2018 International Conference on Matrix Inequalities and Matrix Equations (MIME2018)

2018矩阵不等式及矩阵方程国际会议

Shanghai University

Shanghai, China

June 8-10, 2018

Sponsors

International Research Center for Tensor and Matrix Theory (IRCTMT)

Gaoyuan Discipline of Shanghai –Mathematics

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Conference Venue

New Lehu Hotel, Shanghai University, 716 Jinqiu Road, Baoshan district, Shanghai
上海市宝山区锦秋路716号上海大学北大门乐乎新楼

All lectures will be held in the New Lehu Hotel 2nd building （乐乎新楼2号楼）

Accommodation

Campus accommodation:

New Lehu Hotel, Shanghai University, 716 Jinqiu Road, Baoshan district, Shanghai
上海市宝山区锦秋路716号上海大学北大门乐乎新楼

Alternative accommodation:

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Transportation

From Pudong Airport to Shanghai University (Baoshan Campus)

1. By Metro: Pudong airport by Metro Line 2 to Jing'an Temple, change to Metro Line 7 to Shanghai University. (Total price is 8 RMB.)

2. By Taxi: Directly take taxi to 716 Jingqiu Road, Shanghai University (Baoshan Campus, North Gate). (Total price is about 230 RMB.)

From Hongqiao Airport to Shanghai University (Baoshan Campus)

1. By Metro: Hongqiao airport by Metro Line 2 to Jing'an Temple exchange to Metro Line 7 to Shanghai University. (Total price is 6 RMB.)

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1. By Metro Line 1 to Changshu Road exchange to Metro Line 7 to Shanghai University(Baoshan Campus). (Total price is 4 RMB.)

2. By Metro Line 3 to Zhenping Road exchange to Metro Line 7 to Shanghai University(Baoshan Campus). (Total price is 4 RMB.)

3. Directly take taxi to 716 Jingqiu Road, Shanghai University (Baoshan Campus, North Gate). (Total price is about 50 RMB.)

4. By Bus Route 58: Railway Station (Hengfeng Road) -> terminus (near 716 Jingqiu Road, Shanghai University, Baoshan Campus, North Gate). (Total price is 2 RMB.)

Contact

Prof. Qing-Wen Wang, Email: wqw@shu.edu.cn
Dr. Minghua Lin, Email: m_lin@i.shu.edu.cn
Dr. Jiancai Sun, Email: jcsun@shu.edu.cn
Dr. Zhuo-Heng He, Email: hzh19871126@126.com (Cell phone 15921810027)
Tel: +86-21-66134715(O); +86-13162033063(M) Fax: 86-21-66133292
Website: http://math.shu.edu.cn/MIME2018/

Program

Friday, June 8

9:00-19:00 Registration

Lobby of the Lehu Hotel 乐乎新楼1号楼一楼

17:30-19:30 Dinner

Saturday, June 9

Chair: Qing-Wen Wang Xuehai Hall(学海厅)-乐乎新楼2号楼二楼

8:15-8:45 Opening Ceremony

Opening remarks by Prof. Chi-Kwong Li

Opening remarks by Prof. Gi-Sang Cheon

Opening remarks by Prof. Man-Duen Choi

Welcome speech by the dean of College of Sciences

8:45-9:00 Group Photo

Chair: Chi-Kwong Li Xuehai Hall(学海厅)-乐乎新楼2号楼二楼

9:00-9:30 Speaker: Man-Duen Choi, University of Toronto, Canada (p. 10)

Title: Assorted inequalities for positive linear maps

9:30-10:00 Speaker: Fumio Hiai, Tohoku University, Japan (p. 12)

Title: Ando-Hiai type inequalities for multivariate operator means

10:00-10:15 Coffee Break

Chair: Tin-Yau Tam Xuehai Hall(学海厅)-乐乎新楼2号楼二楼

10:15-10:45 Speaker: Yiu-Tung Poon, Iowa State University, USA (p. 20)

Title: A generalized Hölder type eigenvalue inequality

10:45-11:15 Speaker: Gi-Sang Cheon, Sungkyunkwan University, Korea (p. 9)

Title: A new aspect of Riordan group via Krylov matrices

11:15-11:45 Speaker: Yongdo Lim, Sungkyunkwan University, Korea (p. 17)

Title: Inequalities for (symplectic) eigenvalues of the Cartan barycenter

11:45-12:15 Speaker: Yangfeng Su, Fudan University (p. 21)

Title: Theory and Computation of 2D Eigenvalue Problems

12:15-13:30 Lunch

Parallel Sessions. Session One

Chair: Yimin Wei Siyuan Hall(思源厅)-乐乎新楼2号楼一楼

13:30-14:00 Speaker: Ren-Cang Li, University of Texas at Arlington, USA (p. 16)
Title: Highly Accurate Doubling Algorithm for Quadratic Matrix Equations from Quasi-Birth-And-Death Process

14:00-14:30 Speaker: Lin-Zhang Lu, Xiamen University (p. 17)
Title: Some inequalities for sector matrices

14:30-15:00 Speaker: Jianhong Xu, Southern Illinois University Carbondale, USA (p. 24)
Title: Some Characterizations for the Existence of Diagonal Lyapunov Solutions

