The 8th International Conference on Numerical Optimization and Numerical Linear Algebra

November 7-11, 2011

Xiamen, Fujian, China

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Information for Participants

Conference Hotel and Conference Venue

Hotel:	Peony Wanpeng Hotel
	厦门牡丹万鹏宾馆
Address:	No.17-19, Huyuan Road, Siming District, Xiamen
	厦门市思明区虎园路 17-19 号
Venue:	Conference Room No. 1, Science & Art Center, Xiamen University
	厦门大学科学艺术中心一号会议室
Address:	No. 422, Siming South Road, Siming District, Xiamen
	厦门市思明区思明南路 422 号

Arrival

By air: The distance between Xiamen International Airport and the conference hotel is about 14.2km. It will cost you about 40RMB(6.5USD c.a.) to take a taxi. For the invited speakers, you will be picked up at the airport, if you have sent your arrival information to the organizing committee.

By train: There is about 3.8km from Xiamen railway station to the conference hotel. The taxi fare is about 12RMB(2USD c.a.). Xiamen North railway station is 30.3km away from the conference hotel. Participants who arrive there are suggested to take an inter-city high speed train to Xiamen railway station first (22min., 9RMB).

On-site Registration

On-site registration will take place at the **lobby of Peony Wanpeng Hotel** on **November 6** from **9:00-21:00**. If you want to register at other time, please contact our conference secretary Ms. Jiping Wu.

Currency

Chinese currency is RMB. The current rate is about 6.34 RMB for 1 US dollar. The exchange of foreign currency can be done at the airport or the conference 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. Please notice that some additional processing fee will be charged if you exchange currency in China.

Transportation to Conference Venue

For participants accommodated at our conference hotel (Peony Wanpeng Hotel), in each morning and evening of November 7-9, there will be conference shuttle buses transferring between our conference hotel and conference venue at Xiamen University. The detailed schedule is as follows:

- Start at **07:40** from **Hotel Lobby** to **Science & Art Center**
- Start at **18:10** for **Science & Art Center** to **Hotel Lobby**

In the evening of Nov 9, the schedule will be slightly changed due to the conference banquet, but the shuttle buses will still send all the participants stayed at our conference hotel back.

For participants who don't stay at our conference hotel or miss the time, we are not responsible for your transportation cost.

Contact Information

If you need any help, please feel free to contact

- Dr. Xin Liu: +86-138-1000-2122
- Ms. Jiping Wu: +86-136-9106-6084 (in Chinese)

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The 8th International Conference on Numerical Optimization and Numerical Linear Algebra

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Conference Schedule

November 7, Monday

08:00-08:30 Opening Ceremony

- **08:00-08:10 Welcome Address**
- **08:10-08:30 Group Photo**

08:30-10:20 Invited Talks V1
Chair: Y.X. Yuan

- **08:30-09:30 M.J.D. Powell**, The Lagrange Method and SAO with Bounds on the Dual Variables
- **09:30-10:20 X.J. Chen**, Regularized Least Squares Optimization for Sparse Approximations

10:20-10:40 Coffee Break

10:40-11:30 Invited Talks V2
Chair: M. Fukushima

- **10:40-11:30 G. Di Pillo**, An active set feasible method for large-scale minimization problems with bound constraints

11:30-12:30 Contributed Talks C1
Chair: X.J. Chen

- **11:30-11:50 Y. Zhang**, Computing Dominant SVD of Large and Unstructured Matrices
- **11:50-12:10 B. Morini**, New Preconditioner Updates Applied to Optimization Problems

12:10-12:30 **B. Yu**, Hybrid Divide-and-Conquer Methods for Solving Polynomial Systems

12:30-14:00 Lunch (Cafeteria, Xiamen University)

14:00-16:00 Contributed Talks C2

Chair: G. Di Pillo

14:00-14:20 **L.W. Zhang**, On the Second-order Directional Derivatives of Singular Values of Matrices and Symmetric Matrix-valued Functions

14:20-14:40 **L.C. Matioli**, Two New Augmented Lagrangian Algorithms with Quadratic Penalty for Equality Problems

14:40-15:00 **Q.N. Li**, A Sequential Semismooth Newton Method for the Nearest Low-Rank Correlation Matrix Problem

15:00-15:20 **Z.N. Li**, Approximation Methods for Polynomial Optimization

15:20-15:40 **M. Tao**, Splitting Algorithms for Separate Convex Programming

15:40-16:00 **B. Jiang**, Adaptive Feasible Barzilai-Borwein-like Method for Optimization Problems with Orthogonality Constraints

16:00-16:20 Coffee Break

16:20-18:00 Contributed Talks C3

Chair: Y.H. Dai

16:20-16:40 **Z.W. Wen**, Decentralized Low-Rank Matrix Completion

16:40-17:00 **J.D. Griffin**, A Parallel Krylov-based Interior-point Solver for Large-scale SVM

17:00-17:20 **W. Bian**, Complexity Analysis of Smoothing Methods for the $l_2 - l_p$ Optimization Problem

17:20-17:40 **B.L. Chen**, Maximum Block Improvement and Polynomial Optimization

17:40-18:00 **X. Liu**, On Global Optimality of a Nonconvex Model for Low-rank Matrix Completion

18:30 Dinner (Restaurant, Peony Wanpeng Hotel)

November 8, Tuesday

08:00-10:30 Invited Talks V3

Chair: Y. Zhang

08:00-08:50 **M. Fukushima**, Row Action Methods for Solving L1-L2 Optimization Problems

08:50-09:40 **N.H. Xiu**, Some Relaxation Results on Matrix Rank Minimization Problems

09:40-10:30 **C.T. Kelley**, Sparse Interpolatory Reduced-Order Models for Simulation of Light-Induced Molecular Transformations

10:30-10:50 Coffee Break

10:50-12:30 Invited Talks V4

Chair: B.S. He

10:50-11:40 **O. Burdakov**, Local search for Hop-constrained Directed Steiner Tree Problem with Application to UAV-based Multi-Target Surveillance

11:40-12:30 **Y.M. Wei**, Condition Numbers for Moore-Penrose Inverse, Linear Least Squares, Total Least Squares, Matrix Equations and Tikhonov Regularization

12:30-14:00 Lunch (Cafeteria, Xiamen University)

14:00-16:00 Contributed Talks C4

Chair: N.H. Xiu

14:00-14:20 **Y.Q. Bai**, Semidefinite Optimization Relaxation for Semi-supervised Support Vector Machines

14:20-14:40 **E.W. Karas**, An Optimal Algorithm for Minimizing Convex Functions on Simple Sets

14:40-15:00 **X.Y. Liu**, Perturbation Analysis of the Maximal Solution for SARE

15:00-15:20 **Z.H. Li**, A Fast Subspace Method for Seismic Inversion

15:20-15:40 **J.W. Chen**, A Well-posedness for a System of Constrained Set-valued Variational Inequalities

15:40-16:00 **X. Wang**, A New Trust Region Algorithm for Equality Constrained Optimization Based On the Augmented Lagrangian Function

16:00-16:20 Coffee Break

16:20-18:00 Contributed Talks C5

Chair: W.Y. Sun

16:20-16:40 **D.R. Han**, An ADM-based Splitting Method for Separable Convex Programming

16:40-17:00 **P. Richtárik**, Efficiency of Randomized Block-Coordinate Descent Methods for Minimizing a Composite Function

17:00-17:20 **C. Zhang**, Nonconvex ℓ_p-Regularization and Box Constrained Model for Image Restoration

17:20-17:40 **F.L. Yang**, A Relaxed Fixed Point Method for Mean Curvature-Based Denoising Model

17:40-18:00 **Z.K. Zhang**, Sobolev Seminorm of Quadratic Functions with Applications to Derivative-Free Optimization

18:30 Dinner (Restaurant, Peony Wanpeng Hotel)

November 9, Wednesday

08:00-10:30 Invited Talks V5

Chair: C.T. Kelley

- **08:00-08:50** **L.N. Trefethen**, Robust Rational Interpolation and Padé Approximation
- **08:50-09:40** **R. Chan**, Framelet-Based Algorithm for Medical Imaging Applications
- **09:40-10:30** **S.L. Zhang**, An Arnoldi-like approach for Generalized Eigenvalue Problems

