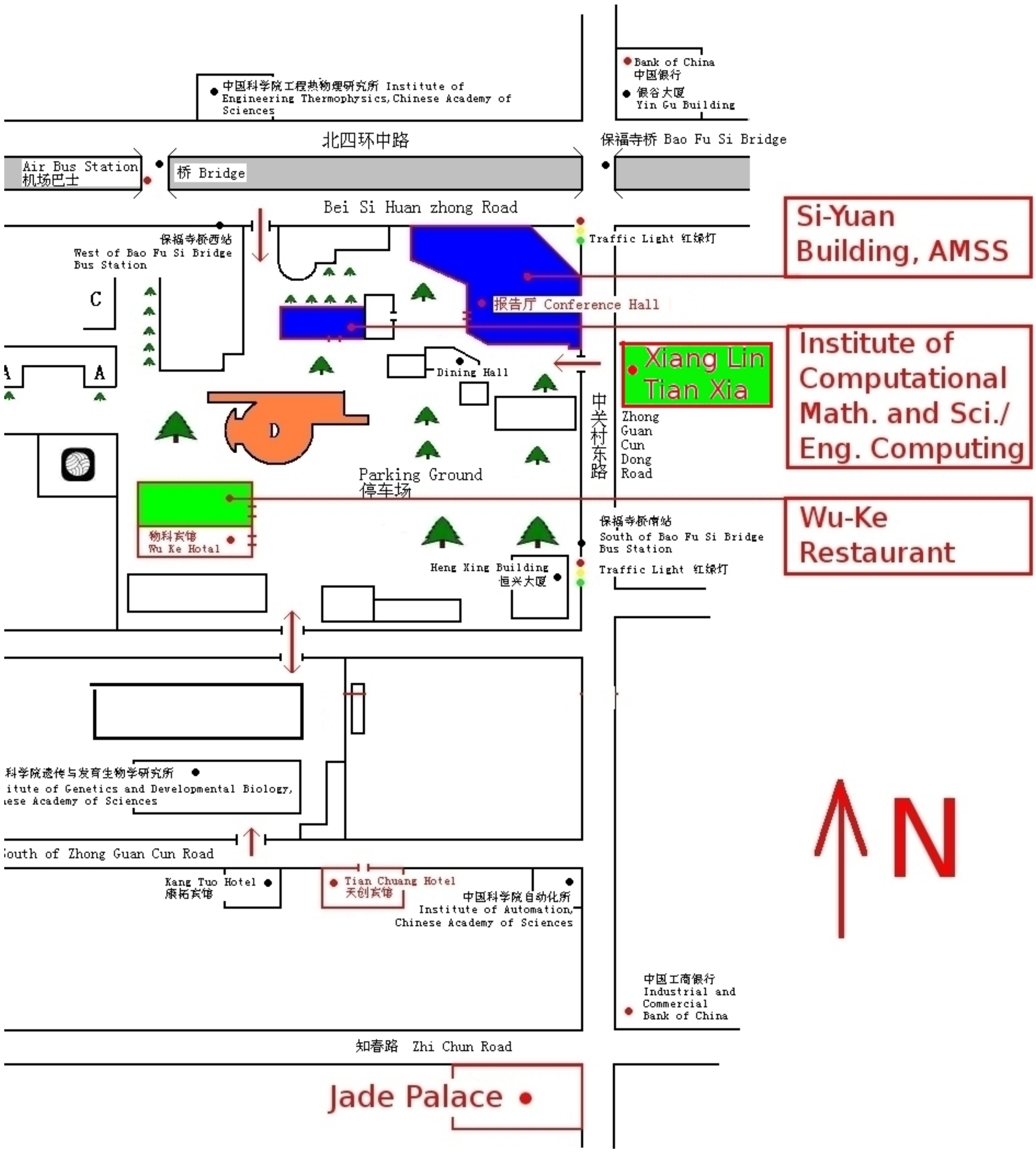
For participants accommodated at Jade Palace: in each morning of September 26-28, Dr. Xin Liu and Miss Cong Sun will guide you to the conference site at AMSS. You will set off punctually at 8:00 a.m., from the lobby of Jade Palace. Please wait in the lobby in advance. There will be only one guidance each morning. If you miss it, you will have to go to the conference site by yourself.

Contact Information

If you need any help, please contact the conference secretaries:

- Ms. Ji-ping Wu: +86-136-9106-6084 (in Chinese).
- Mr. Zaikun Zhang: +86-159-0152-1357.

Local Map



中国科学院工程热物理研究所 Institute of Engineering Thermophysics, Chinese Academy of Sciences
Bank of China
中国银行
银谷大厦
Yin Gu Building
北四环中路
保福寺桥 Bao Fu Si Bridge
Air Bus Station
机场巴士
桥 Bridge
Bei Si Huan zhong Road
保福寺桥西站
West of Bao Fu Si Bridge Bus Station
Traffic Light 红绿灯
Si-Yuan Building, AMSS
报告厅 Conference Hall
C
A
A
Xiang Lin Tian Xia
Institute of Computational Math. and Sci./ Eng. Computing
Dining Hall
D
中关村东路
Zhong Guan Cun Dong Road
Parking Ground
停车场
物科宾馆
Wu Ke Hotal
Wu-Ke Restaurant
保福寺桥南站
South of Bao Fu Si Bridge Bus Station
Heng Xing Building
恒兴大厦
Traffic Light 红绿灯
科学院遗传与发育生物学研究所
itute of Genetics and Developmental Biology,
iese Academy of Sciences
N
South of Zhong Guan Cun Road
Kang Tuo Hotel
康拓宾馆
Tian Chuang Hotel
天创宾馆
中国科学院自动化所
Institute of Automation, Chinese Academy of Sciences
中国工商银行
Industrial and Commercial Bank of China
知春路 Zhi Chun Road
Jade Palace

Sponsors

National Natural Science Foundation of China

Chinese Academy of Sciences

Academy of Mathematics and Systems Science

State Key Laboratory of Scientific and Engineering Computing

Institute of Computational Mathematics and
Scientific/Engineering Computing

Center for Optimization and Applications, AMSS

Committees

Steering Committee

X.J. Chen (Hong Kong Polytechnic University)

S. Fujishige (Kyoto University)

M. Fukushima (Kyoto University)

J.Y. Han (Chinese Academy of Sciences)

B.S. He (Nanjing University)

H. Kawasaki (Kyushu University)

M. Kojima (Tokyo Institute of Technology)

M. Kubo (Tokyo University of Marine Science and Technology)

D. Li (Chinese University of Hong Kong)

L.Z. Liao (Hong Kong Baptist University)

S. Mizuno (Tokyo Institute of Technology)

K. Murota (University of Tokyo)

H. Nagamochi (Kyoto University)

L.Q. Qi (Hong Kong Polytechnic University)

J. Sun (National University of Singapore)

W.Y. Sun (Nanjing Normal University) (**Co-Chair**)

X.L. Sun (Fudan University)

A. Tamura (Keio University)

T. Tanaka (Niigata University)

T. Tanino (Osaka University) (**Co-Chair**)

K.L. Teo (Curtin University)

T. Tsuchiya (National Graduate Institute for Policy Studies)

S.Y. Wang (Chinese Academy of Sciences)

S.Y. Wu (National Cheng Kung University)

H. Yabe (Tokyo University of Science)

H. Yamashita (Mathematical Systems, Inc.)

X.M. Yang (Chongqin Normal University)

A. Yoshise (University of Tsukuba)

Y.X. Yuan (Chinese Academy of Sciences)

J.Z. Zhang (City University of Hong Kong)

X.S. Zhang (Chinese Academy of Sciences)

Organizing Committee

Yu-Hong Dai (Chinese Academy of Sciences, China)

Masao Fukushima (Kyoto University, Japan)

Xin Liu (Chinese Academy of Sciences, China)

Wenyu Sun (Nanjing Normal University, China)

Naihua Xiu (Beijing Jiaotong University, China)

Ya-Xiang Yuan (Chinese Academy of Sciences) (**Chair**)

The 5th Sino-Japan Optimization Meeting

September 26-29, 2011

Beijing, China

Conference Schedule

September 26, Monday

08:30-09:10 Opening Ceremony
(Lecture Hall, Si-Yuan Building)

- **08:30-08:50 Welcome Address**
- **08:50-09:10 Group Photo**

09:10-09:30 Coffee Break

09:30-12:00 Invited Talks I1
Chair: Wenyu Sun (Lecture Hall, Si-Yuan Building)

- **09:30-10:20 Tamás Terlaky**, Cone Linear Optimization (CLO): from LO, SOCO and SDO towards mixed integer CLO
- **10:20-11:10 Mikio Kubo**, Trend in Supply Chain Optimization and Humanitarian Logistics
- **11:10-12:00 Xiaoling Sun**, Modeling and Algorithmic Challenges from Financial Optimization

12:00-13:30 Lunch (4th Floor, Wu-Ke Restaurant)

13:30-15:10 Invited Talks I2
Chair: Tetsuzo Tanino (Lecture Hall, Si-Yuan Building)

- **13:30-14:20 Soon-Yi Wu**, On finite convergence of an explicit exchange method for convex semi-definite programming problems with second-order cone constraints
- **14:20-15:10 Zaiwen Wen**, Optimization with orthogonality constraints and its applications

15:10-15:30 Coffee Break

15:30-18:30 Contributed Talks C1 & C2

C1, Chair: Mikio Kubo (Lecture Hall, Si-Yuan Building)

15:30-16:00 **Shinji Mizuno**, Klee-Minty's LP and Upper Bounds for Dantzig's Simplex Method

16:00-16:30 **Xin Liu**, Limited Memory Block Krylov Subspace Optimization for Computing Dominant Singular Value Decompositions (**Changed**)

16:30-17:00 **Chao Zhang, A New Active Set Method For Nonnegative Matrix Factorization**

17:00-17:30 **Jiming Peng, Sparse Solutions to Classes of Quadratic Programming Problems**

17:30-18:00 **Wei Bian, Smoothing Neural Network for Constrained Non-Lipschitz Optimization with Applications**

18:00-18:30 **Yanfang Zhang, Moreau-Yosida regularization for stochastic linear variational inequalities**

C2, Chair: Yu-Hong Dai (Room 712, Si-Yuan Building)

15:30-16:00 **Rui Diao**, A New Family of Matrix Completion Quasi-Newton Methods (**Changed**)

16:00-16:30 **Mituhiro Fukuda**, High performance software package for SDP: SDPA version 7

16:30-17:00 **Wanyou Cheng**, An Adaptive Gradient Algorithm for Large-scale Nonlinear Bound Constrained Optimization

17:00-17:30 **Cong Sun**, A Hybrid Algorithm for Power Maximization Interference Alignment Problem of MIMO Channels

17:30-18:00 **Zaikun Zhang**, Sobolev Seminorm of Quadratic Functions with Applications to Derivative-Free Optimization

18:00-18:30 **Zhengyong Zhou**, A discretization method for nonlinear semi-infinite programming based on the flatten aggregate constraint homotopy method for solving the discretized problem

18:40 **Dinner (Xiang Lin Tian Xia Restaurant)**

20:00 **SJOM Steering Committee Meeting**
(Room 305, Institute of Computational Mathematics and Scientific/Engineering Computing)

September 27, Tuesday

08:30-10:10 **Invited Talks I3**
Chair: Masao Fukushima (Lecture Hall, Si-Yuan Building)

- **08:30-09:20** **Xiaojun Chen**, Expected Residual Minimization for Stochastic Variational Inequalities
- **09:20-10:10** **Marc Teboulle**, First Order Algorithms for Well Structured Optimization Problems

10:10-10:30 **Coffee Break**

10:30-12:00 **Contributed Talks C3 & C4**

C3, Chair: Xiaojun Chen (Lecture Hall, Si-Yuan Building)