15:00-15:30 Speaker: Pei-Chang Guo, China University of Geosciences (p. 11)
Title: The Newton-like iteration for a quadratic vector equation arising in Markovian binary trees

15:30-15:45 Coffee Break

Chair: Minghua Lin Siyuan Hall(思源厅)-乐乎新楼2号楼一楼

15:45-16:15 Speaker: Seok-zun Song, Jeju National University, Korea (p. 21)
Title: Exponents of primitive matrices and their linear preservers

16:15-16:45 Speaker: Yaokun Wu, Shanghai Jiao Tong University (p. 24)
Title: A simple multibody system on a discrete circle

16:45-17:15 Speaker: Zhi Chen, Nanjing Agricultural University (p. 9)
Title: Permanents of doubly substochastic matrices

17:15-17:45 Speaker: Peng-Ruei Huang, Hirosaki University, Japan (p. 12)
Title: Nonnegative roots of matrices

17:45-19:00 Dinner

Parallel Sessions. Session Two

Chair: Zhuo-Heng He Xuehai Hall(学海厅)-乐乎新楼2号楼二楼

13:30-14:00 Speaker: Tin-Yau Tam, Auburn University, USA (p. 22)
Title: Cauchy's interlacing inequalities revisited

14:00-14:30 Speaker: Ming-Cheng Tsai, National Taipei University of Technology (p. 23)
Title: Upper triangular similarity of upper triangular matrices

14:30-15:00 Speaker: Pan-Shun Lau, The Hong Kong Polytechnic University (p. 15)
Title: The C-numerical range of a set of matrices

15:00-15:30 Speaker: Edgar Pereira, Federal Univ. of Rio Grande do Norte, Brazil (p. 20)
Title: The cyclic rank completion problem with general blocks

15:30-15:45 Coffee Break

Chair: Delin Chu Xuehai Hall(学海厅)-乐乎新楼2号楼二楼

15:45-16:15 Speaker: Yang Zhang, University of Manitoba, Canada (p. 26)
Title: Automated reasoning in (semi-) groups with power-maps

16:15-16:45 Speaker: Libin Li, Yangzhou University (p. 16)
Title: From NIM equations to representation over fusion rings

16:45-17:15 Speaker: Xiaosong Sun, Jilin University (p. 22)
Title: Some applications of matrix theory to affine algebraic geometry

17:15-17:45 Speaker: Mahendra Gupta, Indian Institute of Technology Madras, India (p. 11)
Title: A simple proof for the existence of Jordan form

17:45-19:00 Dinner

Sunday, June 10

Parallel Sessions. Session One

Chair: Ren-Cang Li Siyuan Hall(思源厅)-乐乎新楼2号楼一楼

8:00-8:30 Speaker: Yimin Wei, Fudan University (p. 23)
Title: Solving Multi-linear Systems with M-Tensors

8:30-9:00 Speaker: Zhigang Jia, Jiangsu Normal University (p. 13)
Title: A New Real Structure-preserving Quaternion QR Algorithm

9:00-9:30 Speaker: Qingxiang Xu, Shanghai Normal University (p. 25)
Title: A new kind of common upper bound of two Hermitian positive semi-definite matrices

9:30-10:00 Speaker: Chuan-Long Wang, Taiyuan Normal University (p. 23)
Title: Two Optimal Low-Rank Matrix Approximation Algorithms For Matrix Completion

10:00-10:15 Coffee Break

Chair: Yang Zhang Siyuan Hall(思源厅)-乐乎新楼2号楼一楼

10:15-10:45 Speaker: Seung-Hyeok Kye, Seoul National University, Korea (p. 14)
Title: Lengths of separable states

10:45-11:15 Speaker: Hiromichi Ohno, Shinshu University, Japan (p. 18)
Title: Unitary equivalence classes of one-dimensional quantum walks

11:15-11:45 Speaker: Hua-Lin Huang, Huaqiao University (p. 12)
Title: The Hurwitz problem on compositions of quadratic forms

11:45-12:15 Speaker: Jianlong Chen, Southeast University (p. 9)
Title: Core and dual core inverses of morphisms

12:15-13:30 Lunch

Parallel Sessions. Session Two

Chair: Fuzhen Zhang Xuehai Hall(学海厅)-乐乎新楼2号楼二楼

8:00-8:30 Speaker: Chi-Kwong Li, College of William and Mary, USA (p. 15)
Title: Ranks of quantum states with prescribed reduced states

8:30-9:00 Speaker: Hiroyuki Osaka, Ritsumeikan University, Japan (p. 19)
Title: Maps preserving operator means

9:00-9:30 Speaker: Daryl Q. Granario, Auburn University, USA (p. 10)
Title: The sum of two complex orthogonal matrices

9:30-10:00 Speaker: Takeaki Yamazaki, Toyo University, Japan (p. 26)
Title: On a generalization of the Aluthge transform in the viewpoint of the operator means

10:00-10:15 Coffee Break

Chair: Tin-Yau Tam Xuehai Hall(学海厅)-乐乎新楼2号楼二楼

10:15-10:45 Speaker: Fuzhen Zhang, Nova Southeastern University, USA (p. 26)
Title: Eigenvalue inequalities of the product of a Hermitian matrix and a positive definite matrix