10:30-10:50 Coffee Break

10:50-12:30 Invited Talks V6

Chair: O. Burdakov

- **10:50-11:40** **T. Koch**, What could a million CPUs do to solve Integer Programs?
- **11:40-12:30** **H.C. Zhang**, A C^0 Interior Penalty Method for the Fourth Order Obstacle Problem with Nonhomogeneous Dirichlet Boundary

12:30-14:00 Lunch (Cafeteria, Xiamen University)

14:00-16:00 Contributed Talks C6

Chair: R. Chan

- **14:00-14:20** **G.L. Yuan**, Analysis of Conjugate Gradient for Nonsmooth Problems
- **14:20-14:40** **Z.Y. Huang**, Explicit Resolvent Numerical Methods for Systems of General Variational Inclusions
- **14:40-15:00** **X.F. Wang**, The Linearized Alternating Direction Method for Dantzig Selector
- **15:00-15:20** **L.Y. Yuan**, A Novel Filled Function Method for Nonlinear Equations
- **15:20-15:40** **T. Sun**, Adaptive Surface-related Multiple Substraction Using Sparseness Norm Method
- **15:40-16:00** **C. Sun**, A Hybrid Algorithm for Power Maximization Interference Alignment Problem of MIMO Channels

16:00-16:20 Coffee Break

16:20-18:00 Contributed Talks C7

Chair: X. Liu

16:20-16:40 **Z.J. Bai**, Nonnegative Inverse Eigenvalue Problems with Partial Eigendata

16:40-17:00 **Y.F. Zhang**, Stochastic Variational Inequalities: Residual Minimization Smoothing/Sample Average Approximations

17:00-17:20 **X.L. Fu**, A Self-adaptive Relaxed-PPA Contraction Method for Convex Programming with Linear Constraints

17:20-17:40 **H.L. Sun**, Approximations of Joint Chance Constrained Optimization Problems

17:40-18:00 **L.Q. Wu**, A New Solution Concept in a 3-player Cooperative Game

18:00-18:10 Closing Ceremony

18:30 Conference Banquet

November 10, Thursday

8:00 Start from the Conference Hotel

Fujian Tulou - whole day excursion

18:30 Dinner (Restaurant, Peony Wanpeng Hotel)

November 11, Friday

8:00 Start from the Conference Hotel

Gulangyu Island - half day excursion

12:30 Lunch (Restaurant, Peony Wanpeng Hotel)

Abstracts

Part I

Invited Talks

Local Search for Hop-constrained Directed Steiner Tree Problem with Application to UAV-based Multi-target Surveillance

Oleg Burdakov

Given a weighted directed graph with a selected root node and a set of terminal nodes, the directed Steiner tree problem (DSTP) is to find a directed tree of the minimal weight which is rooted in the root node and spanning all terminal nodes. We consider the DSTP with a constraint on the total number of arcs (hops) in the tree. This problem is known to be NP-hard, and therefore, only heuristics can be applied in the case of its large-scale instances.

For the hop-constrained DSTP, we propose local search strategies aimed at improving any heuristically produced initial Steiner tree. They are based on solving a sequence of hop-constrained shortest path problems for which we have recently developed efficient label correcting algorithms.

The approach presented in this talk is applied to solving the problem of 3D placing unmanned aerial vehicles (UAVs) used for multi-target surveillance. The efficiency of our algorithms is illustrated by results of numerical experiments.

Framelet-Based Algorithm for Medical Imaging Applications

Raymond H. Chan

Framelets have been used successfully in various problems in image processing, including inpainting, impulse noise removal, super-resolution image restoration, etc. It has been shown that the framelet approach is equivalent to a special variational method. In this talk, we will introduce the method and the theory behind the method. We will show how the method can be applied to various image processing problem and finish with two new applications of the method in medical imaging. The first one is segmentation of tube-like structures such as blood vessels in magnetic resonance angiography images. The second application is image reconstruction for parallel magnetic resonance imaging.

Regularized Least Squares Optimization for Sparse Approximations

Xiaojun Chen

We consider linear least squares problems with nonconvex regularization and their applications in variable selection and image reconstruction. For unconstrained problems with l_p norm $(0 < p < 1)$ regularization, we show that finding a global optimal solution is strongly NP-hard and present lower bounds of nonzero entries in every local optimal solution. Such lower bounds can be used to classify zero and nonzero entries in local optimal solutions and select regularization parameters for desirable sparsity of solutions. For box constrained problems with first-order difference regularization operator, we show that the difference between any two entries of a local optimal solution is either 0 or larger than a computable number. Moreover, we present a smoothing conjugate gradient method which can find a stationary point of the nonsmooth, nonconvex regularized least squares problem from any starting point.

This talk reprents join work in the following papers

1. X. Chen, D. Ge, Z. Wang and Y.Ye, Complexity of unconstrained $L_2 - L_p$ minimization, May 2011.

2. X. Chen, M. K. Ng and C. Zhang, Nonconvex l_p regularization and box constrained model for image restoration, December, 2010 submitted to SIAM J. Imaging Sciences, under revision.

3. X. Chen, F. Xu and Y. Ye, Lower bound theory of nonzero entries in solutions of $l_2 - l_p$ minimization, SIAM J. Scientific Computing, 32(2010), 2832-2852.

4. X. Chen and W. Zhou, Smoothing nonlinear conjugate gradient method for image restoration using nonsmooth nonconvex minimization, SIAM J. Imaging Sciences 3(2010), 765-790.

An Active Set Feasible Method for Large-scale Minimization Problems with Bound Constraints

G. Di Pillo

We are concerned with the solution of the bound constrained minimization problem $\{\min f(x), l \leq x \leq u\}$. For the solution of this problem we propose an active set method that combines ideas from projected and nonmonotone Newton-type methods. It is based on an iteration of the form $x^{k+1} = [x^k + \alpha^k d^k]^\sharp$, where α^k is the steplength, d^k is the search direction and $[\cdot]^\sharp$ is the projection operator on the set $[l, u]$. At each iteration a new formula to estimate the active set is first employed. Then the components d_N^k of d^k corresponding to the free variables are determined by a truncated Newton method, and the components d_A^k of d^k corresponding to the active variables are computed by a Barzilai-Borwein gradient method. The steplength α^k is computed by a nonmonotone stabilization technique. The method is a feasible one, since it maintains feasibility of the iterates x^k, and is well suited for large-scale problems, since it uses matrix-vector products only in the truncated Newton method for computing d_N^k. We prove the convergence of the method, with superlinear rate under usual additional assumptions. An extensive numerical experimentation performed on an algorithmic implementation shows that the algorithm compares favorably with other widely used codes for bound constrained problems.

Joint work with M. De Santis and S. Lucidi.

Row Action Methods for Solving $L_1 - L_2$ Optimization Problems

Masao Fukushima

The $L_1 - L_2$ problem is a convex optimization problem which is to minimize the sum of the squared L2 norm of the residual of linear equations and the L1 norm of the vector of variables. This problem has recently drawn much attention in various application areas such as signal and image reconstruction and restoration. Row action methods are iterative methods for systems of linear equations or inequalities, with such a particular feature that, in a single iterative step, access is required to only one row of the matrix involved, which enables us to deal with huge problems in a simple manner. The aim of this talk is to show that particular types of row action methods can effectively be applied to solve the $L_1 - L_2$ problem. More specifically, by way of Fenchel duality, we transform the problem into an optimization problem involving linear interval constraints, and then apply an SOR-type or a Jacobi-type row action method to the latter problem. We show that the methods are globally convergent and can be implemented in a particularly simple manner. Relations with coordinate minimization methods are also discussed.

Sparse Interpolatory Reduced-Order Models for Simulation of Light-Induced Molecular Transformations

C.T. Kelley

We describe an efficient algorithm for using a quantum-chemistry simulator to drive a gradient descent algorithm. Our objective is to model light-induced molecular transformations. The simulator is far too expensive and the design space too high-dimensional for the simulator to be used directly to drive the dynamics. We begin by applying domain-specific knowledge to reduce the dimension of the design space. Then we use sparse interpolation to model the energy from the quantum code on hyper-cubes in configuration space, controlling the volume of the hyper-cubes both to maintain accuracy and to avoid failure of the quantum codes internal optimization. We will conclude the presentation with some examples that illustrate the algorithm's effectiveness.