- **10:30-11:00** **Bingsheng He**, on the $O(1/t)$ convergence rate of the alternating direction methods for convex optimization and monotone variational inequalities
- **11:00-11:30** **Keiji Tatsumi**, A sufficient condition for chaos in a steepest decent system with sinusoidal perturbation for global optimization
- **11:30-12:00** **Bo Jiang**, An improved model for truck dispatching in open pit mine

C4, Chair: Satoru Iwata (Room 712, Si-Yuan Building)

- **10:30-11:00** **Shunsuke Hayashi**, Semi-infinite program with infinitely many conic constraints: optimality condition and algorithms
- **11:00-11:30** **Ryan Loxton**, Optimal Control Problems with Stopping Constraints
- **11:30-12:00** **Lishun Zeng**, On the Separation in 2-Period Double Round Robin Tournaments with Minimum Breaks

12:00-13:30 **Lunch (4th Floor, Wu-Ke Restaurant)**

13:30-15:10 **Invited Talks I4**
Chair: Naihua Xiu (Lecture Hall, Si-Yuan Building)

- **13:30-14:20** **Hiroshi Yamashita**, Primal-dual Interior Point Methods for Nonlinear SDP - Local and Global Analysis

14:20-15:10 **Yu-Hong Dai**, Joint Power and Admission Control for a SISO Interference Channel: Complexity Analysis, Algorithm Design, and Distributed Implementation

15:10-15:30 Coffee Break

15:30-17:00 Contributed Talks C5 & C6

C5, Chair: Hiroshi Yamashita (Lecture Hall, Si-Yuan Building)

15:30-16:00 **Naihua Xiu**, S-goodness: Low-Rank Matrix Recovery from Sparse Signal Recovery

16:00-16:30 **Hidefumi Kawasaki**, An application of a discrete fixed point theorem for contraction mappings to a game in expansive form

16:30-17:00 **Lingchen Kong**, Exact Low-rank Matrix Recovery via Nonconvex M_p-Minimization

C6, Chair: Jiawang Nie (Room 712, Si-Yuan Building)

15:30-16:00 **Qun Lin**, Optimal Fleet Sizing via Dynamic Programming and Golden Section Search

16:00-16:30 **Yasushi Narushima**, A smoothing conjugate gradient method for solving nonsmooth systems of equations

16:30-17:00 **Lei Guo**, M-Stationarity and Stability Analysis for Mathematical Programs with Complementarity Constraints

17:10 Dinner (3rd Floor, Wu-Ke Restaurant)

September 28, Wednesday

08:30-10:10 Invited Talks I5

Chair: Jie Sun (Lecture Hall, Si-Yuan Building)

08:30-09:20 **Yin Zhang**, Some Recent Advances in Alternating Direction Methods: Practice and Theory

09:20-10:10 **Satoru Iwata**, Submodular Optimization and Approximation Algorithms

10:10-10:30 Coffee Break

10:30-12:00 Contributed Talks C7 & C8

C7, Chair: Bingsheng He (Lecture Hall, Si-Yuan Building)

10:30-11:00 **Hiroshi Yabe**, Conjugate gradient methods based on secant conditions that generate descent search directions for unconstrained optimization

11:00-11:30 **Xiao Wang**, An Augmented Lagrangian Trust Region Algorithm for Equality Constrained Optimization

11:30-12:00 **Congpei An**, Regularized least squares approximation over the unit sphere using spherical designs

C8, Chair: Zaiwen Wen (Room 712, Si-Yuan Building)

10:30-11:00 **Ying Lu**, Plan Postponement Strategy: A Definition and Research Model

11:00-11:30 **Min Li**, Inexact Solution of NLP Subproblems in MINLP

11:30-12:00 **Atsushi Kato**, Global and superlinear convergence of inexact sequential quadratically constrained quadratic programming method for convex programming

12:00-13:30 Lunch (4th Floor, Wu-Ke Restaurant)

13:30-15:10 Invited Talks I6

Chair: Soon-Yi Wu(Lecture Hall, Si-Yuan Building)

13:30-14:20 **Luís Nunes Vicente**, Sparse and Smoothing Methods for Nonlinear Optimization Without Derivatives

14:20-15:10 **Ye Lu**, Optimal Policy for an Inventory System with Convex Variable Cost and a Fixed Cost

15:10-15:30 Coffee Break

15:30-16:20 Invited Talks I7

Chair: Yin Zhang (Lecture Hall, Si-Yuan Building)

15:30-16:20 **Jiawang Nie**, Jacobian SDP Relaxation for Polynomial Optimization

16:20-16:30 Closing Ceremony

(Lecture Hall, Si-Yuan Building)

16:50 Bus to Conference Banquet

(Conference Banquet at Da Zhai Men Restaurant)

September 29, Thursday

7:00	**Set off from Jade Palace**
Morning	**Half-day Tour to Great Wall**
Afternoon	**Half-day Tour to Ming Dynasty Tombs**

Abstracts

Part I

Invited Talks

Expected Residual Minimization for Stochastic Variational Inequalities

Xiaojun Chen

Department of Applied Mathematics
The Hong Kong Polytechnic University
Hong Kong
Email: maxjchen@polyu.edu.hk

The stochastic variational inequality (SVI) has been used widely in engineering and economics, as an effective mathematical model for a number of equilibrium problems involving uncertain data. We present an expected residual minimization (ERM) formulation for a class of SVI, including the complementarity problem as a special case. The objective of the ERM-formulation is Lipschitz continuous and semismooth which helps us guarantee the existence of a solution and convergence of approximation methods. Moreover, this minimization problem is convex for linear SVI if the expected matrix is positive semi-definite. We propose a globally convergent (a.s.) smoothing sample average approximation (SSAA) method to minimize the residual function. We show that the ERM problem and its SSAA problems have minimizers in a compact set and any cluster point of minimizers and stationary points of the SSAA problems is a minimizer and a stationary point of the ERM problem (a.s.). We illustrate the ERM and SSAA by examples from traffic equilibrium assignment problems.

Joint Power and Admission Control for a SISO Interference Channel: Complexity Analysis, Algorithm Design, and Distributed Implementation

Yu-Hong Dai

Institute of Computational Mathemtaics and Scientific/Engineering Computing

Chinese Academy of Sciences

Beijing 100190, China

Email: dyh@lsec.cc.ac.cn

Power control, aiming at providing each user in the interference channel with the prescribed quality of service (QoS) target, has been extensively studied. However, when there are too many co-channel users, it is not possible to simultaneously satisfy all users' QoS requirements due to mutual interferences and individual power limits. Therefore, it is necessary to bring up the admission control, and makes sense to maximize the number of admitted users at their desired QoS demands. It is shown that the joint power and admission control problem is strongly NP-hard and there even does not exist a polynomial-time approximation algorithm for it; hence, convex approximation heuristics approaches are considered. We first reformulate the problem as a sparse ℓ_0-minimization problem and then relax it to a linear programming. Next, two easy-checking necessary conditions that all users in the network can be simultaneously supported are derived. Based on above analysis, a new linear programming deflation (NLPD) algorithm is proposed, which minimizes a weighted summation of the total excess transmission power and the total real transmission power in each step. The distributed implementation of NLPD is also developed since the network often suffers a large communication overhead for the implementation of a centralized algorithm. The projected alternate Barzilai-Borwein (PABB) algorithm with the continuation technique is proposed to carry out the power control. The proposed algorithm not only allows each node to locally update its power with limited information exchange, but also preserves the high computational efficiency of the centralized algorithm. Numerical simulations show the proposed centralized and distributed algorithms outperform state-of-the-arts.

This work is jointed with Ya-feng Liu and Zhiquan Luo.

Submodular Optimization and Approximation Algorithms

Satoru Iwata

Research Institute for Mathematical Sciences (RIMS)
Kyoto University
Kyoto 606-8502, Japan
Email: iwata@kurims.kyoto-u.ac.jp

Submodular functions are discrete analogues of convex functions. Examples include cut capacity functions, matroid rank functions, and entropy functions. Submodular functions can be minimized in polynomial time, which provides a fairly general framework of efficiently solvable combinatorial optimization problems. In contrast, the maximization problems are NP-hard and several approximation algorithms have been developed so far.

In this talk, I will review the above results in submodular optimization and present recent approximation algorithms for combinatorial optimization problems described in terms of submodular functions.

Trend in Supply Chain Optimization and Humanitarian Logistics

Mikio Kubo

Department of Information Engineering and Logistics
Tokyo University of Marine Science and Technology
12-5 Echujima Koutou-ku, Tokyo 135-0083, Japan
Email: kubo@kaiyodai.ac.jp

In this talk, we survey the supply chain (SC) optimization. We introduce three decision levels of the SC, show the classification of inventories, and then discuss several basic optimization models such as logistics network design, inventory, scheduling, lot-sizing, and vehicle routing models. We also review recent progress in humanitarian logistics and supply chain risk management.

Optimal Policy for an Inventory System with Convex Variable Cost and a Fixed Cost

Ye Lu

City University of Hong Kong

Hong Kong

Email: yelu22@cityu.edu.hk

We study the optimal policy for a periodic-review inventory system where there is a fixed cost and the variable ordering cost is defined by a piece-wise linear convex function. By introducing the concept of strong (K,c,q)-convexity, we characterize the structure of the optimal policy. Based on this structure, we propose a well performed heuristics algorithm to solve this problem.

Jacobian SDP Relaxation for Polynomial Optimization

Jiawang Nie

Mathematics Department

University of California, San Diego (UCSD)

9500 Gilman Drive, La Jolla, CA 92093, USA

Email: njw@math.ucsd.edu

Consider the global optimization problem of minimizing a polynomial function subject to polynomial equalities and/or inequalities. Jacobian SDP Relaxation is the first method that can solve this problem globally and exactly by using semidefinite programming. This solves an open problem in the field of polynomial optimization. Its basic idea is to use the minors of Jacobian matrix of the given polynomials, add new redundant polynomial equations about the minors to the constraints, and then apply the hierarchy of Lasserre's semidefinite programming relaxations. The main result is that this new semidefinite programming relaxation will be exact for a sufficiently high (but finite) order, that is, the global minimum of the polynomial optimization can be computed by solving a semidefinite programming problem.

Modeling and Algorithmic Challenges from Financial Optimization

Xiaoling Sun

School of Management

Fudan University

670 Guoshun Road, Shanghai 200433, China

Email: xls@fudan.edu.cn

In this talk, we discuss some modeling and algorithmic challenges from financial optimization.

We consider portfolio selection models with three types of hard constraints arising from real-world trading practice:

(i) cardinality constraint;

(ii) probabilistic constraints;

(iii) marginal risk constraints.

These portfolio selection models are of NP-hard optimization problems. We propose some new reformulations and convex relaxation techniques.

Preliminary numerical results will be also reported.

First Order Algorithms for Well Structured Optimization Problems

Marc Teboulle

School of Mathematical Sciences
Tel Aviv University
Ramat Aviv, Tel Aviv 69978, Israel
Email: teboulle@post.tau.ac.il

Many fundamental scientific and engineering problems of recent interest arising in signal recovery, image processing, compressive sensing, machine learning and other fields can be formulated as well structured optimization problems, but which are typically very large scale, and often nonsmooth and nonconvex. This leads to challenging difficulties for their solutions, precluding the use of most well established sophisticated algorithms, such as interior point. Elementary first order methods then often remain our best alternative to tackle such problems.

This talk surveys recent results on the design and analysis of gradient-based algorithms for some generic optimization models arising in a wide variety of applications, highlighting the ways in which problem structures can be beneficially exploited to devise simple and efficient algorithms.