10:45-11:15 Speaker: Diane C.P. Pelejo, Univ. of the Philippines Diliman, Philippines (p. 19)
Title: Sign Pattern Matrices that Allow or Require Algebraic Positivity

11:15-11:45 Speaker: Zhenyun Peng, Guilin University of Electronic Technology (p. 20)
Title: Iteration methods to solve multiple constrained least-squares problem

11:45-12:15 Speaker: Honghai Li, Jiangxi Normal University (p. 15)
Title: On the first and second eigenvalue of finite and infinite uniform hypergraphs

12:15-13:30 Lunch

Chair: Gi-Sang Cheon Xuehai Hall(学海厅)-乐乎新楼2号楼二楼

13:30-14:00 Speaker: Delin Chu, National University of Singapore, Singapore (p. 10)
Title: A Fast Frequent Directions Algorithm for Low Rank Approximation

14:00-14:30 Speaker: Xiao-Qing Jin, University of Macau (p. 13)
Title: A Riemannian inexact Newton-CG method for constructing nonnegative matrix with prescribed realizable spectrum

14:30-15:00 Speaker: Zhongshan Li, Georgia State University, USA (p. 17)
Title: Sign patterns that allow diagonalization

15:00-15:30 Speaker: Dragana Cvetković Ilić, University of Niš, Serbia (p. 13)
Title: Generalizations of some recent results on various systems of matrix equations

15:30-15:45 Coffee Break

Chair: Yiu-Tung Poon Xuehai Hall(学海厅)-乐乎新楼2号楼二楼

15:45-16:15 Speaker: Abbas Salemi, Shahid Bahonar University of Kerman, Iran (p. 21)
Title: Majorization and linear preservers definite matrix

16:15-16:45 Speaker: Ngai-Ching Wong, National Sun Yat-sen University (p. 24)
Title: Random Toeplitz operators and eigenvalue distribution

16:45-17:15 Speaker: Olga Kushel, Shanghai University (p. 14)
Title: Generalized Lyapunov diagonal stability

17:15-17:30 Concluding remarks

17:30-19:00 Dinner

Goodbye

Abstracts

Jianlong Chen

jlchen@seu.edu.cn

Southeast University

Title: Core and dual core inverses of morphisms

Abstract: Core and dual core inverses were introduced by Baksalary and Trenkler in 2010. Rakic etc generalized these notations to ring cases. In this talk, we will introduce the core and dual core inverses of a morphism in a category. There are three parts: 1. Core and dual core inverse of the sum of morphisms. 2. Core and dual core inverse of morphism with factorization. 3. Core and dual core inverse of morphism with kernel.

Zhi Chen

chenzhi@njau.edu.cn

Nanjing Agricultural University

Title: Permanents of doubly substochastic matrices

Abstract: Let $\omega_{n,k}$ denote the convex polytope of doubly substochastic matrices with sub-defect k. Let $h(A)$ and $l(A)$ denote the maximum and minimum diagonals of $A \in \omega_{n,k}$ respectively. In this talk, we give the relation between the permanent function and the maximum (minimum) diagonals. More specifically, we give the upper bound of the permanent function on $\omega_{n,k}$ in terms of the h-function. We also study the upper bound of the permanent function on both the product and direct product of matrices in $\omega_{n,k}$.

Gi-Sang Cheon

gscheon@skku.edu

Sungkyunkwan University, Korea

Title: A new aspect of Riordan group via Krylov matrices

Abstract: In this talk, we use a new angle to interpret Riordan matrices as Krylov matrices. We then provide a new insight that can be useful for an extension of the group of Riordan matrices called the Riordan group. Moreover, we study Lie algebras for the extended Riordan groups and we extend our theory to the ω-Riordan group which is a generalization of the Riordan group.

Man-Duen Choi

choi@math.toronto.edu

University of Toronto, Canada

Title: Assorted inequalities for positive linear maps

Abstract: Since 1970's I worked on this topic. Now, it is the right time to re-examine some known results with new meanings and new values.

Delin Chu

matchudl@nus.edu.sg

National University of Singapore, Singapore

Title: A Fast Frequent Directions Algorithm for Low Rank Approximation

Abstract: Recently a deterministic method, frequent directions (FD) is proposed to solve the high dimensional low rank approximation problem. It works well in practice, but experiences high computational cost. In this talk, we establish a fast frequent directions algorithm for the low rank approximation problem, which implants a randomized algorithm, sparse subspace embedding (SpEmb) in FD. This new algorithm makes use of FD's natural block structure and sends more information through SpEmb to each block in FD. We prove that our new algorithm produces a good low rank approximation with a sketch of size linear on the rank approximated.

Its effectiveness and efficiency are demonstrated by the experimental results on both synthetic and real world datasets.

Daryl Q. Granario

dqg0001@auburn.edu

Auburn University, USA

Title: The sum of two complex orthogonal matrices

Abstract: A matrix $Q \in M_n(\mathbb{C})$ is said to be orthogonal if $Q^TQ = I_n$. It is known that every matrix $A \in M_n(\mathbb{C})$ can be expressed as a finite sum of complex orthogonal matrices. Using a certain matrix equation and some results in the theory of canonical forms, we characterize matrices in $M_n(\mathbb{C})$ that can be expressed as a sum of two complex orthogonal matrices.