What Could a Million CPUs do to Solve Integer Programs?

T. Koch

Given the steady increase in cores per CPU, it is only a matter of time until supercomputers will have a million or more cores. In this talk, we investigate the opportunities and challenges that will arise when trying to utilize this vast computing power to solve a single integer linear optimization problem. We also raise the question of whether best practices in sequential solution of ILPs will be effective in massively parallel environments.

The Lagrange Method and SAO with Bounds on the Dual Variables

M.J.D. Powell

In the Lagrange method for constrained optimization, estimates of the Lagrange multipliers (dual variables), $\underline{\lambda} \in \mathcal{R}^m$ say, are adjusted in an outer iteration, and the Lagrange function $L(\underline{x}, \underline{\lambda})$, $\underline{x} \in \mathcal{X}$, is minimized for each $\underline{\lambda}$, where $\underline{x} \in \mathcal{R}^n$ is the vector of primal variables, and where $\mathcal{X}$ is a prescribed compact subset of $\mathcal{R}^n$. Let $\phi(\underline{\lambda})$ be the least value of $L(\cdot, \underline{\lambda})$. Assuming only that all functions are continuous, it is proved that $\phi(\underline{\lambda})$, $\underline{\lambda} \in \mathcal{R}^m$, is concave. Further, if the minimizer of $L(\cdot, \underline{\lambda})$ is unique, then $\phi(\underline{\lambda})$ is differentiable at $\underline{\lambda} \in \mathcal{R}^m$, the components of $\underline{\nabla}\phi(\underline{\lambda})$ being values of the constraint functions. These properties, and some difficulties that occur when the minimizer of $L(\underline{x}, \underline{\lambda})$, $\underline{x} \in \mathcal{X}$, is not unique, are illustrated by an example that has two variables and one equality constraint.

The name SAO stands for Sequential Approximate Optimization. Now quadratic approximations are made to the objective and constraint functions of the given calculation, and the method above is applied using these approximations instead of the original functions, the approximations being updated in an outermost iteration. They have diagonal second derivative matrices, in order that minimizing every $L(\cdot, \underline{\lambda})$ is easy, which allows n to be huge. The quadratic constraints are often inconsistent, however, so the bounds $\|\underline{\lambda}\|_\infty \leq \Lambda$ may be imposed for some constant Λ. It is proved that, if $\underline{\lambda}$ maximizes $\phi(\underline{\lambda})$ subject to $\|\underline{\lambda}\|_\infty \leq \Lambda$, and if a unique vector $\underline{x}(\underline{\lambda}) \in \mathcal{X}$ minimizes $L(\cdot, \underline{\lambda})$, then $\underline{x}(\underline{\lambda})$ minimizes the objective function plus Λ times the L_1 norm of the violations of the current constraints. This result is highly useful for controlling the updating of the quadratic approximations in the outermost iteration of the SAO method.

Robust Rational Interpolation and Padé Approximation

Lloyd N. Trefethen

Approximating functions or data by polynomials is an everyday tool, starting with Taylor series. Approximating by rational functions can be much more powerful, but also much more troublesome. In different contexts rational approximations may fail to exist, fail to be unique, or depend discontinuously on the data. Some approximations show forests of seemingly meaningless pole-zero pairs or "Froissart doublets", and when these artifacts should not be there in theory, they often appear in practice because of rounding errors on the computer. Yet for some applications, like extrapolation of sequences and series, rational approximations are indispensable.

In joint work with Pedro Gonnet and Ricardo Pachon we have developed an elementary method to get around most of these problems in rational interpolation and least-squares fitting, based on the singular value decomposition. The talk will include many examples.

Condition Numbers for Moore-Penrose Inverse, Linear Least Squares, Total Least Squares, Matrix Equations and Tikhonov Regularization

Yimin Wei

Classical condition numbers are normwise: they measure the size of both input perturbations and output errors using some norms. To take into account the relative of each data component, and, in particular, a possible data sparseness, componentwise condition numbers have been increasingly considered. These are mostly of two kinds: mixed and componentwise. In this talk, we give explicit expressions, computable from the data, for the mixed and componentwise condition numbers for the computation of the Moore-Penrose inverse as well as for the computation of solutions and residues of linear least squares problems, total least squares, Sylvester equations and Tikhonov regularization.

Some Relaxation Results on Matrix Rank Minimization Problems

Naihua Xiu

The matrix rank minimization problem (RMP) is to minimize a rank function 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 minimization problems is popular in optimization community, but it is generally NP-hard. In order to solve RMPs, many researchers proposed a lot of relaxation approaches.

In this talk, we review various relaxation models and corresponding theoretical results for RMPs: (1) convex relaxation model and its theory; (2) nonconvex relaxation models and their theory; (3) smoothed relaxation model and its theory; (4) others. In the last of this talk, we show some future work on the matrix rank minimization problems.

Joint work with Lingchen Kong and Levent Tunçel.

A C^0 Interior Penalty Method for the Fourth Order Obstacle Problem with Nonhomogeneous Dirichlet Boundary

Hongchao Zhang

I will introduce a quadratic C^0 interior penalty finite element method for a fourth-order variational inequality with nonhomogeneous Dirichlet boundary conditions on general polygonal domains. Under proper conditions, the magnitudes of the errors of the method in the energy norm and the L_∞ norm are $O(h^\alpha)$, where h is the mesh size and $\alpha > 1/2$ is determined by the interior angles of the polygonal domain. An active-set optimization algorithm is applied to solve the discretized finite element model. Our numerical results give interesting observations on the accuracy of the method, and on the numerical approximations of the coincidence set and the free boundary.

An Arnoldi-like Approach for Generalized Eigenvalue Problems

Shao-Liang Zhang

The Arnoldi was proposed to compute a few eigenpairs of large-scale generalized eigenvalue problems. For the iterative computation of eigenpairs, this method generates the basis of a subspace by solving linear systems. This leads to considerable computation time for the large-scale problems. In this talk, to reduce the computation time,we try to propose an Arnoldi(M,W,G) approach based on the Arnoldi method.

Part II

Contributed Talks

Semidefinite Optimization Relaxation for Semi-supervised Support Vector Machines

Yanqin Bai

Protein homology detection is a core problem in bioinformatics that helps annotating protein structural and functional features. It can be naturally formed as a mixed integer programming (MIP) problem with semi-supervised support vector machines (SVM), which are accurate discriminative methods for classification. This paper presents two new semidefinite programming (SDP) models for protein homology detection by using novel transformations of the MIP problem. Both models reduce the problem size significantly compared with the existing SDP models. Numerical experiments show that our first SDP model outperforms other methods in terms of misclassification errors for both synthetic data and the real data from Protein Classification Benchmark Collection.

Nonnegative Inverse Eigenvalue Problems with Partial Eigendata

Zhengjian Bai

In this paper, we consider the inverse problem of constructing an n-by-n real nonnegative matrix A from prescribed partial eigendata. We reformulate the inverse problem as a monotone complementarity problem and then propose a nonsmooth Newton-type method for solving the nonsmooth equation related to the monotone complementarity problem. Under some very mild assumptions, we show that our method has simultaneously a global and quadratic convergence. We also specialize our method to the symmetric nonnegative inverse problem, and to the cases of a prescribed lower bound and of prescribed entries. Numerical tests demonstrate the efficiency of the proposed method and support our theoretical findings.

Complexity Analysis of Smoothing Methods for the $l_2 - l_p$ Optimization Problem

Wei Bian

We propose a new algorithm for solving the $l_2 - l_p$ minimization problem with $0 < p < 1$, based on smoothing techniques and proximal gradient method. By using a class of smooth and convex optimization problems, we give the convergence and complexity analysis of the proposed algorithm. Some experiments are given to show the effectiveness and performance of he proposed algorithms.

This is a join work with Xiaojun Chen.