Cone Linear Optimization (CLO): from LO, SOCO and SDO towards mixed integer CLO

Tamás Terlaky

Harold S. Mohler Laboratory

Lehigh University

200 West Packer Avenue, Bethlehem, PA 18015-1582, USA

Email: terlaky@lehigh.edu

Cone Linear Optimization (CLO) has been the subject of intense study in the past two decades. Interior Point Methods (IPMs) provide polynomial time algorithms in theory, and powerful software tools in computational practice. The applications of Second-Order Conic (SOCO) and Semi-Definite Optimization (SDO) expanded rapidly. The first part of this talk reviews model formulation, IPM fundamentals, available software and some applications of CLO problems.

The use of integer variables naturally occur in CLO problems too, thus the need for dedicated mixed integer CLO algorithms and software is evident. The second part of this talk gives some insight of how to design disjunctive conic cuts for mixed integer CLO problems.

Biography:

Tamás Terlaky, George N. & Soteria Kledaras '87 Endowed Chair; Prof. Chair, Department of Industrial and Systems Engineering, Lehigh University; P. C., Rossin College of Engineering and Applied Science Lehigh University.

Degrees: M.Sc. Mathematics (1979), Ph.D. Operations Research (1981), Eötvös University, Budapest), CSc (1985) and DSc (2005), Hungarian Academy of Sciences. He has previously taught at Eötvös University; TU Delft; McMaster University, where he was the founding Director of the School of Computational Engineering and Science. He has published four books, edited fifteen books and journal special issues, published over 170 papers. Topics include theoretical and algorithmic foundations of optimization, such as criss-cross and interior point methods, worst case examples of the central path, nuclear reactor core reloading optimization, oil refinery and VLSI design optimization, robust RTT optimization.

Terlaky is founding editor-in-chief of Optimization and Engineering; associate editor of eight journals; served as conference chair; distinguished invited speaker all over the World; member, former chair, officer of numerous professional organizations; Chair of the Continuous Optimization Steering Committee of MOS; Fellow of the Fields Institute, and received the MITACS Mentorship Award for his distinguished graduate student supervision. His research interests include high-performance optimization methods, algorithms and software, and solving optimization problems in engineering sciences.

Sparse and Smoothing Methods for Nonlinear Optimization Without Derivatives

Luís Nunes Vicente

Department of Mathematics

University of Coimbra

300-454 Coimbra, Portugal

Email: lnv@mat.uc.pt

In this talk we have the ambitious goal of showing some recent developments on two different aspects of derivative-free optimization (DFO), linked together by the usage of the l1 norm.

In many application problems in DFO, one has little or no correlation between problem variables, and such (sparsity) structure is unknown in advance. We will describe how to compute quadratic interpolants by l1-minimization when the Hessian is sparse, and show that when using random sample sets significantly less than $O(n^2)$ points are required for a similar order of accuracy.

On the other hand, we will apply smoothing techniques to DFO problems, having in mind the goal of bounding the worst-case complexity or cost of DFO methods (in particular direct search) for non-smooth objective functions. Tractable smoothing functions in DFO require the knowledge of the non-smooth component, one relevant example being precisely the composition of the l1 norm with a smooth operator.

Optimization with orthogonality constraints and its applications

Zaiwen Wen

Department of Mathematics and Institute of Natural Sciences
Shanghai Jiao tong University
Shanghai, China
Email: zw2109@sjtu.edu.cn

Minimization with respect to a matrix X subject to orthogonality constraints $X^\top X = I$, or with respect to a vector x subject to constraint $\|x\|_2 = 1$, has wide applications in polynomial optimization, combinatorial optimization, eigenvalue problems, the total energy minimization in electronic structure calculation, subspace tracking, sparse principal component analysis, p-harmonic flow, and matrix rank minimization, etc. These problems are generally difficult because the constraints are not only non-convex but also numerically expensive to preserve during iterations. To deal with these difficulties, we propose a fast algorithm based on an inexpensive constraint-preserving updating scheme and curvilinear search procedures. Numerical results on a wide collection of problems show that the proposed algorithm is very promising.

This is a joint work with Wotao Yin at Rice University.

On finite convergence of an explicit exchange method for convex semi-infinite programming problems with second-order cone constraints

Soon-Yi Wu

Department of Mathematics, National Cheng Kung University, Tainan, Taiwan;

National Center for Theoretical Sciences, Taiwan

Email: soonyi@mail.ncku.edu.tw

We consider the convex semi-infinite programming problem with second-order cone constraints (for short, SOCCSIP). We propose an explicit exchange method for solving SOCCSIP, and prove that the algorithm terminates in a finite number of iterations under some mild conditions. In the analysis, the complementarity slackness condition with respect to second-order cones plays an important role. To deal with such complementarity conditions, we utilize the spectral factorization techniques in Euclidean Jordan algebra. We also show that the obtained output is an approximate optimum of SOCCSIP. We also report some numerical results involving the application to the robust optimization in the classical convex semi-infinite programming.

Key words. semi-infinite programming, finite termination, explicit method, second-order cone

Primal-dual Interior Point Methods for Nonlinear SDP - Local and Global Analysis

Hiroshi Yamashita

Mathematical Systems, Inc., Japan

10F Four Seasons Bldg., 2-4-3 Shinjuku, Shinjuku-ku, Tokyo 160-0022, Japan

Email: hy@msi.co.jp

In this talk, various algorithmic aspects of primal-dual interior point methods for solving nonconvex nonlinear semidefinite programming problems will be described. It will be shown that it is possible to extend usual primal-dual algorithms for NLP to NLSDP. In order to have globally convergent practical algorithms, we propose a new primal-dual merit function. Both line search method and trust region method will be described along with their numerical behaviors. Also rate of convergence of unscaled (AHO) and scaled (HRVW/KSH/M and NT) method will be discussed. It is possible to have local and superlinear convergence of these methods.

Some Recent Advances in Alternating Direction Methods: Practice and Theory

Yin Zhang

Department of Computational and Applied Mathematics

Rice University

Houston, Texas 77005, USA

Email: yzhang@rice.edu

The classic Augmented Lagrangian Alternating Direction Method (ALADM or simply ADM) has recently found great utilities in solving convex, separable optimization problems arising from signal/image processing and sparse optimization. In this talk, we briefly introduce the classic ADM approach, give some recent examples of its applications including extensions to solving some non-convex and non-separable problems. We then present new local and global convergence results that extend the classic ADM convergence theory in several aspects.

Part II

Contributed Talks

Regularized Least squares approximations on the sphere using spherical designs

Congpei An

Department of Applied Mathematics

The Hong Kong Polytechnic University

Hong Kong

Email: andbach@163.com

We consider polynomial approximation on the unit sphere $\mathbb{S}^2 = \{(x, y, z) \in \mathbb{R}^3 : x^2 + y^2 + z^2 = 1\}$ by a class of regularized discrete least squares methods, with novel choices for the regularization operator and the point sets of the discretization. We allow different kinds of rotationally invariant regularization operators, including the zero operator (in which case the approximation includes interpolation, quasi-interpolation and hyperinterpolation); powers of the negative Laplace-Beltrami operator (which can be suitable when there are data errors); and regularization operator that yield filtered polynomial approximations. As node sets we use spherical t-designs, which are point sets on the sphere which when used as equal-weight quadrature rules integrate all spherical polynomials up to degree t exactly. More precisely, we use well conditioned spherical t-designs [1] obtained in a previous paper by maximizing the determinants of the Gram matrices subject to the spherical design constraint. For $t \geq 2L$ and an approximating polynomial of degree L it turns out that there is no linear algebra problem to be solved, and the approximation in some cases recovers known polynomial approximation schemes, including interpolation, hyperinterpolation and filtered hyperinterpolation. For $t \in [L, 2L)$ the linear system needs to be solved numerically. Finally, we give numerical examples to illustrate the theoretical results, and show that well chosen regularization operator and well conditioned spherical t-designs can provide good polynomial approximation on the sphere, with or without the presence of data errors.

This is a join work with Xiaojun Chen, Ian H. Sloan and Robert S. Womersley.

References:

[1] C. An, X, Chen, I. H. Sloan and R. S. Womersley, *Well conditioned spherical designs for integration and interpolation on the two-sphere*, SIAM J. Numer. Anal., 48 (2010), pp. 2135-2157.

[2] C. An, X. Chen, I. H. Sloan, and R. S. Womersley, *Regularized spherical least-squares approximations on the sphere using spherical designs.* submitted to SIAM J. Numer. Anal. June 2011.

Smoothing Neural Network for Constrained Non-Lipschitz Optimization with Applications

Wei Bian[*] **and Xiaojun Chen**[†]

[*]Department of Mathematics
Harbin Institute of Technology
Harbin, China
Email: bianweilvse520@163.com

[†]Department of Applied Mathematics
The Hong Kong Polytechnic University
Hong Kong
Email: maxjchen@polyu.edu.hk

In this paper, a smoothing neural network is proposed for a class of constrained non-Lipschitz optimization problems, where the objective function is the sum of a nonsmooth, nonconvex function and a non-Lipschitz function, and the feasible set is a closed convex subset of R^n. Using the smoothing approximate techniques, the proposed neural network is modeled by a differential equation, which can be implemented easily. Under the level bounded condition on the objective function in the feasible set, we prove the global existence and uniform boundedness of the solutions of the smoothing neural network with any initial point in the feasible set. The uniqueness of the solution of the smoothing neural network is provided under the Lipschitz property of smoothing functions. We show that any accumulation point of the solutions of the smoothing neural network is a stationary point of the optimization problem. Numerical results including image restoration, blind source separation, variable selection and minimizing condition number are presented to illustrate the theoretical results and show the efficiency of the smoothing neural network. Comparisons with some existing algorithms show the advantages of the smoothing neural network.

Keywords Smoothing neural network, non-Lipschitz optimization, stationary point, image and signal restoration, variable selection.

References:

[1] X. Chen, F. Xu and Y. Ye, *Lower bound theory of nonzero entries in solutions of l_2-l_p minimization*, SIAM J. Sci. Comput., vol. 32, no. 5, pp. 2832-2852, 2010.

[2]R. Saab, O. Yilmaz, M.J. Mckeown and R. Abugharbieh, *Underdetermined anechoic blind source separation via l_q-basis-pursuit with $q < 1$*, IEEE Trans. Signal Process., vol. 55, no. 8, pp. 4004-4017, 2007.

[3]X. Chen, M.K. Ng and C. Zhang, *Nonconvex l_p-regularization and box constrained model for image restoration*, preprint, 2010.

[4]W. Bian and X. Chen, *Smoothing dynamical approach to nonsmooth, nonconvex constrained minimization*, preprint, 2011.

An Adaptive Gradient Algorithm for Large-scale Nonlinear Bound Constrained Optimization[1]

Wanyou Cheng* **and Erbao-Cao**†

*College of Computer
Dongguan University of Technology
Dongguan 523000, China
Email: chengwanyou421@yahoo.com.cn

†College of Mathematics and Econometrics
Hunan University
Changsha 410082, China
Email: dhli@hnu.cn

In this paper, an adaptive gradient algorithm based on an active identification technique for box constrained optimization is developed. The algorithm consists of a nonmonotone gradient projection step, a conjugate gradient step and a rule for branching between the two steps. Under appropriate conditions, we establish the global convergence of the method. Moreover, we also show that the algorithm eventually reduces to the conjugate gradient algorithm for unconstrained optimization without restarts for a nondegenerate stationary point. Numerical experiments are presented using box constrained problems in the CUTEr test problem libraries.

Keywords: bound constrained optimization, PRP method, global convergence

[1]Supported by the NSF of China via grant 1101087 and by the Key Project of Chinese Ministry of Education 309023.