Pei-Chang Guo

peichang@cugb.edu.cn

China University of Geosciences

Title: The Newton-like iteration for a quadratic vector equation arising in Markovian binary trees

Abstract: For the nonlinear matrix equation arising in Markovian binary trees, the minimal nonnegative solution can be found by Newton-like methods. Starting with zero initial guess or some other suitable initial guess, the Newton-like iteration provides a monotonically increasing sequence of nonnegative vectors converging to the minimal nonnegative solution. Numerical examples illustrate the effectiveness of the Newton-Shamanskii iteration.

Mahendra Kumar Gupta

mahendra14389@gmail.com

Indian Institute of Technology Madras, India

Title: A simple proof for the existence of Jordan form

Abstract: In this work, we provide a new and simple proof for the following theorem which is the main result of the paper.

Theorem 0.1. *Let λ be an eigenvalue of $A \in \mathbb{R}^{n\times n}$ of algebraic multiplicity a and geometric multiplicity g. Let m be the least positive integer such that $rank(\lambda I - A)^m = rank(\lambda I - A)^{m+1}$. Then there exists a set $B = \{x_{jk}, 1 \le j \le g, 1 \le k \le m\}$ of L.I. vectors such that*

$$(\lambda I - A)x_{j1} = 0, \qquad \forall\, 1 \le j \le g \tag{1a}$$

$$(\lambda I - A)x_{jk} = x_{j(k-1)} : \qquad k > 1 \tag{1b}$$

and more importantly, $|B| = a$.

As a corollary of the theorem above, existence of the Jordan from is proved. The proof is constructive for computation of Jordan blocks, eigenvectors and generalized eigenvectors. All results are provided for general case. In order to prove Theorem 0.1, we use the following matrix properties. Independent proofs of some of these properties are also given.

1. Rank Nullity theorem.
2. Elementary row/column transformations.
3. $A \in \mathbb{R}^{m\times n}$ and $B \in \mathbb{R}^{n\times k}$, then

$$rank(AB) \ge rankA + rankB - n.$$

4. If $rank(A^i) = rank(A^{i+1})$ for some particular i then

$$rank(A^i) = rank(A^{i+k}) \; for \; all \; k \in \mathbb{N}.$$

5. Let matrix $A \in \mathbb{R}^{n \times n}$ be a singular matrix and if

$$rankA = rankA^2,$$

then algebraic multiplicity for 0 eigenvalue is equal to geometric multiplicity.

6. $Ax = b$ is not solvable then $rank \begin{bmatrix} A & b \end{bmatrix} = rankA + 1$.

Fumio Hiai

hiai.fumio@gmail.com

Tohoku University, Japan

Title: Ando-Hiai type inequalities for multivariate operator means

Abstract: We present several Ando-Hiai type inequalities for n-variable operator means for positive invertible operators. Ando-Hiai's inequalities given here are not only of the original type but also of the complementary type and of the reverse type involving the generalized Kantorovich constant.
This is joint work with Yuki Seo and Shuhei Wada.

Hua-Lin Huang

hualin.huang@hqu.edu.cn

Huaqiao University

Title: The Hurwitz problem on compositions of quadratic forms

Abstract: We shall give an introduction to the Hurwitz problem on compositions of quadratic forms and report some recent progress via an approach of Hopf algebras and tensor categories.

Peng-Ruei Huang

h16ds202@hirosaki-u.ac.jp

Hirosaki University, Japan

Title: Nonnegative roots of matrices

Abstract: The root of matrices is a classical problem in matrix theory which can be traced back to the work of Arthur Cayley in 1858. However, not much is known about the question of existence of

entrywise nonnegative square roots for a nonnegative matrix. We will consider the nonnegative roots of rank-one matrices and circulant marices, etc.

Dragana Cvetković Ilić

dragana@pmf.ni.ac.rs

University of Niš, Serbia

Title: Generalizations of some recent results on various systems of matrix equations

Abstract: We will discuss the system of matrix equations $A_iXB_i = C_i$, $i = \overline{1,4}$ and present some necessary and sufficient conditions for its solvability as well as an expression for the general solution. The presented solvability conditions are purely algebraic and the method used in the proof allows a generalization of the obtained results to some more general structures such as algebras of bounded linear operators or rings, under only some additional assumptions concerning regularity. As corollaries we get generalizations of some recent results that involve solving some other systems of matrix equations.

Zhigang Jia

zhgjia@jsnu.edu.cn

Jiangsu Normal University

Title: A New Real Structure-preserving Quaternion QR Algorithm

Abstract: New real structure-preserving decompositions are introduced to develop fast and robust algorithms for the (right) eigenproblem of general quaternion matrices. Under the orthogonally JRS-symplectic transformations, the Francis JRS-QR step and the JRS-QR algorithm are firstly proposed for JRS-symmetric matrices and then applied to calculate the Schur forms of quaternion matrices. A novel quaternion Givens matrix is defined and utilized to compute the QR factorization of quaternion Hessenberg matrices. An implicit double shift quaternion QR algorithm is presented with a technique for automatically choosing shifts and within real operations. Numerical experiments are provided to demonstrate the efficiency and accuracy of newly proposed algorithms.

Xiao-Qing Jin

xqjin@umac.mo

University of Macau

Title: A Riemannian inexact Newton-CG method for constructing nonnegative matrix with prescribed

realizable spectrum

Abstract: In this talk, we consider the inverse eigenvalue problem of constructing a nonnegative matrix with prescribed realizable spectrum.