Maximum Block Improvement and Polynomial Optimization

Bilian Chen

In this work we propose an efficient method for solving the spherically constrained homogeneous polynomial optimization problem. The new approach has the following three main ingredients. First, we establish a block coordinate descent type search method for nonlinear optimization, with the novelty being that we only accept a block update that achieves the maximum improvement, hence the name of our new search method: *Maximum Block Improvement* (MBI). Convergence of the sequence produced by the MBI method to a stationary point is proven. Second, we establish that maximizing a homogeneous polynomial over a sphere is equivalent to its tensor relaxation problem, thus we can maximize a homogeneous polynomial function over a sphere by its tensor relaxation via the MBI approach. Third, we propose a scheme to reach a KKT point of the polynomial optimization, provided that a stationary solution for the relaxed tensor problem is available. Numerical experiments have shown that our new method works very efficiently: for a majority of the test instances that we have experimented with, the method finds the global optimal solution at a low computational cost.

This is a joint work with Simai He, Zhening Li, and Shuzhong Zhang.

a-well-posedness for a System of Constrained Set-valued Variational Inequalities

Jiawei Chen

In this paper, the notions of a-well-posedness and generalized a-well-posedness for a system of constrained variational inequalities involving set-valued mappings (for short, (SCVI)) are introduced in Hilbert spaces. Existence theorems of solutions for (SCVI) are established by using penalty techniques. Metric characterizations of a-well-posedness and generalized a-well-posedness, in terms of the approximate solutions sets, are presented. Finally, the equivalences between (generalized) a-well-posedness for (SCVI) and existence and uniqueness of its solutions are also derived under quite mild assumptions.

This is a joint work with Zhongping Wan.

A Self-adaptive Relaxed-PPA Contraction Method for Convex Programming with Linear Constraints

Xiaoling Fu

In this paper, we present a novel algorithm for solving linearly constrained convex programming. Our algorithmic framework employs an implementable proximal step by a slight relaxation to the subproblem of proximal point algorithm (PPA). In particular, our algorithm is simple yet effective in the case that the objective function is preferable to a proximal step. Self-adaptive strategies are proposed to improve the convergence in practice. We theoretically show under wild conditions that our method converges in a global sense. Finally, we discuss applications and perform numerical experiments which confirm the efficiency of the proposed method. Comparisons of our method with some state-of-art algorithms are also provided.

A Parallel Krylov-based Interior-point Solver for Large-scale SVM

Joshua David Griffin

This talk will discuss an implementation of a parallel Krylov-based interior-point algorithm for solving large scale support vector machine problems using both linear and polynomial-based kernels. Active-set preconditioning is used to exploit the property that, for many SSM optimization problems, the number of support vector tends to be much smaller than the number of data-points (which can be in the millions). Unfortunately, iterative approaches for interior-point methods often suffer the stigma that they are incapable of yielding the same accuracy as direct-factorization counterparts. A benefit of active-set preconditioning is that theory exist proving the preconditioners are exact in the limit; hence the solution accuracy from an iterative interior-point algorithm using active-set preconditioners should be no different than direct-factorization approaches. Parallel linear-algebra operations are used on distributed data-sets to exploit the availability of multiple cores and processors. Extensive numerical results will be presented.

An ADM-based Splitting Method for Separable Convex Programming

Deren Han

We consider the linearly constrained convex program with a block-separable structure in which the objective function is the sum of three functions without coupled variables. To develop an algorithm for such a structured problem, the easiest idea is to extend the alternating direction method (ADM) which is well known as an efficient solver for the simpler case where the objective function is a sum of two convex functions. This straightforward extension of ADM, however, is not theoretically guaranteed to converge, even though its numerical efficiency has been verified empirically in the literature. This paper presents an ADM-based splitting method for solving the structured problem under consideration. The new method differs from the straightforward extension of ADM only in some slight correction computation, and the resulting subproblems of these two methods are of the same level of difficulty. We prove the global convergence of the new metod under standard assumptions, and we show the efficiency of the new method by some applications in the areas of image processing and statistics.

Explicit Resolvent Numerical Methods for Systems of General Variational Inclusions

Zhenyu Huang

In this talk, we will introduce and consider a new system of extended general variational inclusions involving eight different operators and we will use the resolvent operator techniques to show that the new system of extended general variational inclusions is equivalent to the fixed point problem. Some new explicit numerical methods in general scheme are provided with strong convergence. Our results improve and extend some recent results with easier implement and less computational workload.

Adaptive Feasible Barzilai-Borwein-like Method for Optimization Problems with Orthogonality Constraints

Bo Jiang

In this talk, we consider the adaptive feasible Barzilai-Borwein (BB)-like methods for optimization problems with orthogonality constraints. Firstly, we give some reviews of the existing feasible update schemes for orthogonality constraints. Secondly, we introduce a new class of feasible update schemes which are based on a novel idea. Then, we propose the adaptive BB-like methods. Some numerical tests are also presented.

This work is jointed with Yu-Hong Dai.

An Optimal Algorithm for Minimizing Convex Functions on Simple Sets

Elizabeth W. Karas

We describe an algorithm based on Nesterov's and on Auslender and Teboulle's ideas for minimizing a convex Lipschitz continuously differentiable function on a simple convex set (a set into which it is easy to project a vector). The algorithm does not depend on the knowledge of any Lipschitz constant, and it achieves a precision ε for the objective function in $O(1/\sqrt{\varepsilon})$ iterations. We describe the algorithm, the main complexity result and some computational experiments.

A Sequential Semismooth Newton Method for the Nearest Low-Rank Correlation Matrix Problem

Qingna Li

In this talk, we consider the nearest correlation matrix problem with rank constraint. Based on the well known result that the sum of largest eigenvalues of a symmetric matrix can be represented as a semidefinite programming problem (SDP), we formulate the problem as a nonconvex SDP and propose a numerical method that solves a sequence of least-square problems. Each of the least-square problems can be solved by a specifically designed semismooth Newton method, which is shown to be quadratically convergent.The sequential method is guaranteed to produce a stationary point of the nonconvex SDP. Our numerical results demonstrate the high efficiency of the proposed method on large scale problems.

A Fast Subspace Method for Seismic Inversion

Zhenhua Li

A robust subspace method is applied to seismic inversion with Gaussian beam representations of Green's function. The linearized inversion of seismic data for reflectivity model usually requires solving a weighted least square problem. It is well known that iteratively solving this problem is very time consuming, which makes it less possible for practical use. If harmonic solution of Green's function is adopted, the weighted least square inversion can be efficiently performed by FFT or GRT. However, using this kind of method will generate great error when an inaccurate velocity model is used or the depth is large. In this paper, we represent the Green's function by a summation of Gaussian beams and accelerate the inversion using a subspace method. Previous research is mainly on solving the inverse model in a full space. The subspace method is originated from optimization theory and is implanted into seismic inversion for the first time. The problem is first formulated by incorporating regularizing constraints, and then it is changed from full space to subspace and it is solved by a trust-region method. To test the potential of the application of the developed method, synthetic data simulation and field data application are performed. The numerical experiments show that this method is promising for ill-posed reverse scattering problems in seismic inversion.

This is a joint work with Yanfei Wang.

Approximation Methods for Polynomial Optimization

Zhening Li

Polynomial optimization is an emerging field in optimization, attracting an increasing amount of attentions in the recent years. It has applications in a large range of areas, including biomedical engineering, control theory, investment science, numerical linear algebra, quantum mechanics, signal processing, etc. In this work, we aim at developing computational methods to deal with optimization models with polynomial objective functions in any fixed degrees, over some commonly encountered constraint sets. All the problems under consideration are NP-hard in general, and the focus is on design and analysis of polynomial-time approximation algorithms with guaranteed worst-case performance ratios. These approximation ratios are dependent on the problem dimensions only. We also discuss some recent improvements of the approximation bounds for some subclasses of polynomial optimization models.

This is a joint work with Simai He and Shuzhong Zhang.

Perturbation Analysis of the Maximal Solution for SARE

Xiaoyi Liu

Consider the maximal solution of stochastic algebraic Riccati equation which arises in stochastic linear-quadratic optimal control problem. In this paper, a perturbation bound for the maximal solution is derived, and an explicit expression of its condition number is obtained. The results are illustrated by using some numerical examples.