A New Family of Matrix Completion Quasi-Newton Methods

Rui Diao

Institute of Computational Mathemtaics and Scientific/Engineering Computing

Chinese Academy of Sciences

Beijing 100190, China

Email: diarui@lsec.cc.ac.cn

Based on the idea of maximum determinant positive definite matrix completion, Yamashita (2008) proposed a sparse quasi-Newton update, called MCQN, for unconstrained optimization problems with sparse Hessian structures. Such MCQN update keeps the sparsity structure of the Hessian while relaxing the secant condition. Cheng et al. proposed a method NMCQN, in which the quasi-Newton matrix satisfies the secant condition, but does not have the same sparsity structure as the Hessian in general. By introducing a new patameter, we proposed a new family of quasi-Newton methods base on MCQN and NMCQN. A local and superlinear convergence property holds. Our numerical results demonstrate the usefulness of the new parameter.

High performance software package for SDP: SDPA version 7

Mituhiro Fukuda

Department of Mathematical and Computing Sciences

Tokyo Institute of Technology

Tokyo, Japan

Email: mituhiro@is.titech.ac.jp

SDPA (SemiDefinite Programming Algorithm, version 7) is a high-performance software to solve large-scale Semidefinite Programs (SDPs). The new features of this version include a new storage data structure, which accelerates its performance on multiple block matrices; sparse Cholesky factorization to solve the key linear system of equations; and multi-thread computing. We give extensive computational results which compare the well-known codes to solve SDPs and corroborates with the advantages of SDPA.

The multi-precision versions of SDPA: SDPA-DD (double-double precision arithmetic), SDPA-QD (quad-double precision arithmetic), and SDPA-GMP (arbitrarily precision arithmetic) replace the standard double precision arithmetic calculations of SDPA by its corresponding one. This is done using MPACK, developed by Maho Nakata, instead of the usual LAPACK library required by SDPA. These software packages requires an enormous computational time if compared with SDPA. However, they are the unique alternative to solve SDPs which are ill-posed numerically such as problems from computational geometry, graph theory [1], quantum chemistry [2], *etc.*

This is a joint work with Makoto Yamashita[1], Katsuki Fujisawa[2], Kazuhide Nakata[3], Maho Nakata[4], Kazuhiro Kobayashi[5], and Kazushige Goto[6].

References:

[1] de Klerk, E., Sotirov, R., *A new library of structured semidefinite programming instances*, Optim. Methods Softw. **24**, 959–971 (2009). http://lyrawww.uvt.nl/ sotirovr/library/index.html.

[2] Nakata, M., Braams, B.J., Fujisawa, K., Fukuda, M., Percus, J.K., Yamashita, M., Zhao, Z., *Variational calculation of second-order reduced density matrices by strong N-representability conditions and an accurate semidefinite programming solver*, J. Chem. Phys. **128**, 164113 (2008).

[1] Department of Mathematical and Computing Sciences, Tokyo Institute of Technology.

[2] Department of Industrial and Systems Engineering, Chuo University.

[3] Department of Industrial Engineering and Management, Tokyo Institute of Technology.

[4] Advanced Center for Computing and Communication, RIKEN.

[5] Center for Logistics Research, National Maritime Research Institute.

[6] Microsoft Research.

M-Stationarity and Stability Analysis for Mathematical Programs with Complementarity Constraints

Lei Guo and Guihua Lin

School of Mathematical Sciences

Dalian University of Technology

Dalian 116024, China

Email: {lei_guo_opt, lin_g_h}@yahoo.com.cn

This paper studies the M-stationarity (Mordukhovich stationarity) and its stability for mathematical programs with complementarity constraints (MPCC). We first show that a local minimizer of an MPCC must be M-stationary under suitable constraint qualification. Then we focus on the stability of the M-stationarity. We show that, under the no nonzero abnormal multiplier constraint qualification (NNAMCQ), both the multiplier mapping and M-stationary solution mapping are locally bounded and upper semicontinuous with respect to the perturbation parameter. Furthermore, under the NNAMCQ and the second-order sufficient condition (SOSC), the local optimal solution mapping and the M-stationary solution mapping are both continuous at 0 with respect to the perturbation parameter. We also show that the M-stationary pair mapping is calm under suitable conditions.

Keywords: MPCC, MPCC-stationarity, MPCC-constraint qualification, calmness, stability.

Semi-infinite program with infinitely many conic constraints: optimality condition and algorithms

Takayuki Okuno, Shunsuke Hayashi, and Masao Fukushima

Department of Applied Mathematics and Physics

Graduate School of Informatics, Kyoto University

Kyoto 606-8501, Japan

Email: {t_okuno, shunhaya, fuku}@amp.i.kyoto-u.ac.jp

We consider the following optimization problem with an infinite number of *conic* constraints:

$$\begin{aligned} &\text{Minimize} && f(x) \\ &\text{subject to} && A(t)^\top x - b(t) \in C \ \text{ for all } t \in T, \end{aligned} \tag{1}$$

where $f : \mathbb{R}^n \to \mathbb{R}$ is a continuously differentiable convex function, $A : T \to \mathbb{R}^{n\times m}$ and $b : T \to \mathbb{R}^m$ are continuous functions, $T \subset \mathbb{R}^\ell$ is a given compact set, and $C \subset \mathbb{R}^m$ is a closed convex cone with nonempty interior. We call this problem the semi-infinite conic program, SICP for short. We assume that SICP (1) has a nonempty solution set.

When $m = 1$ and $C = \mathbb{R}_+ := \{z \in \mathbb{R} \mid z \geq 0\}$, SICP (1) reduces to the classical semi-infinite program (SIP) which has a wide application in engineering [3, 4]. A more general choice for C is the symmetric cone such as the second-order cone $\mathcal{K}^m := \left\{(z_1, z_2, \ldots, z_m)^\top \in \mathbb{R}^m \mid z_1 \geq \|(z_2, z_3, \ldots, z_m)^\top\|_2\right\}$ and the semi-definite cone $\mathcal{S}^m_+ := \{Z \in \mathbb{R}^{m\times m} \mid Z = Z^\top,\ Z \succeq 0\}$. We note that our algorithm needs to solve a sequence of subproblems in which T is replaced by a finite subset $\{t_1, t_2, \ldots, t_r\} \subseteq T$. To such a subproblem, we can apply an existing algorithm such as the interior-point method and the smoothing Newton method [1, 2].

The main purpose of the paper is two-fold. First, we study the Karush-Kuhn-Tucker (KKT) conditions for SICP. Although the original KKT conditions for SICP could be described by means of integration and Borel measure, we show that they can be represented by a *finite* number of elements in T under the Robinson constraint qualification. Second, we provide two algorithms for solving SICP (1). Since any closed convex cone can be represented as an intersection of finitely or infinitely many halfspaces, we may reformulate (1) as a classical SIP with infinitely many linear inequality constraints, and solve it by using existing SIP algorithms [3, 4]. However, such a reformulation approach brings more difficulties since the dimension of the index set may become much larger than that of the original SICP (1).[1] Therefore, it is more reasonable to deal with the cones directly without losing their special structures.

The two algorithms proposed in this study are based on the exchange method, which solves a sequence of subproblems with *finitely* many conic constraints. The first algorithm is an explicit exchange method, of which we show global convergence under the strict convexity of the objective function. The second algorithm is a regularized explicit exchange method, which is a hybrid of the explicit exchange method and the regularization method. With the help of regularization, global convergence of the algorithm can be established without the strict convexity assumption.

[1] In the case where $C = \mathcal{K}^m$, since $\mathcal{K}^m = \{z \in \mathbb{R}^m \mid z^\top s \geq 0,\ \forall s \in S\}$, where $S := \{(1, \bar{s})^\top \in \mathbb{R}^m \mid \|\bar{s}\| = 1\}$, SICP (1) can be reformulated as the SIP: min $f(x)$ s.t. $s^\top(A(t)^\top x - b(t)) \geq 0$ for all $(s,t) \in S \times T$. The dimension of $S \times T$ is then equal to $m + \dim T - 1$, where $\dim T$ denotes the dimension of T.

References:

[1] F. Alizadeh and D. Goldfarb, *Second-order cone programming*, Mathematical Programming, 95:3–51, 2003.

[2] S. Hayashi, N. Yamashita, and M. Fukushima, *A combined smoothing and regularization method for monotone second-order cone complementarity problems*, SIAM Journal on Optimization, 15:593–615, 2005.

[3] R. Hettich and K. O. Kortanek, *Semi-infinite programming: Theory, methods, and applications*, SIAM Review, 35:380–429, 1993.

[4] M. López and G. Still, *Semi-infinite programming*, European Journal of Operational Research, 180:491–518, 2007.

On the $O(1/t)$ convergence rate of the alternating direction methods for convex optimization and monotone variational inequalities

Bingsheng He

Department of Mathematics
Nanjing University
Nanjing 210093, China
Email: hebma@nju.edu.cn

The alternating directions method (ADM) has found many new applications and its empirical efficiency has been well illustrated in various fields. However, the estimate of ADM's convergence rate remains a theoretical challenge for a few decades. In this talk, we show that the convergence rate of ADM is $O(1/t)$ in the context of convex programming. The complexity statement is true also for the ADM with relaxation factor in the update form of the multiplier as suggested by Glowinski. We give numerical results to indicate that taking a suitable relaxation factor will accelerate the convergence.

An improved model for truck dispatching in open pit mine

Bo Jiang

Institute of Computational Mathemtaics and Scientific/Engineering Computing

Chinese Academy of Sciences

Beijing 100190, China

Email: jiangbo@lsec.cc.ac.cn

In this talk, we will give a brief review of truck dispatching problem in open pit mine and propose an improved two-stage mathematical model. At the first stage of the model, we solve a truck flow programming problem with a suitable objective function as a whole guide for real dispatching. At the second stage, we use different dispatching strategies corresponding to the truck flow programming. Besides, in order to give a better guide, we can also solve the truck flow programming for several times. Preliminary numerical tests are also presented.

Global and superlinear convergence of inexact sequential quadratically constrained quadratic programming method for convex programming

Atsushi Kato[*], **Yasushi Narushima**[†], **and Hiroshi Yabe**[‡]

[*]Department of Mathematical Information Science
Tokyo University of Science
1-3, Kagurazaka, Shinjuku-ku, Tokyo 162-8601, Japan
Email: j1410702@ed.kagu.tus.ac.jp

[†]Department of Communication and Information Science
Fukushima National College of Technology
30 Nagao, Tairakamiarakawa-aza, Iwaki-shi, Fukushima 970-8034, Japan
Email: narushima@fukushima-nct.ac.jp

[‡]Department of Mathematical Information Science
Tokyo University of Science
1-3, Kagurazaka, Shinjuku-ku, Tokyo 162-8601, Japan
Email: yabe@rs.kagu.tus.ac.jp

We consider the following convex programming problem:

$$\begin{cases} \text{minimize} & f(x) \\ \text{subject to} & g_i(x) \leq 0 \quad (i = 1, \cdots, m) \end{cases}$$

where $f : \mathbf{R}^n \to \mathbf{R}$ and $g_i : \mathbf{R}^n \to \mathbf{R}$ are convex functions. The sequential quadratic programming (SQP) method is one of effective numerical methods for nonlinear programming problems. Since the SQP method lacked its second order information, the Maratos effect occurs. This phenomenon is that the unit step size is not necessarily accepted and prevents the SQP method from attaining superlinear convergence. The SQCQP (sequential quadratically constrained quadratic programming) method is the method which overcomes the Maratos effect. The SQCQP method for convex programming generates a search direction d_k by solving the following quadratically constrained quadratic programming (QCQP) subproblem at kth iteration:

$$\begin{cases} \text{minimize} & \nabla f(x_k)^T d + \dfrac{1}{2} d^T B_k d \\ \text{subject to} & g_i(x_k) + \nabla g_i(x_k)^T d + \dfrac{1}{2} d^T \nabla^2 g_i(x_k) d \leq 0 \quad (i = 1, \cdots, m) \end{cases}$$

where B_k is a kth approximate Hessian matrix of the objective function. Generally, this subproblem is not solvable. We deal with the feasible QCQP subproblem given by Fukushima, Luo and Tseng [1] and propose the method whose subproblem is inexactly solved. Furthermore, we show the convergence property of our method.