Problem I. Given an n-tuple $\{\lambda_1, \lambda_2, \ldots, \lambda_n\}$, which is a realizable spectrum for nonnegative matrices, find an n-by-n nonnegative matrix C such that its eigenvalues are $\lambda_1, \lambda_2, \ldots, \lambda_n$.

Olga Kushel

kushel@mail.ru

Shanghai University

Title: Generalized Lyapunov diagonal stability

Abstract: Here we consider a real $n \times n$ matrix $\mathbf{A}$, which satisfies the following generalized Lyapunov equation:

$$\sum_{i,j=0}^{n-1} c_{ij} (\mathbf{A}^T)^i \mathbf{H} \mathbf{A}^j = \mathbf{Q}, \qquad c_{ij} = c_{ji} \in \mathbb{R}$$

for some symmetric positive definite matrices $\mathbf{H}$ and $\mathbf{Q}$. Such matrices are known to have their spectra inside a stability region $\mathfrak{D} \subset \mathbb{C}$, defined by the above equation. In this talk, we consider the following question: when solvability of a generalized Lyapunov equation within a given subclass of symmetric positive definite matrices leads to some more specific properties of matrix spectra? A well-known partial case here is Lyapunov diagonal stability (a matrix $\mathbf{A}$ is called Lyapunov diagonally stable if

$$\mathbf{DA} + \mathbf{A}^T \mathbf{D} = \mathbf{Q}$$

for some positive diagonal matrix $\mathbf{D}$ and symmetric positive definite matrix $\mathbf{Q}$) which implies D-stability (a matrix $\mathbf{A}$ is called D-stable if $\mathbf{DA}$ is stable for every positive diagonal matrix $\mathbf{D}$).

Seung-Hyeok Kye

kye@snu.ac.kr

Seoul National University, Korea

Title: Lengths of separable states

Abstract: A state is called *separable* when it is decomposed into a sum of pure product states. A decomposition is said to be *optimal* when the number of pure product states in the decomposition is minimal, and this minimal number is called the *length* of the separable state. It is known that the length of a $2 \otimes 2$ or $2 \otimes 3$ state is equal to the maximum of ranks of the state and its partial transpose, but this is not true in higher dimensional systems. In the $3 \otimes 3$ and $2 \otimes 4$ systems, separable states with lengths ten are known. Note that the lengths are even strictly greater than the whole dimensions. In

this talk, we exhibit one parameter family of three qubit separable states whose length are ten. Those examples appear on the boundary between separable states and entangled states.

Pan-Shun Lau

panlau@connect.hku.hk

The Hong Kong Polytechnic University

Title: The C-numerical range of a set of matrices

Abstract: For $n \times n$ matrices C and A, the C-numerical range of A is defined by

$$W_C(A) := \{\mathrm{tr}(CU^*AU) : U \text{ is unitary}\}.$$

Let $\mathcal{F}$ be a set of $n \times n$ matrices. In this talk, we study the union of the C-numerical ranges of the matrices in the set $\mathcal{F}$, denoted by $W_C(\mathcal{F})$. We obtain basic algebraic and topological properties of $W_C(\mathcal{F})$, and show that there are connections between the geometric properties of $W_C(\mathcal{F})$ and the algebraic properties of C and the matrices in $\mathcal{F}$. We shall also discuss the star-shapedness of $W_C(\mathcal{F})$ when $\mathcal{F}$ is convex.

Chi-Kwong Li

ckli@math.wm.edu

College of William and Mary, USA

Title: Ranks of quantum states with prescribed reduced states

Abstract: Let $\mathcal{M}_n$ be the set of $n \times n$ complex matrices. In this note we determine all the possible ranks of a bipartite state in $\mathcal{M}_m \otimes \mathcal{M}_n$ with prescribed reduced states in the two subsystems. The results are used to determine the Choi rank of quantum channels $\Phi : \mathcal{M}_m \to \mathcal{M}_n$ sending I/m to a specific state $\sigma_2 \in \mathcal{M}_n$.

This is joint work with Yiu-Tung Poon (Iowa State University) and Xuefeng Wang (Ocean University of China).

Honghai Li

lhh@jxnu.edu.cn

Jiangxi Normal University

Title: On the first and second eigenvalue of finite and infinite uniform hypergraphs

Abstract: The spectral gap of a graph is intimately related to its expansion properties, and more precisely the graph with higher spectral gap is more expanding. Note that regular graphs have its degree as its largest eigenvalue, the well-known Alon-Boppana Theorem answers for regular graphs

how small the second largest eigenvalue can be. Using the eigenvalues of the adjacency tensor associated with hypergraphs, lower bounds for the first and the second eigenvalue of uniform regular hypergraphs are obtained. One of these bounds is a generalization of the Alon-Boppana Theorem to hypergraphs.

Libin Li

lbli@yzu.edu.cn

Yangzhou University

Title: From NIM equations to representation over fusion rings

Abstract: In this talk, we shall prove that the rank of the irreducible NIM-modules over a near-group fusion ring is no more than the rank of the near-group ring. As an application, we show that the irreducible NIM-modules over the fusion ring of rank 2 correspond to an equivalence class of some non-negative integer matrices of order 2.