On Global Optimality of a Nonconvex Model for Low-rank Matrix Completion

Xin Liu

It has been observed that for some nonconvex minimization problems with generic data local optimization algorithms seem to be able to find global minimizers with extremely high probability (such as in the case of solving low-rank matrix completion problems with solver LMaFit). We will report some preliminary analytic results, obtained on a nonconvex model for low-rank matrix completion, in an effort of trying to understand this curious phenomenon. Some open questions will be raised as well.

Joint work with Yin Zhang.

Two New Augmented Lagrangian Algorithms with Quadratic Penalty for Equality Problems

Luiz Carlos Matioli

In this paper we present two augmented Lagrangian methods applied to nonlinear programming problems with equality constraints. Both use quadratic penalties and the structure of modern methods to problems with inequality constraints. Therefore, they can be seen as augmented Lagrangian applied to problem with inequality constraints extended to problems with equality constraints without additional of slack variables. In the main result of the paper, we show that under conventional hypotheses the augmented Lagrangian function generated by the two methods has local minimizer, as in the case of the proposed method by Hestenes and Powell. Comparative numerical experiments on CUTEr problems are presented to illustrate the performance of the algorithms.

New Preconditioner Updates Applied to Optimization Problems

Benedetta Morini

We consider sequences of large and sparse linear systems of the form $(A + D_j)x_j = b_j, j = 1, ..., m$, where A is a symmetric positive definite matrix and D_j are positive semidefinite diagonal matrices. Such sequences often arise in optimization, e.g. in trust-region and regularization subproblems, Levenberg-Marquadt approaches, affine scaling methods for quadratic programming, and nonlinear least-squares. Our interest is in the case where the systems are solved by preconditioned Krylov methods. Since the spectral properties of the matrices of the sequence may considerably differ, it may be inappropriate to use a frozen preconditioner for all the systems. Therefore, we investigate how to form an efficient preconditioner for each system of the sequence without recomputing the preconditioner from scratch. The proposed strategies can reduce considerably the overall computational cost. In this talk, we discuss techniques to update an incomplete LDL^T factorization of the matrix A. The procedures presented extend the previous work on shifted systems and are cheap and easy to implement. A theoretical justification of our approaches is presented along with numerical experiments illustrating their performance.

This is a joint work with Stefania Bellavia, Valentina De Simone and Daniela di Serafino.

Efficiency of Randomized Block-Coordinate Descent Methods for Minimizing a Composite Function

Peter Richtárik

We develop a randomized block-coordinate descent method for minimizing the sum of a smooth and a simple nonsmooth block-separable convex function and prove that it obtains an ϵ-accurate solution with probability at least $1-\rho$ in at most $O((2n/\epsilon)\log(1/\rho))$ iterations, where n is the dimension of the problem. For strongly convex functions the method converges linearly. This extends recent results of Nesterov [Efficiency of coordinate descent methods on huge-scale optimization problems, CORE Discussion Paper #2010/2], which cover the smooth case, to composite minimization, while at the same time improving the complexity by the factor of 4 and removing ϵ from under the logarithm. More importantly, in contrast with the aforementioned work in which the authors achieve the results by applying their method to a regularized version of the objective function with an unknown scaling factor, we show that this is not necessary, thus achieving true iteration complexity bounds. In the smooth case we also allow for arbitrary probability vectors and non-Euclidean norms. We demonstrate numerically that the algorithm is able to solve huge-scale ℓ_1-regularized support vector machine and least squares problems with billion variables. Finally, we present computational results with a GPU-accelerated parallel version of the method, achieving speedups of up to two orders of magnitude when compared to a single-core implementation in C.

This is a joint work with Martin Takáč.

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

Cong Sun

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 preserve 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. Simulations show that the proposed hybrid algorithm obtains better performance than the existed algorithm.

Approximations of Joint Chance Constrained Optimization Problems

Hailin Sun

Conditional Value at Risk (CVaR) has been recently used to approximate a chance constraint. In this paper, we study the convergence of stationary points when sample average approximation (SAA) method is applied to a CVaR approximated joint chance constrained stochastic minimization problem. Specifically, we prove, under some moderate conditions, that optimal solutions and stationary points obtained from solving sample average approximated problems converge with probability one (w.p.1) to their true counterparts. Moreover, by exploiting the recent results on large deviation of random functions and sensitivity results for generalized equations, we derive exponential rate of convergence of stationary points and give an estimate of sample size. The discussion is extended to the case when CVaR approximation is replaced by a DC-approximation. Some preliminary numerical test results are reported.

This is a joint work with Huifu Xu and Yong Wang.

Adaptive Surface-related Multiple Substraction Using Sparseness Norm Method

Tao Sun

The problem of multiple attenuation, which is difficult to solve, is an important problem in the seismic data processing especially in the marine case. A strategy for multiple removal consists of estimating a model of the multiples and then adaptively subtracting this model from the data by estimating shaping filters. A classical approach of this strategy is the surface-related multiple elimination (SRME) method (Berkhout et al., 1997). In the surface-related multiple elimination process the subtraction stage plays an important role, because there are amplitude, phase, and frequency distortions in the predicted multiple model. Typically, in this stage the primaries are assumed to have minimum energy (L_2 norm). Methods using this norm are robust in the presence of noise, but can produce bad results when primaries and multiples interfere (A. Guitton et al, 2004). Replacing the L_2 norm, a sparseness constraint is used in the new approach. The sparseness constraint should give the better result because the correct subtraction of the predicted multiples should lead to a primary estimation with a minimum number of events. The effective results of the new method are illustrated with the synthetic data in the 1D and 2D case. It is showed that the sparseness norm leads to much improved attenuation of the multiples while the minimum energy assumption is violated. The multiples being subtracted is fitted to the multiples in the data, while preserving the energy of primaries.

Splitting Algorithms for Separate Convex Programming

Min Tao

We consider the linearly constrained separable convex programming whose objective function is separable into m individual convex functions with non-overlapping variables. The alternating direction method (ADM) has been well studied in the literature for the special case $m = 2$. But the convergence of extending ADM to the general case $m = 3$ is still open. In this paper, we show several splitting algorithms for the tempt to the extension of ADM. The algorithmic framework of thses splitting algorithms is new in the literature. For all these methods, we prove its convergence via the analytic framework of contractive type methods and convergence rate of $O(1/t)$ in the sense of ergodic. We show its numerical efficiency by some application problems.

The Linearized Alternating Direction Method for Dantzig Selector

Xiangfeng Wang

The Dantzig Selector was recently proposed to perform variable selection and model fitting in the linear regression model, and it can be solved numerically by the alternating direction method (ADM). In this paper, we show that the ADM for Dantzig Selector can be speeded up significantly if one of its resulting subproblems at each iteration is linearized. The resulting linearized ADM for Dantzig Selector is shown to be globally convergent, and its efficiency is verified numerically by both simulation and real world data-sets.

This is a joint work with Xiaoming Yuan.

A New Trust Region Algorithm for Equality Constrained Optimization Based On the Augmented Lagrangian Function

Xiao Wang

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. Moreover, we compare our new algorithm with IPOPT and Matlab function "fmincon", which reveals that the performance of the new method is very promising.

Decentralized Low-Rank Matrix Completion

Zaiwen Wen

This talk introduces algorithms for the decentralized low-rank matrix completion problem. Assume a low-rank matrix $W = [W_1, W_2, ..., W_L]$. In a network, each agent i observes some entries of W_i. In order to recover the unobserved entries of W via decentralized computation, we factorize the unknown matrix W as the product of a public matrix X, common to all agents, and a private matrix $Y = [Y_1, Y_2, ..., Y_L]$, where Y_i is held by agent i. Each agent i alternatively updates Y_i and its local estimate of X while communicating with its neighbors toward a consensus on the estimate. Once this consensus is (nearly) reached throughout the network, each agent i recovers $W_i = XY_i$, and thus W is recovered. The communication cost is scalable to the number of agents, and W_i and Y_i are kept private to agent i to a certain extent. The algorithm is accelerated by extrapolation and compares favorably to the centralized code in terms of recovery quality and robustness to rank over-estimate. This is a joint work with Qing Ling, Yangyang Xu and Wotao Yin. This talk is based on joint works with Xin Chen and Shuzhong Zhang, supported by AFOSR and NSF.