Keyword; Convex programming, Global convergence, Superlinear convergence, Sequential quadratically constrained quadratic programming method.

References:

[1] M. Fukushima, Z. Luo and P. Tseng, *A sequential quadratically constrained quadratic programming methods for differentiable convex minimization*, SIAM Journal on Optimization, 13 (2003), 1098–1119.

An application of a discrete fixed point theorem for contraction mappings to a game in expansive form

H. Kawasaki

Faculty of Mathematics

Kyushu University

Motooka 744, Nishi-ku, Fukuoka, 819-0395, Japan

Email: kawasaki@math.kyushu-u.ac.jp

In the game theory, fixed point theorems are useful to show the existence of Nash equilibrium. Since they are strong tools with continuous variables, it is expected that discrete fixed point theorems also useful to guarantee the existence of pure-strategy Nash equilibrium.

In this talk, we first review discrete fixed point theorems such as Robert's and Richard-Shih-Dong's fixed point theorems. Next, we present our discrete fixed point theorem for contraction mappings from the product set of integer intervals into itself, which is an extension of Robert's fixed point theorem. Finally, we apply our fixed point theorem to game theory. We show that our fixed point theorem works well in a game in expansive form with perfect information.

Exact Low-rank Matrix Recovery via Nonconvex M_p-Minimization

Lingchen Kong and Naihua Xiu

Department of Applied Mathematics

Beijing Jiaotong University

Beijing 100044, China

Email: {lchkong, nhxiu}@bjtu.edu.cn

The low-rank matrix recovery (LMR) arises in many fields such as signal and image processing, statistics, computer vision, system identification and control, and it is NP-hard. It is known that under some restricted isometry property (RIP) conditions we can obtain the exact low-rank matrix solution by solving its convex relaxation, the nuclear norm minimization. In this paper, we consider the nonconvex relaxations by introducing M_p-norm $(0 < p < 1)$ of a matrix and establish RIP conditions for exact LMR via M_p-minimization. Specifically, letting $\mathcal{A}$ be a linear transformation from $\mathcal{R}^{m\times n}$ into $\mathcal{R}^s$ and r be the rank of recovered matrix $X \in \mathcal{R}^{m\times n}$, and if $\mathcal{A}$ satisfies the RIP condition $\sqrt{2}\delta_{\max\{r+\frac{3}{2}k,2k\}} + \left(\frac{k}{2r}\right)^{\frac{1}{p}-\frac{1}{2}}\delta_{2r+k} < \left(\frac{k}{2r}\right)^{\frac{1}{p}-\frac{1}{2}}$ for a given positive integer $k \le m-r$, then r-rank matrix can be exactly recovered. In particular, we not only obtain a uniform bound on restricted isometry constant $\delta_{4r} < \sqrt{2}-1$ for any $p \in (0,1]$ for LMR via M_p-minimization, but also obtain the one $\delta_{2r} < \sqrt{2}-1$ for any $p \in (0,1]$ for sparse signal recovery via l_p-minimization.

Inexact Solution of NLP Subproblems in MINLP

Min Li

Department of Mathematics
University of Coimbra
3001-454 Coimbra, Portugal
Email: limin@mat.uc.pt

In the context of convex mixed-integer nonlinear programming (MINLP), we investigate how the outer approximation method and the generalized Benders decomposition method are affected when the respective NLP subproblems are solved inexactly. We show that the cuts in the corresponding master problems can be changed to incorporate the inexact residuals, still rendering equivalence and finiteness in the limit case. Some numerical results will be presented to illustrate the behavior of the methods under NLP subproblem inexactness.

Co-author: L. N. Vicente, CMUC, Department of Mathematics, University of Coimbra, 3001-454 Coimbra, Portugal (lnv@mat.uc.pt).

Optimal Fleet Sizing via Dynamic Programming and Golden Section Search

Qun Lin

Department of Mathematics and Statistics
Curtin University
GPO Box U1987 Perth Western Australia 6845
Email: Q.Lin@curtin.edu.au

In this talk, we will consider the problem of determining the optimal composition of a heterogeneous vehicle fleet consisting of multiple vehicle types, given that future vehicle requirements follow a known probability distribution. The problem is to choose the number of vehicles of each type to purchase so that the total expected cost of operating the fleet is minimized. The total expected cost is the sum of fixed and variable costs associated with the fleet, as well as hiring costs that are incurred when vehicle requirements exceed fleet capacity. We develop a novel algorithm, which combines dynamic programming and the golden section method, for solving this fleet sizing problem. Numerical simulations indicate that our algorithm is highly efficient, and is capable of solving large-scale problems involving hundreds of vehicle types.

Limited Memory Block Krylov Subspace Optimization for Computing Dominant Singular Value Decompositions

Xin Liu

Institute of Computational Mathemtaics and Scientific/Engineering Computing

Chinese Academy of Sciences

Beijing 100190, China

Email: liuxin@lsec.cc.ac.cn

In many data-intensive applications, the use of principal component analysis (PCA) and other related techniques is ubiquitous for dimension reduction, data mining or other transformational purposes. Such transformations often require efficiently, reliably and accurately computing dominant singular value decompositions (SVDs) of large unstructured matrices. In this paper, we propose and study a subspace optimization technique to significantly accelerate the classic simultaneous iteration method. We analyze the convergence of the proposed algorithm, and numerically compare it with several state-of-the-art SVD solvers under the MATLAB environment. Extensive computational results show that on a wide range of large unstructured matrices, the algorithm provides improved efficiency or robustness over existing algorithms.

Optimal Control Problems with Stopping Constraints

Ryan Loxton

Department of Mathematics and Statistics
Curtin University
GPO Box U1987 Perth Western Australia 6845
Email: R.Loxton@curtin.edu.au

In this talk, we will consider an optimal control problem in which the governing dynamic system terminates once a stopping constraint is satisfied. The most interesting aspect of this problem is that the terminal time is not fixed, but is instead a function of the control. Thus, conventional optimal control techniques are not applicable. We develop a novel approximation scheme that results in a finite-dimensional approximation of the optimal control problem. We then show that this approximate problem can be solved effectively using an exact penalty method. Finally, we conclude the talk with a discussion of some important convergence results.

Plan Postponement Strategy: A Definition and Research Model

Ying Lu

Department of Transportation

Jiangsu University

Zhenjiang 212013, China

Email: luying@ujs.edu.cn

This paper was motivated by a practical situation in the auto industry. Nowadays some automobile manufacturers made their production schedule step by step as time proceeded to waiting for more demand information available so that the decisions about the products could be more accurately. We name this method as *plan postponement strategy.* By classifying the production differentiations into two levels-basic specification and secondary specification, we analyze the plan postponement strategy problem as two-level hierarchical structure, which is characterized by families and items . The concept of family represents a set of items that have the same basic specification components, analogous to the car-lines in auto industry ,while item is a specific unit in each family which is determined by the second specification components in a certain family. We first formulate this problem as a stochastic mixed integer programming problem. Then, we solve it by means of an algorithm that involves generalized linear programming to obtain the approximate solution. We illustrate the procedure using a numerical example. The computational results demonstrate the effectiveness of the production plan postponement in a practical setting .Finally, a number of managerial insights are provided.

Klee-Minty's LP and Upper Bounds for Dantzig's Simplex Method

Tomonari Kitahara and Shinji Mizuno

Graduate School of Decision Science and Technology

Tokyo Institute of Technology

Ookayama, Meguro-ku, Tokyo, 152-8552, Japan

Email: {kitahara.t.ab, mizuno.s.ab}@m.titech.ac.jp

Kitahara and Mizuno (2010) get two upper bounds for the number of different basic feasible solutions generated by Dantzig's simplex method. The size of the bounds highly depends on the ratio between the maximum and the minimum values of all the positive elements of basic feasible solutions. We show that the ratio for a simple variant of Klee-Minty's LP is equal to the number of iterations by Dantzig's simplex method for solving it. This implies that it is impossible to get a better upper bound than the ratio.

Keywords: Simplex method, Linear programming, Basic feasible solutions, Klee-Minty's LP

A smoothing conjugate gradient method for solving nonsmooth systems of equations

Yasushi Narushima

Department of Communication and Information Science

Fukushima National College of Technology

30 Nagao, Tairakamiarakawa-aza, Iwaki-shi, Fukushima 970-8034, Japan

Email: narushima@fukushima-nct.ac.jp

We treat numerical methods for solving nonsmooth systems of equations:

$$F(x) = 0,$$

where a function $F : \mathbb{R}^n \to \mathbb{R}^m$ $(n \leq m)$ is continuous but not necessarily differentiable. Many problems in real world are reduced to nonsmooth systems of equations and hence many researchers study numerical methods for solving them. As numerical methods for solving such systems, Newton like methods are known as efficient numerical methods. However, these methods cannot be applied to large-scale problems, because they must keep matrices.

On the other hand, the nonlinear conjugate gradient method is known as an efficient numerical method for solving large-scale unconstrained optimization problems.

In this talk, we propose a smoothing method which is based on the nonlinear conjugate gradient method and does not use any matrices for solving nonsmooth systems of equations. In addition, we prove the global convergence property of the proposed method under standard assumptions.

Keyword; Nonsmooth systems of equations, smoothing conjugate gradient method, global convergence

Sparse Solutions to Classes of Quadratic Programming Problems

Jiming Peng

Dept. of Industrial & Enterprise Systems Engineering

University of Illinois at Urbana-Champaign

104 S. Mathews Ave., Urbana, IL 61801, USA

Email: pengj@illinois.edu

Sparse solutions to classes of optimization problems has been a major concern for optimization problems arising from many disciplines such as image processing and portfolio selection. It has been observed for long that for numerous classes of quadratic optimization problems such as the standard quadratic programming problem (StQP), though theoretically intractable, there always exist sparse optimal solutions for instances from many real-world applications. In this project, we present a new theoretical framework to interpret why there always exist sparse optimal or approximate solutions to classes of intractable and non-convex QPs and derive precise probabilistic characterization of the sparsity at the sparsest optimal or approximate solutions to the underlying QPs.

This talk is based on joint works with Xin Chen and Shuzhong Zhang, supported by AFOSR and NSF.

A Hybrid Algorithm for Power Maximization Interference Alignment Problem of MIMO Channels

Cong Sun

Institute of Computational Mathemtaics and Scientific/Engineering Computing

Chinese Academy of Sciences

Beijing 100190, China

Email: suncong@lsec.cc.ac.cn

In this talk, we would like to solve proper precoding and decoding matrices in a K-user MIMO interference channel of wireless communication system. A model to maximize the desired signal power with interference alignment conditions as its constraints. The contraints are added to the objective function by the Courant penalty function technique, to form a nonlinear matrix optimization problem with only matrix orthogonal constraints. A hybrid algorithm is proposed to solve the problem. First, we propose a new algorithm to iterate with Householder transformation to keep orthogonality. From any initial point, this algorithm helps to find points nearby the local optimal solution. Then alternating minimization algorithm is used to iterate from this point to the local optimum. Analysis shows that the proposed hybrid algorithm has lower computational complexity than the existed algorithm and simulations validate such conclusions.