Ren-Cang Li

rcli@uta.edu

University of Texas at Arlington, USA

Title: Highly Accurate Doubling Algorithm for Quadratic Matrix Equations from Quasi-Birth-And-Death Process

Abstract: One of the most fundamental quadratic matrix equations in the quasi-birth-and-death process (QBD) is

$$A_0 + A_1X + A_2X^2 = X,$$

where A_0, A_1 and A_2 are blocks in an infinite block-tridiagonal transition matrix and A_i $(i = 0, 1, 2)$ are $n \times n$ nonnegative matrices. In the application, $I - A_0 - A_1 - A_2$ is irreducible and singular, and, in particular, $(A_0 + A_1 + A_2)\mathbf{1_n} = \mathbf{1_n}$, where $\mathbf{1_n}$ (often simply $\mathbf{1}$ when its dimension is clear from the context) is the column n-vector of all ones. It is known that the QBD equation has a unique minimal nonnegative solution Φ for which $\Phi\mathbf{1} \leq \mathbf{1}$. This solution Φ is the one of interest. In this talk, we will present a highly accurate doubling algorithm to compute the minimal nonnegative solution with deserved entrywise accuracy.

Zhongshan Li

zli@gsu.edu

Georgia State University, USA

Title: Sign patterns that allow diagonalization

Abstract: A sign pattern (matrix) is a matrix whose entries are from the set $\{+, -, 0\}$. A square sign pattern $\mathcal{A}$ is said to allow diagonalization if there is a diagonalizable real matrix whose entries have signs specified by the corresponding entries of $\mathcal{A}$. Characterization of sign patterns that allow diagonalization has been a long-standing open problem. It is known that a sign pattern allows diagonalization if and only if it allows rank-principality. In this talk, we establish some new necessary/sufficient conditions for a sign pattern to allow diagonalization, and explore possible ranks of diagonalizable matrices with a specified sign pattern. In particular, it is shown that every irreducible sign pattern with minimum rank 2 allows diagonalization at rank 2 and also at the maximum rank. Sign patterns whose maximal zero submatrices are strongly disjoint are shown to allow diagonalization with the maximum rank.
This is joint work with Xinlei Feng, Wei Gao, Frank Hall, Guangming Jing, and Chris Zagrodny.

Yongdo Lim

ylim@skku.edu

Sungkyunkwan University, Korea

Title: Inequalities for (symplectic) eigenvalues of the Cartan barycenter

Abstract: We establish log-majorizations for the (symplectic) eigenvalues of the Cartan barycenter of integrable probability Borel measures on the Cartan-Hadamard manifold of positive definite matrices. This leads a version of Jensen's inequality for geometric integrals of matrix-valued integrable random variables.
This is joint work with Fumio Hiai.

Lin-Zhang Lu

lzlu@xmu.edu.cn

Xiamen University

Title: Some inequalities for sector matrices

Abstract: If A is a sector matrix,i.e., the numerical rang of A

$$W(A) = \{x^*Ax | x \in \mathbb{C}^n, x^*x = 1\}$$

is contained in a sector:

$$S_\alpha = \{z \in \mathbb{C}^n : \mathscr{R}z > 0, |\mathscr{J}z| \leq \mathscr{R}z\, tan(\alpha)\}$$

for some $\alpha \in [0, \pi/2)$, then we have the following two results(three inequalities).

1) Let $f : [0.\infty) \to [0.\infty)$ be a concave function and $A = \begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix}$ be a complex partitioned matrix where A_{11} and A_{22} are square. If A is normal, then

$$\|f(|A|)\| \leq ||f(sec(\alpha)|A_{11}|)|| + ||f(sec(\alpha)|A_{22}|)|| \tag{1}$$

for any unitarily invariant norm $||\cdot||$. This inequality improves a recent result given by Zhao and Ni in [Lin. Mult. Alg.doi:10.1080/03081087.2017.1301359].

2) Let $A \in \mathbb{M}_n(\mathbb{M}_k)$, then

$$tr|A| + ||A||_q \geq cos(\alpha)||tr_1 A||_q + cos(\alpha)||tr_2 A||_q; \tag{2}$$

$$(tr|A|)^{nk} + det|A| \geq cos^{nk}(\alpha)|det(tr_1 A)|^n + cos^{nk}(\alpha)|det(tr_2 A)|^k. \tag{3}$$

where tr_1 and tr_2 stand for the first and second partial trace, respectively, a notion form quantum information theory.

When A is a density matrix, (2) is the inequality

$$1 + ||A||_q \geq ||tr_1 A||_q + ||tr_2 A||_q,$$

presented by Audenaert in [J.Math.Phys. 48(2007)]

When A is a density matrix, (3) is the inequality

$$1 + det(A) \geq det(tr_1 A)^n + det(tr_2 A)^k.$$

presented by Lin in [Canad. Math. Bull. 59(2016)].