A New Solution Concept in a 3-player Cooperative Game

Leqin Wu

In this talk, we study a three-player cooperative game with transferable utility where the players may form different coalition structures. A new concept of stability of a coalition is introduced, and the existence of a stable coalition is proven. Based on this stability concept, a novel approach is given to determine sensible allocations in a grand coalition of three players.

A joint work with Ye Lu, Xin Chen and Ya-xiang Yuan.

A Relaxed Fixed Point Method for Mean Curvature-Based Denoising Model

Fenlin Yang

Mean curvature-based energy minimization denoising models by Zhu and Chan offer one approach for restoring both smooth (no edges) and non-smooth (with edges) images. The resulting fourth order partial differential equations (PDE) arising from minimization of this model is non-trivial to solve due to appearance of a high nonlinearity and sti?ness term, because simple alternative methods such as the lagged fixed-point method and the primal dual method do not work. In this paper, we first present a relaxed fixed point method for solving such equations and further to combine with a homotopy algorithm to achieve fast convergence. Numerical experiments show that our method is able to maintain all important information in the image, and at the same time to filter out noise.

This is a joint work with Ke Chen and Bo Yu.

Hybrid Divide-and-Conquer Methods for Solving Polynomial Systems

Bo Yu

In this talk, a brief introduction of some hybrid divide-and-conquer methods for solving polynomial systems will be given. At first, for polynomial systems derived from mixed trigonometric polynomial systems, a hybrid homotopy and its improved symmetric version will be introduced, and the sketch of a hybrid divide-and-conquer method for this special class of polynomial systems will be formulated. Then, a framework of a general-purpose hybrid divide-and-conquer method for solving deficient polynomial systems will be given. Some numerical results will also be given to show the efficiency of the proposed algorithm.

Analysis of Conjugate Gradient for Nonsmooth Problems

Gonglin Yuan

The conjugate gradient (CG) method is one of the most popular methods for solving smooth unconstrained optimization problems due to its simplicity and low memory requirement. However, the usage of CG methods are mainly restricted in solving smooth optimization problems so far. The purpose of this report is to present efficient conjugate gradient-type methods to solve nonsmooth optimization problems. By using the Moreau-Yosida regulation (smoothing) approach, we propose a modified Polak-Ribière-Polyak (PRP) CG algorithm for solving a nonsmooth unconstrained convex minimization problem. Our algorithm possesses the following three desired properties. (i) The search direction satisfies the sufficiently descent property and belongs to a trust region automatically; (ii) The search direction makes use of not only gradient information but also function information; (iii) The algorithm inherits an important property of the well-known PRP method: the tendency to turn towards the steepest descent direction if a small step is generated away from the solution, preventing a sequence of tiny steps from happening. Under standard conditions, we show that the algorithm converges globally to an optimal solution. Numerical experiment shows that our algorithm is effective and suitable for solving large-scale nonsmooth unconstrained convex optimization problems.

This is a joint work with Zengxin Wei and Guoyin Li.

A Novel Filled Function Method for Nonlinear Equations

Liuyang Yuan

In this paper a novel filled function method is suggested for solving box-constrained systems of nonlinear equations. Firstly, the original problem is converted into an equivalent global optimization problem. Subsequently, a novel filled function with one parameter is proposed for solving the converted global optimization problem. Some properties of the filled function are studied and discussed. Finally, an algorithm based on the proposed novel filled function for solving systems of nonlinear equations is presented. The objective function value can be reduced by quarter in each iteration of our algorithm. The implementation of the algorithm on several test problems is reported with satisfactory numerical results.

Nonconvex ℓ_p-Regularization and Box Constrained Model for Image Restoration

Chao Zhang

Nonsmooth nonconvex regularization has remarkable advantages for the restoration of piecewise constant images. Constrained optimization can improve the image reconstruction using a priori information. In this paper, we study regularized nonsmooth nonconvex minimization with box constraints for image restoration. We present a computable positive constant θ for using nonconvex nonsmooth regularization, and show that the difference between each pixel and its four adjacent neighbors is either 0 or larger than θ in the recovered image. Moreover, we give an explicit form of θ for the box constrained image restoration model with the non-Lipschitz nonconvex ℓ_p-norm ($0 < p < 1$) regularization. Our theoretical results show that any local minimizer of this imaging restoration problem is composed of constant regions surrounded by closed contours and edges. Numerical examples are presented to validate the theoretical results and show that the proposed model can recover image restoration results very well.

This is a joint work with Xiaojun Chen and Michael K. Ng.

On the Second-order Directional Derivatives of Singular Values of Matrices and Symmetric Matrix-valued Functions

Liwei Zhang

The (parabolic) second-order directional derivatives of singular values of matrices and symmetric matrix-valued functions induced by real-valued functions play important roles in studying second-order optimality conditions for different types of matrix cone optimization problems. We propose a direct way to derive the formula for the second-order directional derivative of any eigenvalue of a symmetric matrix in Torki (2001), from which a formula for the second-order directional derivative of any singular value of a matrix is established. We demonstrate a formula for the second-order directional derivative of the symmetric matrix-valued function. As applications, the second-order derivative for the projection operator over the SDP cone is derived and used to get the second-order tangent set of the SDP cone in Bonnans and Shapiro (2000), and the tangent cone and the second-order tangent set of the epigraph of the nuclear norm are given as well.

Stochastic Variational Inequalities: Residual Minimization Smoothing/Sample Average Approximations

Yanfang Zhang

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. This paper presents a new expected residual minimization (ERM) formulation for a class of SVI. 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. We propose, a globally convergent (a.s.) smoothing sample average approximation (SSAA) method to minimize the residual function; this minimization problem is convex for linear SVI if the expected matrix is positive semi-definite. 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.). Our examples come from applications involving traffic flow problems. We show that the conditions we impose are satisfied and that the solutions, efficiently generated by the SSAA-procedure, have desirable properties.

This is a joint work with Xiaojun Chen and Roger J-B Wets.

Computing Dominant SVD of Large and Unstructured Matrices

Yin Zhang

Singular value decompositions (SVD) is a fundamental computational tool in many data-intensive applications where usually a dominant part of SVD is computed such as in principal component analysis. Various algorithms have been developed for efficiently computing dominant SVD of large sparse matrices, but they may not be the most suitable for large and unstructured matrices. We propose a limited memory Krylov subspace optimization scheme to significantly accelerate the simple subspace iteration scheme. Theoretical and extensive numerical results will be presented showing a superior performance of the proposed algorithm over a wide range of unstructured matrices.

Joint work with Xin Liu and Zaiwen Wen.

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

Zaikun Zhang

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.

List of Participants of ICNONLA 2011

Yanqin Bai

Department of Mathematics
Shanghai University
Shanghai, China
Email: yqbai@shu.edu.cn

Zhengjian Bai

School of Mathematical Sciences
Xiamen University
Xiamen, China
Email: zjbai@xmu.edu.cn

Yuting Bao

School of Mathematics
Nanjing Normal University
Nanjing, China
Email: yutingworld@126.com

Wei Bian

Department of Mathematics
Harbin Institute of Technology
Harbin, China
Email: Bianweilvse520@163.com

Oleg Burdakov

Department of Mathematics
Linkoping University
SE -581 83 Linkoping, Sweden
Email: Oleg.Burdakov@liu.se

Hongyan Cai

Institute of Geology and Geophysics
Chinese Academy of Science
Beijing, China
Email: Hy_cai75@163.com

Raymond H. Chan

Department of Mathematics
Chinese University of Hong Kong
Hong Kong
Email: rchan@math.cuhk.edu.hk

Bilian Chen

Department of Systems Engineering and Engineering Management
The Chinese University of Hong Kong
Shatin，Hong Kong
Email: blchen@se.cuhk.edu.hk

Guizhi Chen

School of Mathematical Sciences
Xiamen University
Xiamen, China
Email: chengz@xmu.edu.cn

Jiawei Chen

School of Mathematics and Statistics
Wuhan University
Wuhan, China
Email: jeky99@126.com

Jinhua Chen

School of Mathematical Sciences
Xiamen University
Xiamen, China
Email: jinxiuchina@xmu.edu.cn

Jun Chen

School of Mathematics and Statistics
Wuhan University
Wuhan, China
Email: flywalkor@sina.com