A sufficient condition for chaos in a steepest decent system with sinusoidal perturbation for global optimization

Keiji Tatsumi and **Tetsuzo Tanino**

Division of Electrical, Electronic and Information Engineering

Graduate School of Engineering, Osaka University

Osaka 565-0871, Japan

Email: {tatsumi, tanino}@eei.eng.osaka-u.ac.jp

Recently, global optimization methods using chaotic dynamics have been investigated. In those methods, it is significant what kind of chaotic dynamical system is selected. We already proposed a new dynamical system which generates a chaotic sequence by the steepest descent method for minimizing an objective function with additional sinusoidal perturbation terms. We showed that the proposed system has good properties to search for solutions extensively without being trapped at undesirable local minima, and that it works more effectively for solving some benchmark global optimization problems than the existing one in numerical experiments. However, the system has some parameters which should be appropriately selected for an efficient search.

Therefore, in this paper, we theoretically derive the sufficient condition of the parameter values under which the proposed system is chaotic. In addition, we verify the sufficient condition by calculating the Lyapunov exponents of the proposed one and analyze its bifurcation structure through numerical experiments.

Keywords: metaheurisitcs, chaotic dynamics, global optimization.

An Augmented Lagrangian Trust Region Algorithm for Equality Constrained Optimization

Xiao Wang and **Ya-Xiang Yuan**

Institute of Computational Mathemtaics and Scientific/Engineering Computing

Chinese Academy of Sciences

Beijing 100190, China

Email: {wangxiao, yyx}@lsec.cc.ac.cn

In this paper, we present a new trust region method for equality constrained optimization. The method is based on the augmented Lagrangian function. New strategies to update the penalty parameter and the Lagrangian multiplier are proposed. Under very mild conditions, global convergence of the algorithm is proved. Preliminary numerical experience for problems with equalities from the CUTEr collection is also reported. The numerical performance indicate that for problems with equality constraints the new method is effective and competitive with the famous algorithm LANCELOT.

S-goodness: Low-Rank Matrix Recovery from Sparse Signal Recovery

Lingchen Kong[*], **Levent Tunçel**[†], and **Naihua Xiu**[*]

[*]Department of Applied Mathematics
Beijing Jiatong University
Beijing 100044, China
Email: {lchkong, nhxiu}@bjtu.edu.cn

[†]Department of Combinatorics and Optimization, Faculty of Mathematics
University of Waterloo
Waterloo, Ontario N2L 3G1, Canada
Email: ltuncel@math.uwaterloo.ca

The low-rank matrix recovery (LMR) is a rank minimization problem subject to linear equality constraints, and it arises in many fields such as signal and image processing, statistics, computer vision, system identification and control. This class of optimization problems is NP-hard and a popular approach replaces the rank function with the nuclear norm of the matrix variable.

In this paper, we extend the concept of s-goodness for a sensing matrix in sparse signal recovery (proposed by Juditsky and Nemirovski [Math Program, 2011]) to linear transformations in LMR. Then, we give characterizations of s-goodness in the context of LMR. Using the two characteristic s-goodness constants, γ_s and $\hat{\gamma}_s$, of a linear transformation, not only do we derive necessary and sufficient conditions for a linear transformation to be s-good, but also provide sufficient conditions for exact and stable s-rank matrix recovery via the nuclear norm minimization under mild assumptions. Moreover, we give computable upper bounds for one of the s-goodness characteristics which leads to verifiable sufficient conditions for exact low-rank matrix recovery.

Conjugate gradient methods based on secant conditions that generate descent search directions for unconstrained optimization

Hiroshi Yabe* **and Yasushi Narushima†**

*Department of Mathematical Information Science
Tokyo University of Science
1-3, Kagurazaka, Shinjuku-ku, Tokyo 162-8601, Japan
Email: yabe@rs.kagu.tus.ac.jp

†Department of Communication and Information Science
Fukushima National College of Technology
30 Nagao, Tairakamiarakawa-aza, Iwaki-shi, Fukushima 970-8034, Japan
Email: narushima@fukushima-nct.ac.jp

In this talk, we deal with conjugate gradient methods for solving unconstrained optimization problems:

$$\min_{x \in R^n} \quad f(x),$$

where $f : \mathbb{R}^n \to \mathbb{R}$ is continuously differentiable and its gradient is available. Conjugate gradient methods have been paid attention to, because they can be directly applied to large-scale unconstrained optimization problems. In order to incorporate second order information of the objective function into conjugate gradient methods, Dai and Liao [1] proposed a conjugate gradient method based on the secant condition. However, their method does not necessarily generate a descent search direction. On the other hand, Hager and Zhang [2] proposed another conjugate gradient method which always generates a descent search direction.

Combining Dai-Liao's idea and Hager-Zhang's idea, we propose conjugate gradient methods based on secant conditions that generate descent search directions. In addition, we establish global convergence properties of the proposed methods.

Keywords: Unconstrained optimization, conjugate gradient method, descent search direction, secant condition, global convergence.

References:

[1]Y.H. Dai and L.Z. Liao, *New conjugacy conditions and related nonlinear conjugate gradient methods*, Applied Mathematics and Optimization, **43** (2001), 87–101.

[2]W.W. Hager and H. Zhang, *A new conjugate gradient method with guaranteed descent and an efficient line search*, SIAM Journal on Optimization, **16** (2005), 170–192.

On the Separation in 2-Period Double Round Robin Tournaments with Minimum Breaks

Lishun Zeng and **Shinji Mizuno**

Graduate School of Decision Science and Technology

Tokyo Institute of Technology

Tokyo, 152-8552, Japan

Email: {zeng.l.aa, mizuno.s.ab}@m.titech.ac.jp

This paper considers the separation in 2-period double round robin tournaments (2P-DRRTs) with minimum breaks. The separation is a lower bound on the number of slots between the two games with the same opponents. None of the known schemes provides 2P-DRRTs with minimum breaks and a positive separation. We first propose a new scheme to generate 2-separation 2P-DRRTs with minimum breaks, based on single round robin tournaments (SRRTs) with minimum breaks which have the last break in the third slot from the end. We experimentally show that such SRRTs exist for 8 to 76 teams. Secondly, we consider maximizing the separation in general 2P-DRRTs with minimum breaks by integer programming and constraint programming, respectively. Both a direct formulation and a "first-break, then-schedule" decomposition approach are presented and compared. We obtain the maximum separation for up to 12 teams. Furthermore, we consider the application with place constraints to show the flexibility and efficiency of scheduling 2P-DRRTs with minimum breaks and a positive separation.

A New Active Set Method For Nonnegative Matrix Factorization

Chao Zhang

Department of Applied Mathematics

Beijing Jiaotong University

Beijing 100044, China

Email: zc.njtu@163.com

Nonnegative matrix factorization (NMF) has been proved powerful to a variety of data analysis applications, which seeks a lower rank approximation of a given nonnegative matrix by two nonnegative factors of lower dimensions. NMF can be reformulated as an ordinary vector-variable minimization problem with nonnegative bound constraints. Techniques leading faster algorithms for vector-variable minimization can be extended to NMF. In this paper, we propose a new matrix-based active set method for NMF, which allows fast algorithms for bound constrained problem and exhibits strong convergent result. Numerical experiments on several data set demonstrate the good performance of the proposed method.

References:

[1] W.W. Hager and H. Zhang, *A new active set algorithm for box constrained optimization*, SIAM J. Optim. 17(2006), pp. 526-557. 2.

[2] H. Kim and H. Park, *Non-negative matrix factorization based on alternating non-negativity constrained least squares and active set method*, SIAM J. Matrix Anal. & Appl., 30(2008), pp. 713-730. 3.

[3] C.-J. Lin, *Projected gradient methods for nonnegative matrix factorization*, Neural Computation 19(2007), pp. 2756-2779. 4. L.

[4] L. Sun, G. He, Y. Wang and L. Fang, *An active set quasi-Newton method with projected search for bound constrained minimization*, Computers and Mathematics with Applications 58 (2009), pp. 161-170.

Moreau-Yosida regularization for stochastic linear variational inequalities

Yanfang Zhang

Department of Applied Mathematics

The Hong Kong Polytechnic University

Hong Kong

Email: 0900332R@polyu.edu.hk

We apply the Moreau-Yosida regularization to a convex expected residual minimization (ERM) formulation for a class of stochastic linear variational inequalities. To have the convexity of sample average approximations (SAA) of the ERM formulation, we adopt the Tikhonov regularization. We show that any cluster point of minimizers of the Moreau-Yosida regularization of the SAA of the ERM formulation with the Tikhonov regularization is a minimizer of the ERM formulation as the sample size $N \to \infty$ and the Tikhonov regularization parameter $\varepsilon \to 0$. Moreover, we prove the minimizer is the least l_2-norm solution of the ERM formulation. We also prove the semismoothness of the gradient of the Moreau-Yosida regularization of the SAA of the ERM formulation with the Tikhonov regularization. What is more, we estimate the values of uncertainty quantities in both the distribution form and moments to get a robust decision for our stochastic linear variational inequalities.

References:

[1] X. Chen and M. Fukushima, *Expected residual minimization method for stochastic linear complementarity problems*, Math. Oper. Res. 30(2005) 1022–1038.

[2] X. Chen, R. J-B Wets and Y. Zhang, *Stochastic variational inequalities: residual minimization smoothing/sampling average approximations*, Optimization-On-Line, February 2011, http://www.optimization-online.org.

[3] X. Chen, C. Zhang and M. Fukushima, *Robust solution of monotone stochastic linear complementarity problems*, Math. Program. 117(2009) 51-80.

[4] G.H. Lin and M. Fukushima, *Stochastic equilibrium problems and stochastic mathematical programs with equilibrium constraints: A survey*, Pac. J. Optim. 6(2010) 455-482.

[5] Y. Zhang, *Numerical investigation of deterministic formulations for stochastic complementarity problems*, Pac. J. Optim. 7(2011) 317-337.

Sobolev Seminorm of Quadratic Functions with Applications to Derivative-Free Optimization

Zaikun Zhang

Institute of Computational Mathemtaics and Scientific/Engineering Computing

Chinese Academy of Sciences

Beijing 100190, China

Email: zhangzk@lsec.cc.ac.cn

In this talk, we inspect the classical H^1 Sobolev seminorm of quadratic functions over balls of $\mathbb{R}^n$. We express the seminorm explicitly in terms of the coefficients of the quadratic function under consideration. The seminorm gives some new insights into the least-norm interpolation widely used in derivative-free optimization. It shows the geometrical/analytical essence of the least-norm interpolation and explains why it is successful. We finally present some numerical results to show that H^1 seminorm is helpful to the model selection of derivative-free optimization.

A discretization method for nonlinear semi-infinite programming based on the flatten aggregate constraint homotopy method for solving the discretized problem

Zhengyong Zhou and **Bo Yu**

School of Mathematical Sciences
Dalian University of Technology
Dalian 116024, China
Email: zzy198300@163.com, yubo@dlut.edu.cn

In this paper, a discretization method for nonlinear semi-infinite programming is developed. After discreteing the problem into a sequence of finite-dimensional problems, a globally convergent method, the flatten aggregate constraint homotopy method, is used to solve the discretized problem using a adaptive scheme. Since only a smooth inequality constraint is used, the dimension of the homotopy map keeps invariable for different discretization mesh-sizes. Moreover, only discretized constraint functions that are nearly active at the current point are needed to evaluate their gradients and Hessians. Hence, the computational costs of the functional-value and the Jacobian of the homotopy map, and consequentially the discretized flatten aggregate constraint homotopy method is less expensive than common methods. Under some common conditions, the global convergence of the proposed method, which means the global convergence of the homotopy method for the discretized problem and the convergence of the solution of the discretized problem to the solution of the semi-infinite problem depending on the discretization mesh-size, is proven. Preliminary numerical results show that the proposed method is efficient.