Hiromichi Ohno

h_ohno@shinshu-u.ac.jp

Shinshu University, Japan

Title: Unitary equivalence classes of one-dimensional quantum walks

Abstract: Quantum walks can be considered as a quantum analog of classical random walks and have been studied in various fields, such as quantum information theory and quantum probability theory. A quantum walk is defined by a pair $(U, \{\mathcal{H}_v\}_{v\in V})$, in which V is a countable set, $\{\mathcal{H}_v\}_{v\in V}$ is a family of separable Hilbert spaces, and U is a unitary operator on $\mathcal{H} = \oplus_{v\in V}\mathcal{H}_v$. In this talk, we discuss unitary equivalence classes of one-dimensional quantum walks, in which $V = \mathbb{Z}$ and $\mathcal{H}_v = \mathbb{C}^2$.

Hiroyuki Osaka

osaka@se.ritsumei.ac.jp

Ritsumeikan University, Japan

Title: Maps preserving operator means

Abstract: Let σ be a non-rivial operator mean in the sense of Kubo and Ando and let OM_+^1 the set of normalized positive operator monotone functions on $(0,\infty)$. In this talk, we discuss the problem to determine $f \in OM_+^1$ which satisfies

$$f(A\sigma B) \leq f(A)\sigma f(B)$$

for all positive operators A and B. We give some criteria for this function f to be trivial, that is $f(t) = 1$ or $f(t) = t$. We also establish a condition for f and σ to satisfy

$$f(A\sigma B) = f(A)\sigma f(B)$$

for all positive operators A and B. More precisely, if $\lim_{t\to 0}(1\sigma t) = 0$, then the above equality holds if and only if f and $1\sigma t$ are functions which correspond to the harmonic mean.

Diane Christine P. Pelejo

dcpelejo@math.upd.edu.ph

University of the Philippines Diliman, Philippines

Title: Sign Pattern Matrices that Allow or Require Algebraic Positivity

Abstract: A square matrix M with real entries is said to be positive, written $M > 0$, if all its entries are positive. On the other hand M is said to be *algebraically positive* if there exists a real polynomial p such that all entries of the matrix $p(M) > 0$. Algebraic positivity can be viewed as a generalization of the concepts of positivity, eventual positivity and primitivity.

A square sign pattern matrix S is a matrix whose entries are in $\{+, -, 0\}$. We say that S *allows* algebraic positivity if there is an algebraically positive matrix M whose sign pattern class is S. We say that S *requires* algebraic positivity if any matrix M, having sign pattern class S, is algebraically positive.

Motivated by open problems raised in the work of Kirkland, Qiao and Zhan (2016) on algebraically positive matrices, we look at some conditions that will guarantee that a sign pattern matrix allows or requires algebraic positivity.

Zhenyun Peng

yunzhenp@163.com

Guilin University of Electronic Technology

Title: Iteration methods to solve multiple constrained least-squares problem

Abstract: In this report, augmented lagrangian method (ALM), alternating direction method of multipliers (ADMM) andInexact alternating direction method of multipliers (IADMM) to compute multiple constrained least-squares solution of the matrix equation $AXB = C$ are derived. Numerical comparison of these methodsis given. Problems that need to be studied in further are listed.

Edgar Pereira

edgar@ccet.ufrn.br

Federal University of Rio Grande do Norte, Brazil

Title: The cyclic rank completion problem with general blocks

Abstract: We present an upper bound for the minimal completion rank of a partial matrix P whose block pattern is a single cycle of size $2k$ with specified blocks $A_1, \cdots, A_{2k}$. The bound becomes quite sharp when k increases, under certain conditions. This extends previous results in which the specified blocks $A_1, \cdots, A_{2k}$ were assumed regular.

The upper bound is constructed from invariants associated with the canonical form of the given partial matrix, under row and column operations. These invariants can be expressed in terms of ranks of certain matrices constructed directly from the data blocks $A_1, \cdots, A_{2k}$, independently of P being in canonical form. Some examples illustrate the presented theory.
This is joint work with Nir Cohen.

Yiu-Tung Poon

ytpoon@iastate.edu

Iowa State University, USA

Title: A Generalized Hölder Type Eigenvalue Inequality

Abstract: In this note, we prove that if $A_1, \ldots, A_m$ are $n \times n$ contractive matrices, $r \geq 1$ and $p_1, \ldots, p_m > 0$ with $\frac{1}{p_1} + \frac{1}{p_2} + \cdots + \frac{1}{p_m} = 1$, then

$$\prod_{j=1}^{k} (1 - \lambda_j(|A_1 \cdots A_m|)^r) \geq \prod_{i=1}^{m} \prod_{j=1}^{k} (1 - \lambda_j(|A_i|)^{rp_i})^{\frac{1}{p_i}}$$

for each $k = 1, 2, \ldots, n$. This generalizes an inequality due to Hua and Marcus.
This is joint work with Jun-Tong Liu and Qing-Wen Wang.

Abbas Salemi

salemi@uk.ac.ir

Shahid Bahonar University of Kerman, Iran

Title: Majorization and linear preservers

Abstract: Let X and Y be real $n \times m$ matrices. We say that X is circulant matrix majorized by Y and write $X \prec_c Y$, if $X = QY$ for some circulant doubly stochastic matrix $Q \in M_n(\mathbb{R})$. A linear operator $T : M_{n,m}(\mathbb{R}) \longrightarrow M_{n,m}(\mathbb{R})$ is said to be a preserver of $\prec_c$, if $TX \prec_c TY$ whenever $X \prec_c Y$ for $X, Y \in M_{n,m}(\mathbb{R})$. In this lecture, we characterize linear preservers of $\prec_c$ on real rectangular matrices. Also, we present a simple method to prove Ando's Theorem [Linear Algebra Appl. 118 (1989) 163-248] and several known results. Finally, we consider a group majorization and its linear preservers.
This is joint work with Shiva Mohtashami and Mohammad Soleymani.