Ning Chen

School of Mathematics
Nanjing Normal University
Nanjing, China
Email: chenning861212@163.com

Xiaojun Chen

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

Zhong Chen

Department of Mathematics
Yangtze University
Jingzhou, China
Email: czhong@yangtzeu.edu.cn

Dandan Cui

School of Mathematics and Computer Science
Gannan Normal University
Ganzhou, China
Email: cuidandan09@126.com

Yuhong Dai

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

Bin Fan

School of Mathematics and Computer Science
Fujian Normal University
Fuzhou, China
Email: 543308280@qq.com

Jinyan Fan

Department of Mathematics
Shanghai Jiaotong University
Shanghai, China
Email: jyfan@sjtu.edu.cn

Shiqiang Feng

College of Mathematic and Information
China West Normal University
Nanchong, China
Email: cwnufsq@163.com

Yuming Feng

National Science Library
Chinese Academy of Sciences
Beijing, China
Email: fengym@mail.las.ac.cn

Xiaoling Fu

Southest University
Nanjing, China
Email: Fufei1980@163.com

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

Suluan Gao

Department of Mathematics and Information Sciences
Guangxi University
Nanning, China
Email: gaosuluan815@163.com

Joshua David Griffin

Georgia Institute of Technology
Atlanta，USA
Email: Joshua.Griffin@sas.com

Jian Gu

College of Science
Dalian Ocean University
Dalian, China
Email: gujian82@yahoo.cn

Ke Guo

College of Mathematic and Information
China West Normal University
Nanchong, China
Email: robertjo@126.com

Bingsheng He

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

Hongjin He

Department of Mathematics
Nanjing Normal University
Nanjing, China
Email: hehj2003@163.com

Bo Jiang

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

Jianlin Jiang

College of Science
Nanjing University of Aeronautics and Astronautics
Nanjing, China
Email: jiangjianlin_nju@163.com

Elizabeth W. Karas

Departamento de Matemática
Universidade Federal do Paraná
Curitiba, Brasil
Email: ewkaras@ufpr.br

C.Tim Kelley

Department of Mathematics, College of Physical and Mathematical Sciences
North Carolina State University
Raleigh, NC 27695-8205, USA
Email: tim_kelley@ncsu.edu

T. Koch

ZIB
Berlin, Germany
Email: koch@zib.de

Deren Han

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

Chunlin Hao

College of Applied Sciences
Beijing University of Technology
Beijing, Chian
Email: haochl@bjut.edu.cn

Jie Hu

Academy of Mathematics and Systems Science
Chinese Academy of Sciences
Beijing, China
Email: orsc@amt.ac.cn

Yaping Hu

School of Science
East China University of Science and Technology
Shanghai, China
Email: yapinghu@163.com

Zhenyu Huang

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

An Li

School of Mathematical Sciences
Xiamen University
Xiamen, China
Email: anlee@xmu.edu.cn

Meng Li

College of Science
Xi'an Jiaotong University
Xi'an, China
Email: Lm_huijiale@stu.xjtu.edu.cn

Jinghui Li

School of Mathematics and Computer Science
Fujian Normal University
Fuzhou, China
Email: liujh07@qq.com

Qingna Li

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

Zhenhua Li

Institute of Geology and Geophysics
Chinese Academy of Science
Beijing, China
Email: lizhenhua@mail.iggcas.ac.cn

Zhening Li

Department of Mathematics
Shanghai University
Shanghai, China
Email: zheningli@shu.edu.cn

Yanan Lin

School of Mathematical Sciences
Xiamen University
Xiamen, China
Email: ynlin@xmu.edu.cn

Xin Liu

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

Xinwei Liu

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

Sha Lu

School of Science
East China University of Science and Technology
Shanghai, China
Email: lusha_nn@126.com

Changfeng Ma

School of Mathematics and Computer Science
Fujian Normal University
Fuzhou, China
Email: macf@fjnu.edu.cn

Yun Ma

School of Mathematics
Nanjing Normal University
Nanjing, China
Email: my.0129@163.com

Luiz Carlos Matioli

Departamento de Matemática
Universidade Federal do Paraná
Curitiba, Brasil
Email: matioli@ufpr.br

Benedetta Morini

Department of Energy Engineering “Sergio Stecco”
University of Florence
Viale Morgagni 40-50134 FIRENZE，Italy
Email: benedetta.morini@unifi.it

Puyan Nie

Institute of Industrial Economics
Jinan University
Guangzhou, China
Email: pynie2005@yahoo.com.cn

Datian Niu

Dalian Nationalities University
Dalian, China
Email: niudt@dlnu.edu.cn

Liping Pang

School of Mathematical Sciences
Dalian University of Technology
Dalian, China
Email: lppang@dlut.edu.cn

Wenxing Zhu

Fuzhou University
Fuzhou, China
Email: wxzhu@fzu.edu.cn

Gianni Di Pillo

Department of Computer and System Sciences
Sapienza University of Rome
Via Ariosto, 25-00185 Roma, Italy
Email: dipillo@dis.uniroma1.it

Michael J.D. Powell

Department of Applied Mathematics and Theoretical Physics, Centre for Mathematical Sciences
University of Cambridge
Cambridge CB3 0WA, England
Email: M.J.D.Powell@damtp.cam.ac.uk

Peter Richtarik

School of Mathematics
University of Edinburgh
Edinburgh, EH9 3JZ, UK
Email: peter.richtarik@ed.ac.uk

Yuan Shen

Department of Mathematics
Nanjing University
Nanjing, China
Email: ocsiban@126.com

Xinghua Shi

School of Mathematical Sciences
Fudan University
Shanghai, China
Email: 10110180031@fudan.edu.cn

Ting Shi

Department of Mathematics and Information Sciences
Guangxi University
Nanning, China
Email: xiaoyao0215@yahoo.com.cn

Cong Sun

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

Hailin Sun

Harbin Institute of Technology
Harbin, China
Email: mathhlsun@gmail.com

Tao Sun

Institute of Geology and Geophysics
Chinese Academy of Science
Beijing, China
Email: sunjt@mail.ustc.edu.cn

Wenyu Sun

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

Min Tao

Department of Mathematics
Nanjing University
Nanjing, China
Email: taomin0903@gmail.com

Lloyd Nick Trefethen

Oxford University Mathematical Institute
Oxford University
Oxford OX1 3LB, UK
Email: trefethen@maths.ox.ac.uk

Chengjing Wang

Southwest Jiaotong University
Chengdu, China
Email: renascencewang@hotmail.com

Guan Wang

College of Science
Xi'an Jiaotong University
Xi'an, China
Email: Wghappy123@stu.xjtu.edu.cn

Liping Wang

Department of Mathematics
Nanjing University of Aeronautics and Astronautics
Nanjing, China
Email: wlpmath@yahoo.com.cn

Liumei Wang

School of Mathematics
Nanjing Normal University
Nanjing, China
Email: Wangliumei111@sina.com

Xiangfeng Wang

Department of Mathematics
Nanjing University
Nanjing, China
Email: xfwang.nju@gmail.com

Xiao Wang

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

Xiaoyi Wang

School of Mathematical Sciences
Dalian University of Technology
Dalian, China
Email: 308581578@qq.com

Xiuyu Wang

Changchun University of Technology
Changchun, China
Email: wxyjxw@sina.cn

Yanfei Wang

Institute of Geology and Geophysics
Chinese Academy of Science
Beijing, China
Email: yfwang@mail.iggcas.ac.cn

Yimin Wei

School of Mathematical Sciences
Fudan University
Shanghai 200433, China
Email: ymwei@fudan.edu.cn, yimin.wei@gmail.com

Zengxin Wei

Department of Mathematics and Information Sciences
Guangxi University
Nanning, China
Email: zxwei@gxu.edu.cn

Zaiwen Wen

Department of Mathematics and Institute of Natural Sciences
Shanghai Jiaotong University
Shanghai, China
Email: Zw2109@sjtu.edu.cn

Chao Wu

School of Mathematics and Computer Science
Fujian Normal University
Fuzhou, China
Email: 229099671@qq.com

Leqin Wu

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

Jiping Wu

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

Qiong Wu

School of Mathematics
Nanjing Normal University
Nanjing, China
Email: qiongyaochen@163.com