List of Participants of SJOM 2011

Congpei An

Department of Applied Mathematics
The Hong Kong Polytechnic University
Hong Kong
Email: andbach@163.com

Wei Bian

Department of Mathematics
Harbin Institute of Technology
Harbin, China
Email: bianweilvse520@163.com

Xiaojun Chen

Department of Applied Mathematics
The Hong Kong Polytechnic University
Hong Kong
Email: maxjchen@polyu.edu.hk

Wanyou Cheng

College of Computer
Dongguan University of Technology
Dongguan 523000, China
Email: chengwanyou421@yahoo.com.cn

Yu-Hong Dai

Institute of Computational Mathemtaics and Scientific/Engineering Computing
Chinese Academy of Sciences
Beijing 100190, China
Email: dyh@lsec.cc.ac.cn

Rui Diao

Institute of Computational Mathemtaics and Scientific/Engineering Computing
Chinese Academy of Sciences
Beijing 100190, China
Email: diaorui@lsec.cc.ac.cn

Shiman Ding

Department of mathematics
Tsinghua University

Beijing 100084, China
Email: dingshiman@gmail.com

Shouqiang Du

Department of Mathematics
Qingdao University
Qingdao 266071, China
Email: Dsq8933@163.com

Jinyan Fan

Department of Mathematics
Shanghai Jiao Tong University
Shanghai 200240, China
Email: jyfan@sjtu.edu.cn

Mituhiro Fukuda

Department of Mathematical and Computing Sciences
Tokyo Institute of Technology
Tokyo, Japan
Email: mituhiro@is.titech.ac.jp

Masao Fukushima

Department of Applied Mathematics and Physics
Graduate School of Informatics, Kyoto University
Kyoto 606-8501, Japan
Email: fuku@i.kyoto-u.ac.jp

Aiquan Guo

Department of Mathematics and Information Sciences
Xihua Normal University
Nanchong 637002, China
Email: gaq19@163.com

Lei Guo

School of Mathematical Sciences
Dalian University of Technology
Dalian 116024, China
Email: lei_guo_opt@yahoo.com.cn

Deren Han

Department of Mathematics
Nanjing Normal University
Nanjing 210046, China
Email: handeren@njnu.edu.cn

Shunsuke Hayashi

Department of Applied Mathematics and Physics
Graduate School of Informatics, Kyoto University
Kyoto 606-8501, Japan
Email: shunhaya@amp.i.kyoto-u.ac.jp

Bingsheng He

Department of Mathematics
Nanjing University
Nanjing 210093, China
Email: hebma@nju.edu.cn

Satoru Iwata

Research Institute for Mathematical Sciences (RIMS)
Kyoto University
Kyoto 606-8502, Japan
Email: iwata@kurims.kyoto-u.ac.jp

Bo Jiang

Institute of Computational Mathemtaics and Scientific/Engineering Computing
Chinese Academy of Sciences
Beijing 100190, China
Email: jiangbo@lsec.cc.ac.cn

Atsushi Kato

Department of Mathematical Information Science
Tokyo University of Science
1-3, Kagurazaka, Shinjuku-ku, Tokyo 162-8601, Japan
Email: j1410702@ed.kagu.tus.ac.jp

H. Kawasaki

Faculty of Mathematics
Kyushu University
Motooka 744, Nishi-ku, Fukuoka, 819-0395, Japan
Email: kawasaki@math.kyushu-u.ac.jp

Lingchen Kong

Department of Applied Mathematics
Beijing Jiaotong University
Beijing 100044, China
Email: lchkong@bjtu.edu.cn

Mikio Kubo

Department of Information Engineering and Logistics
Tokyo University of Marine Science and Technology
12-5 Echujima Koutou-ku, Tokyo 135-0083, Japan
Email: kubo@kaiyodai.ac.jp

Min Li

Department of Mathematics
University of Coimbra
3001-454 Coimbra, Portugal
Email: limin@mat.uc.pt

Qingna Li

Institute of Computational Mathemtaics and Scientific/Engineering Computing
Chinese Academy of Sciences
Beijing 100190, China
Email: qnl@lsec.cc.ac.cn

Qun Lin

Department of Mathematics and Statistics
Curtin University
GPO Box U1987 Perth Western Australia 6845
Email: Q.Lin@curtin.edu.au

Guihua Lin

School of Mathematical Sciences
Dalian University of Technology
Dalian 116024, China
Email: lin_g_h@yahoo.com.cn

Bingbing Liu

Department of Mathematics and Statistics
Wuhan University
Wuhan 430072, China
Email: lbb122400@126.com

Jingjing Liu

Department of Mathematics and Information Sciences
Xihua Normal University
Nanchong 637002, China
Email: wjing1231@126.com

Tianxiang Liu

Institute of Computational Mathemtaics and Scientific/Engineering Computing
Chinese Academy of Sciences
Beijing 100190, China
Email: liutx@lsec.cc.ac.cn

Xin Liu

Institute of Computational Mathemtaics and Scientific/Engineering Computing
Chinese Academy of Sciences
Beijing 100190, China
Email: liuxin@lsec.cc.ac.cn

Xinwei Liu

Department of Applied Mathematics
Hebei University of Technology
Tianjin, China
Email: mathlxw@hebut.edu.cn

Yafeng Liu

Institute of Computational Mathemtaics and Scientific/Engineering Computing
Chinese Academy of Sciences
Beijing 100190, China
Email: yafliu@lsec.cc.ac.cn

Ryan Loxton

Department of Mathematics and Statistics
Curtin University
GPO Box U1987 Perth Western Australia 6845
Email: R.Loxton@curtin.edu.au

Ye Lu

City University of Hong Kong
Hong Kong
Email: yelu22@cityu.edu.hk

Ying Lu

Department of Transportation
Jiangsu University
Zhenjiang 212013, China
Email: luying@ujs.edu.cn

John Linglei Meng

Springer Beijing Representative Office

Room 408-412, Li XIang Guo Ji Building
No 58 Zhon Guan Cun West Road, Beijing, China
Email: John.meng@springer.com

Guofen Ming

Department of Mathematics and Information Sciences
Xihua Normal University
Nanchong 637002, China
Email: mingguofen18988@163.com

Shinji Mizuno

Graduate School of Decision Science and Technology
Tokyo Institute of Technology
Ookayama, Meguro-ku, Tokyo, 152-8552, Japan
Email: mizuno.s.ab@m.titech.ac.jp

Yasushi Narushima

Department of Communication and Information Science
Fukushima National College of Technology
30 Nagao, Tairakamiarakawa-aza, Iwaki-shi, Fukushima 970-8034, Japan
Email: narushima@fukushima-nct.ac.jp

Jiawang Nie

Mathematics Department
University of California, San Diego (UCSD)
9500 Gilman Drive, La Jolla, CA 92093, USA
Email: njw@math.ucsd.edu

Puyan Nie

Institute of Industrial Economics
Jinan University
Guangzhou 510632, China
Email: tpynie@jnu.edu.cn

Thanawath Niyamosoth

Department of Mathematics
Graduate University of Chinese Academy of Sciences
Beijing, China
Email: t_niyamosoth@hotmail.com

Jiming Peng

Dept. of Industrial & Enterprise Systems Engineering
University of Illinois at Urbana-Champaign

104 S. Mathews Ave., Urbana, IL 61801, USA
Email: pengj@illinois.edu

Yun Peng

Beijing University of Chemical Technology
Beijing 100029, China
Email: 651613934@163.com

Yu Ren

Academy of Industry and Economics
Jinan University
Guangzhou 510632, China
Email: renyu66@126.com

Youlin Shang

School of Mathematics and Statistics
Henan University of Science and Technology
Luoyang 471003, China
Email: mathshang@sina.com

Zhenli Sheng

Institute of Computational Mathemtaics and Scientific/Engineering Computing
Chinese Academy of Sciences
Beijing 100190, China
Email: szl@lsec.cc.ac.cn

Ke Su

Department of Mathematics and Computer Sciences
Hebei University
Baoding 071102, China
Email: pigeonsk@163.com

Cong Sun

Institute of Computational Mathemtaics and Scientific/Engineering Computing
Chinese Academy of Sciences
Beijing 100190, China
Email: suncong@lsec.cc.ac.cn

Jie Sun

Department of Decision Sciences, School of Business
National University of Singapore
Republic of Singapore 119260
Email: jsun@nus.edu.sg

Wenyu Sun

Department of Mathematics
Nanjing Normal University
Nanjing 210046, China
Email: wysun@njnu.edu.cn

Xiaoling Sun

School of Management
Fudan University
670 Guoshun Road, Shanghai 200433, China
Email: xls@fudan.edu.cn

Tetsuzo Tanino

Division of Electrical, Electronic and Information Engineering
Graduate School of Engineering, Osaka University
Osaka 565-0871, Japan
Email: tanino@eei.eng.osaka-u.ac.jp

Keiji Tatsumi

Division of Electrical, Electronic and Information Engineering
Graduate School of Engineering, Osaka University
Osaka 565-0871, Japan
Email: tatsumi@eei.eng.osaka-u.ac.jp

Marc Teboulle

School of Mathematical Sciences
Tel Aviv University
Ramat Aviv, Tel Aviv 69978, Israel
Email: teboulle@post.tau.ac.il

Tamás Terlaky

Harold S. Mohler Laboratory
Lehigh University
200 West Packer Avenue, Bethlehem, PA 18015-1582, USA
Email: terlaky@lehigh.edu

Luís Nunes Vicente

Department of Mathematics
University of Coimbra
300-454 Coimbra, Portugal
Email: lnv@mat.uc.pt

Chuanlong Wang

Department of Mathematics
Taiyuan Normal University
Taiyuan 030012, China
Email: clwang218@126.com

Fusheng Wang

Department of Mathematics
Taiyuan Normal University
Taiyuan 030012, China
Email: fswang2005@163.com

Liping Wang

Department of Mathematics, School of Sciences
Nanjing University of Aeronautics and Astronautics
Nanjing 210093, China
Email: wlpmath@yahoo.com.c

Xiao Wang

Institute of Computational Mathemtaics and Scientific/Engineering Computing
Chinese Academy of Sciences
Beijing 100190, China
Email: wangxiao@lsec.cc.ac.cn

Zhouhong Wang

Department of Applied Mathematics
Beijing Jiaotong University
Beijing 100044, China
Email: wangzhh@bjtu.edu.cn

Zaiwen Wen

Department of Mathematics and Institute of Natural Sciences
Shanghai Jiao tong University
Shanghai, China
Email: zw2109@sjtu.edu.cn

Dan Wu

Department of Mathematics and Statistics
Henan University of Science and Technology
Luoyang 471003, China
Email: lywd2964@126.com

Leqin Wu

Institute of Computational Mathemtaics and Scientific/Engineering Computing
Chinese Academy of Sciences
Beijing 100190, China
Email: wlq@lsec.cc.ac.cn

Soon-Yi Wu

Department of Mathematics, National Cheng Kung University, Tainan, Taiwan;
National Center for Theoretical Sciences, Taiwan
Email: soonyi@mail.ncku.edu.tw

Yong Xia

School of Mathematics and System Sciences
Beihang University
Beijing 100191, China
Email: dearyx@gmail.com

Naihua Xiu

Department of Applied Mathematics
Beijing Jiaotong University
Beijing 100044, China
Email: nhxiu@bjtu.edu.cn

Jinmei Xu

Department of Mathematics and Information Sciences
Xihua Normal University
Nanchong 637009, China
Email: xujinmei2009@126.com

Hiroshi Yabe

Department of Mathematical Information Science
Tokyo University of Science
1-3, Kagurazaka, Shinjuku-ku, Tokyo 162-8601, Japan
Email: yabe@rs.kagu.tus.ac.jp

Hiroshi Yamashita

Mathematical Systems, Inc., Japan
10F Four Seasons Bldg., 2-4-3 Shinjuku, Shinjuku-ku, Tokyo 160-0022, Japan
Email: hy@msi.co.jp

Yang, Ching-Yu

Department of Mathematics
National Taiwan Normal University

No.88, Sec.4, Ting-Chou Rd, Taipei, Taiwan
Email: yangcy@math.ntnu.edu.tw

Bo Yu

Department of Mathematics
Dalian University of Technology
Dalian 116024, China
Email: yubo@dlut.edu.cn

Ya-Xiang Yuan

Institute of Computational Mathemtaics and Scientific/Engineering Computing
Chinese Academy of Sciences
Beijing 100190, China
Email: yyx@lsec.cc.ac.cn

Lishun Zeng

Graduate School of Decision Science and Technology
Tokyo Institute of Technology
Tokyo, 152-8552, Japan
Email: zeng.l.aa@m.titech.ac.jp

Chao Zhang

Department of Applied Mathematics
Beijing Jiaotong University
Beijing 100044, China
Email: zc.njtu@163.com

Qinghong Zhang

Department of Mathematics and Computer Science
Northern Michigan University
Marquette, MI 49855 USA
Email: qzhang@nmu.edu

Ruiyan Zhang

Department of Mathematics
Graduate University of Chinese Academy of Sciences
Beijing, China
Email: zhangry@scichina.org

Wenhui Zhang

Institute of Computational Mathemtaics and Scientific/Engineering Computing
Chinese Academy of Sciences
Beijing 100190, China
Email: wenhui@lsec.cc.ac.cn

Yanfang Zhang

Department of Applied Mathematics
The Hong Kong Polytechnic University
Hong Kong
Email: 0900332R@polyu.edu.hk

Yin Zhang

Department of Computational and Applied Mathematics
Rice University
Houston, Texas 77005, USA
Email: yzhang@rice.edu

Zaikun Zhang

Institute of Computational Mathemtaics and Scientific/Engineering Computing
Chinese Academy of Sciences
Beijing 100190, China
Email: zhangzk@lsec.cc.ac.cn

Zhengyong Zhou

School of Mathematical Sciences
Dalian University of Technology
Dalian 116024, China
Email: zzy198300@163.com

Sightseeing Information

Great Wall[1]

The Great Wall (Chinese: 万里长城; pinyin: Wàn Lǐ Cháng Chéng; literally, *Ten-Thousand-Mile-Long Wall*) of China is a series of stone and earthen fortifications in northern China, built originally to protect the northern borders of the Chinese Empire against intrusions by various nomadic groups. Several walls have been built since the 5th century BC that are referred to collectively as the Great Wall, which has been rebuilt and maintained from the 5th century BC through the 16th century. One of the most famous is the wall built between 220-206 BC by the first Emperor of China, Qin Shi Huang. Little of that wall remains; the majority of the existing wall was built during the Ming Dynasty.

The Great Wall stretches from Shanhaiguan in the east, to Lop Lake in the west, along an arc that roughly delineates the southern edge of Inner Mongolia. The most comprehensive archaeological survey, using advanced technologies, has concluded that the entire Great Wall, with all of its branches, stretches for 8,851.8 km (5,500.3 mi). This is made up of 6,259.6 km (3,889.5 mi) sections of actual wall, 359.7 km (223.5 mi) of trenches and 2,232.5 km (1,387.2 mi) of natural defensive barriers such as hills and rivers.

The Chinese were already familiar with the techniques of wall-building by the time of the Spring and Autumn Period, which began around the 8th century BC. During the Warring States Period from the 5th century BCE to 221 BCE, the states of Qin, Wei, Zhao, Qi, Yan and Zhongshan all constructed extensive fortifications to defend their own borders. Built to withstand the attack of small arms such as swords and spears, these walls were made mostly by stamping earth and gravel between board frames.

Qin Shi Huang conquered all opposing states and unified China in 221 BCE, establishing the Qin Dynasty. Intending to impose centralized rule and prevent the resurgence of feudal lords, he ordered the destruction of the wall sections that divided his empire along the former state borders. To protect the empire against intrusions by the Xiongnu people from the north, he ordered the building of a

[1] From Wikipedia: http://en.wikipedia.org/wiki/Great_Wall_of_China.

new wall to connect the remaining fortifications along the empire's new northern frontier. Transporting the large quantity of materials required for construction was difficult, so builders always tried to use local resources. Stones from the mountains were used over mountain ranges, while rammed earth was used for construction in the plains. There are no surviving historical records indicating the exact length and course of the Qin Dynasty walls. Most of the ancient walls have eroded away over the centuries, and very few sections remain today. The human cost of the construction is unknown, but it has been estimated by some authors that hundreds of thousands, if not up to a million, workers died building the Qin wall. Later, the Han, Sui, and Northern dynasties all repaired, rebuilt, or expanded sections of the Great Wall at great cost to defend themselves against northern invaders. The Tang and Song Dynasties did not build any walls in the region. The Liao, Jin, and Yuan dynasties, who ruled Northern China throughout most of the 10-13th centuries, had their original power bases north of the Great Wall proper; accordingly, they would have no need throughout most of their history to build a wall along this line. The Liao carried out limited repair of the Great Wall in a few areas, however the Jin did construct defensive walls in the 12th century, but those were located much to the north of the Great Wall as we know it, within today's Inner and Outer Mongolia.

The Great Wall concept was revived again during the Ming Dynasty in the 14th century, and following the Ming army's defeat by the Oirats in the Battle of Tumu in 1449. The Ming had failed to gain a clear upper hand over the Manchurian and Mongolian tribes after successive battles, and the long-drawn conflict was taking a toll on the empire. The Ming adopted a new strategy to keep the nomadic tribes out by constructing walls along the northern border of China. Acknowledging the Mongol control established in the Ordos Desert, the wall followed the desert's southern edge instead of incorporating the bend of the Huang He.

Unlike the earlier Qin fortifications, the Ming construction was stronger and more elaborate due to the use of bricks and stone instead of rammed earth. As Mongol raids continued periodically over the years, the Ming devoted considerable resources to repair and reinforce the walls. Sections near the Ming capital of Beijing were especially strong.

During the 1440s-1460s, the Ming also built a so-called "Liaodong Wall".

Similar in function to the Great Wall (whose extension, in a sense, it was), but more basic in construction, the Liaodong Wall enclosed the agricultural heartland of the Liaodong province, protecting it against potential incursions by Jurched-Mongol Oriyanghan from the northwest and the Jianzhou Jurchens from the north. While stones and tiles were used in some parts of the Liaodong Wall, most of it was in fact simply an earth dike with moats on both sides.

Towards the end of the Ming Dynasty, the Great Wall helped defend the empire against the Manchu invasions that began around 1600. Even after the loss of all of Liaodong, the Ming army under the command of Yuan Chonghuan held off the Manchus at the heavily fortified Shanhaiguan pass, preventing the Manchus from entering the Chinese heartland. The Manchus were finally able to cross the Great Wall in 1644, after Beijing had fallen to Li Zicheng's rebels, and the gates at Shanhaiguan were opened by the commanding Ming general Wu Sangui, who hoped to use the Manchus to expel the rebels from Beijing. The Manchus quickly seized Beijing, and defeated both the rebel-founded Shun Dynasty and the remaining Ming resistance, establishing the Qing Dynasty rule over the entire China. In 2009, an additional 290 km (180 mi) of previously undetected portions of the wall, built during the Ming Dynasty, were discovered. The newly discovered sections range from the Hushan mountains in the northern Liaoning province, to Jiayuguan in western Gansu province. The sections had been submerged over time by sandstorms which moved across the arid region.

Under Qing rule, China's borders extended beyond the walls and Mongolia was annexed into the empire, so construction and repairs on the Great Wall were discontinued. On the other hand, the so-called Willow Palisade, following a line similar to that of the Ming Liaodong Wall, was constructed by the Qing rulers in Manchuria. Its purpose, however, was not defense but rather migration control.

Ming Dynasty Tombs[1]

The Ming Dynasty Tombs (Chinese: 明十三陵; pinyin: Míng Shí Sān Líng; literally, *Thirteen Tombs of the Ming Dynasty*) are located some 50 kilometers due north of central Beijing, within the suburban Changping District of Beijing

[1] From Wikipedia: http://en.wikipedia.org/wiki/Ming_Dynasty_Tombs.

municipality. The site, located on the southern slope of Tianshou Mountain (originally Mount Huangtu), was chosen on the feng shui principles by the third Ming Dynasty emperor Yongle (1402-1424), who moved the capital of China from Nanjing to its the present location in Beijing. He is credited with envisioning the layout of the Ming-era Beijing as well as a number of landmarks and monuments located therein. After the construction of the Imperial Palace (the Forbidden City) in 1420, the Yongle Emperor selected his burial site and created his own mausoleum.

From the Yongle Emperor onwards, 13 Ming Dynasty Emperors were buried in this area. The Xiaoling Tomb of the first Ming Emperor, Hongwu, is located near his capital Nanjing; the second emperor, Jianwen was overthrown by Yongle and disappeared, without a known tomb. The "temporary" Emperor Jingtai was also not buried here, as the Emperor Tianshun had denied him an imperial burial; instead, Jingtai was buried west of Beijing. The last Ming emperor Chongzhen, who hanged himself in April 1644, named Si Ling by the Qing emperor, was the last to be buried here, but on a much smaller scale than his predecessors.

During the Ming dynasty the tombs were off limits to commoners, but in 1644 Li Zicheng's army ransacked and set many of the tombs on fire before advancing and capturing Beijing in April of that year.

The site of the Ming Dynasty Imperial Tombs was carefully chosen according to Feng Shui (geomancy) principles. According to these, bad spirits and evil winds descending from the North must be deflected; therefore, an arc-shaped area at the foot of the Jundu Mountains north of Beijing was selected. This 40 square kilometer area –enclosed by the mountains in a pristine, quiet valley full of dark earth, tranquil water and other necessities as per Feng Shui – would become the necropolis of the Ming Dynasty.

A seven kilometer road named the "Spirit Way" (Shen Dao) leads into the complex, lined with statues of guardian animals and officials, with a front gate consisting of a three-arches, painted red, and called the "Great Red Gate". The Spirit Way, or Sacred Way, starts with a huge stone memorial archway lying at the front of the area. Constructed in 1540, during the Ming Dynasty, this archway is one of the biggest stone archways in China today.

Farther in, the Shengong Shengde Stele Pavilion can be seen. Inside it, there is a 50-ton tortoise shaped dragon-beast carrying a stone tablet. This was added during Qing times and was not part of the original Ming layout. Four white marble Huabiao (pillars of glory) are positioned at each corner of the stele pavilion. At the top of each pillar is a mythical beast. Then come two Pillars on each side of the road, whose surfaces are carved with the cloud design, and tops are shaped like a rounded cylinder. They are of a traditional design and were originally beacons to guide the soul of the deceased, The road leads to 18 pairs of stone statues of mythical animals, which are all sculpted from whole stones and larger than life size, leading to a three-arched gate known as the Dragon and Phoenix Gate.

Export all coordinates as KML Export all coordinates as GeoRSS Map of all microformatted coordinates Place data as RDF At present, only three tombs are open to the public. There have been no excavations since 1989, but plans for new archeological research and further opening of tombs have circulated. They can be seen on Google earth: Chang Ling, the largest; Ding Ling, whose underground palace has been excavated; and Zhao Ling.

The Ming Tombs were listed as a UNESCO World Heritage Site in August 2003. They were listed along with other tombs under the "Imperial Tombs of the Ming and Qing Dynasties" designation.

The organizing committee wishes you a pleasant stay in Beijing!