Cheng Xiao

School of Mathematical Sciences
Fudan University
Shanghai, China
Email: 09210180027@fudan.edu.cn

Xiantao Xiao

School of Mathematical Science
Dalian University of Technology
Dalian, China
Email: xtzhang@dlut.edu.cn

Naihua Xiu

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

Yi Xu

Department of Mathematics
Nanjing University
Nanjing, China
Email: Yi.xu1983@gmail.com

Dan Xue

Department of Mathematics
Nanjing Normal University
Nanjing, China
Email: wtxuedan@126.com

Wei Xue

School of Mathematics and Computer Science
Gannan Normal University
Ganzhou, China
Email: wxmaths@163.com

Fenlin Yang

School of Mathematical Science
Dalian University of Technology
Dalian, China
Email: yangfenlinlin@126.com

Junfeng Yang

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

Li Yang

College of Mathematics and Information
China West Normal University
Nanchong, China
Email: yang288@yeah.net

Qingzhi Yang

School of Mathematical Sciences
Nankai University
Tianjin, China
Email: qz-yang@nankai.edu.cn

Xiaoqiu Yang

South China Sea Institute of Oceanology
Chinese Academy of Sciences
Guangzhou, China
Email: yxq2081@scsio.ac.cn

Yuning Yang

School of Mathematical Sciences
Nankai University
Tianjin, China
Email: nk0310145@gmail.com

Hongming You

School of Mathematics and Computer Science
Fujian Normal University
Fuzhou, China
Email: 386667250@qq.com

De Yu

School of Mathematics and Computer Science
Fujian Normal University
Fuzhou, China
Email: 297125145@qq.com

Bo Yu

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

Gaohang Yu

School of Mathematics and Computer Science
Gannan Normal University
Ganzhou, China
Email: maghyu@163.com

Gonglin Yuan

Department of Mathematics and Information Sciences
Guangxi University
Nanning, China
Email: glyuan@gxu.edu.cn

Liuyang Yuan

School of Mathematics and Statistics
Wuhan University
Wuhan, China
Email: yangly0601@126.com

Yaxiang Yuan

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

Chao Zhang

Department of Applied Mathematics
Beijing Jiaotong University
Beijing 100044, China
Email: chzhang2@bjtu.edu.cn

Hongchao Zhang

Department of Mathematics
Center for Computational & Technology (CCT), Luisanne State University
Baton Rouge, LA 70803, USA
Email: hozhang@math.lsu.edu

Hongwei Zhang

School of Mathematical Sciences
Dalian University of Technology
Dalian, China
Email: hwzhang@dlut.edu.cn

Liang Zhang

School of Mathematics
Nanjing Normal University
Nanjing, China
Email: burgers@yeah.net

Liwei Zhang

School of Mathematical Sciences
Dalian University of Technology
Dalian, China
Email: lwzhang@dlut.edu.cn

Qifeng Zhang

School of Mathematics and Statistics
Huazhong University of Science and Technology
Wuhan, China
Email: zhangqifeng0504@163.com

Shao-Liang Zhang

Nagoya University
Nagoya, Aichi, 464-8603, Japan
Email: zhang@na.cse.nagoya-u.ac.jp

Shenggui Zhang

School of Mathematics and Computer Science
Fujian Normal University
Fuzhou, China
Email: zsgll@fjnu.edu.cn

Xinli Zhang

Department of Mathematics
Nanjing Normal University
Nanjing, China
Email: zxl0616@stu.xjtu.edu.cn

Yanfang Zhang

Department of Applied Mathematics
The Hong Kong Polytechnic University
Hong Kong
Email: 09900332R@polyu.edu.hk

Yin Zhang

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

Yongfu Zhang

School of Mathematical Sciences
Dalian University of Technology
Dalian, China
Email: zhyf88888@163.com

Zaikun Zhang

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

Lijuan Zhao

Department of Mathematics
Nanjing Normal University
Nanjing, China
Email: zzlljj210@163.com

Qiumei Zhao
Department of Mathematics and Information Sciences
Guangxi University
Nanning, China
Email: zhaoqm87@163.com

Xiaoming Zhao
School of Mathematical Sciences
Nankai University
Tianjin, China
Email: nk0310145@gmail.com

Xinyuan Zhao
College of Applied Science
Beijing University of Technology
Beijing, China
Email: xyzhao@bjut.edu.cn

Excursion Information

Fujian Tulou[1]

Fujian Tulou (Chinese: 福建土楼; pinyin: Fú Jiàn Tǔ Lóu, literally, "Fujian earthen structures") is a type of Chinese rural dwellings of the Hakka and others in the mountainous areas in southeastern Fujian, China. They were mostly built between the 12th and the 20th centuries.

A tulou is usually a large, enclosed and fortified earth building, rectangular or circular in configuration, with very thick load-bearing rammed earth walls between three and five storeys high and housing up to 80 families. Smaller interior buildings are often enclosed by these huge peripheral walls which can contain halls, storehouses, wells and living areas, the whole structure resembling a small fortified city.

The fortified outer structures are formed by compacting earth, mixed with stone, bamboo, wood and other readily available materials, to form walls up to 6 feet (1.8 m) thick. Branches, strips of wood and bamboo chips are often laid in the wall as additional reinforcement. The end result is a well-lit, well-ventilated, windproof and earthquake-proof building that is warm in winter and cool in summer.Tulous usually have only one main gate, guarded by 4 – 5-inch-thick (100 – 130 mm) wooden doors reinforced with an outer shell of iron plate. The top level of these earth buildings has gun holes for defensive purposes.

A total of 46 Fujian Tulou sites, including Chuxi tulou cluster, Tianluokeng tulou cluster, Hekeng tulou cluster, Gaobei tulou cluster, Dadi tulou cluster, Hongkeng tulou cluster, Yangxian lou, Huiyuan lou, Zhengfu lou and Hegui lou, have been inscribed in 2008 by UNESCO as World Heritage Site, as "exceptional examples of a building tradition and function exemplifying a particular type of communal living and defensive organization in a harmonious relationship with their environment".

[1] from Wikipedia: http://en.wikipedia.org/wiki/Fujian_Tulou.

Gulangyu Island[1]

Gulangyu (Chinese: 鼓浪屿; pinyin: Gǔ Làng Yǔ, literally, “Drum Wave Islet”) is a car free island off the coast of Xiamen, Fujian province in southern China, about 2 square kilometres (0.77 sq mi) in area. It is home to about 20,000 people and is a very popular tourist destination. Visitors can reach it by ferry from Xiamen Island in about 5 minutes. Gulangyu Island is renowned for its beaches and winding lanes and its varied architecture. The island is on China’s list of National Scenic Spots and also ranks at the top of the list of the ten most-scenic areas in Fujian Province.

Xiamen (formerly known as Amoy) became a treaty port resulting from China’s loss in the First Opium War and the Treaty of Nanking in 1842, hence the predominantly Victorian-era style architecture throughout Gulangyu Island, where 13 countries including Great Britain, France and Japan established consulates, churches, and hospitals. Gulangyu was officially designated an International Settlement in 1903. Japanese occupation of the island began in 1942, and lasted until the end of World War II. The Amoy dialect of Hokkien is spoken on the island.

As a place of residence for Westerners during Xiamen’s colonial past, Gulangyu is famous for its architecture and for hosting China’s only piano museum, giving it the nickname of “Piano Island” or “The Town of Pianos” or “The Island of Music”. There are over 200 pianos on this island. The Chinese name also has musical roots, as “Gu Lang” means drum waves so-called because of the sound generated by the ocean waves hitting the reefs. Yu means ”islet”.

In addition, on the west beach of the island you can rent pedal boats and jet skis. There’s a garden of 12 grottos to represent each of the animals on the zodiac. Built into the hillside, its a maze of caves and tunnels to find all twelve (and the exit). There are many boutique hotels to stay in as well. The island of Gulangyu is a pedestrian only destination, where the only vehicles on the islands are several fire trucks and electric tourist buggies. The narrow streets on the island, together with the architecture of various styles around the world, give the island a unique appearance.

[1] from Wikipedia: http://en.wikipedia.org/wiki/Gulangyu_Island.

The organizing committee wishes you a pleasant stay in Xiamen!