Seok-zun Song

szsong@jejunu.ac.kr

Jeju National University, Korea

Title: Exponents of primitive matrices and their linear preservers

Abstract: An $n \times n$ matrix A is said to be *primitive* if A^k has all nonzero entries for some positive integer k. A primitive matrix A is said to have *exponent* k if A^k has all nonzero entries and A^s has a zero entry if $s < k$. We consider the exponents of primitive matrices and the subsets of primitive matrices with fixed exponent. We investigate linear preservers of these subsets of primitive matrices defined by their exponents. In particular, we shall characterize linear operators that preserve subsets with exponents 1 and 2, and those that preserve subsets with exponents $n^2 - 2n + 2$ and $n^2 - 2n + 1$. We also characterize those linear operators that strongly preserve subsets with exponents 2, $n^2 - 2n + 2$ or $n^2 - 2n + 1$.
This is joint work with LeRoy B. Beasley (Utah State University, USA).

Yangfeng Su

yfsu@fudan.edu.cn

Fudan University

Title: Theory and Computation of 2D Eigenvalue Problems

Abstract: The 2D eigenvalue problem (2dEVP) is a class of the double eigenvalue problems first

studied by Blum and Chang in 1970s. The 2dEVP seeks scalars λ, μ, and a corresponding vector x satisfying the following equations

$$\begin{aligned} Ax &= \lambda x + \mu Cx, \\ x^H Cx &= 0, \\ x^H x &= 1, \end{aligned}$$

where A and C are Hermitian and C is indefinite. We show the connections between 2dEVP with well-known numerical linear algebra and optimization problems such as quadratic programming, the distance to instability and H_∞-norm. We will discuss (1) fundamental properties of 2dEVP including well-posedness, types and regularity, (2) perturbation theory and (3) numerical algorithms with backward error analysis.

Xiaosong Sun

sunxs@jlu.edu.cn

Jilin University

Title: Some applications of matrix theory to affine algebraic geometry

Abstract: Affine algebraic geometry is a branch of algebraic geometry which focuses on automorphisms of affine varieties (especially affine spaces). There are several notable problems in this field such as the Jacobian conjecture and the tame generators problem. In this talk, I will introduce some applications of matrix theory to affine algebraic geometry, especially to the Jacobian conjecture and the tame generators problem.

Tin-Yau Tam

tamtiny@auburn.edu

Auburn University, USA

Title: Cauchy's interlacing inequalities revisited

Abstract: We will discuss Cauchy's interlacing inequalities for the eigenvalues of a Hermitian matrix and its principle submatrices. We will discuss their relatives, for example, interlacing inequalities for the singular values of a complex matrix and its submatrices. We seek a possible unified treatment for different interlacing inequalities.

Ming-Cheng Tsai

mctsai2@mail.ntut.edu.tw

National Taipei University of Technology

Title: Upper triangular similarity of upper triangular matrices

Abstract: The upper triangular similarity class of a upper triangular matrix is determined by those of some strictly upper triangular matrices. This talk will give a survey on the progress of classifying the upper triangular similarity classes of strictly upper triangular matrices. In particular, a "nice" possible canonical form will be chosen.
This is joint work with Huajun Huang, Meaza Bogale.

Chuan-Long Wang

clwang218@126.com

Taiyuan Normal University

Title: Two Optimal Low-Rank Matrix Approximation Algorithms For Matrix Completion

Abstract: In this paper, we mainly propose two optimal low-rank matrix approximation algorithms for the matrix completion problem based on the minimum distance between the feasible matrix and its projection onto the r-dimensional manifold (where r is less than or equal to the rank of the completion matrix). The main idea is to search an optimal feasible matrix in the feasible matrix set by multi-step iterations. If the minimum distance is equal to zero, then the feasible matrix is no other than the optimal low-rank matrix to the matrix completion problem; otherwise, the dimension of the manifold changes to (r+1) automatically, and the above process of searching the optimal feasible matrix is repeated. In theory, we analysis the convergence and convergent rate of the new algorithms in detail, and prove that the new algorithms are better than the orthogonal rank-one matrix pursuit (OR1MP) algorithm in precision. Finally, some numerical experiments and image recovery results show the algorithms are more effective in CPU time and precision than the orthogonal rank-one matrix pursuit, and more efficient than the augmented Lagrange multiplier algorithm when the observation ratio is lower.

Yimin Wei

ymwei@fudan.edu.cn

Fudan University

Title: Solving Multi-linear Systems with M-Tensors

Abstract: This talk is concerned with solving some structured multi-linear systems, especially

focusing on the equations whose coefficient tensors are M-tensors, or called M-equations for short. We prove that a nonsingular M-equation with a positive right-hand side always has a unique positive solution. Several iterative algorithms are proposed for solving multi-linear nonsingular M-equations, generalizing the classical iterative methods and the Newton method for linear systems. Furthermore, we apply the M-equations to some nonlinear differential equations and the inverse iteration for spectral radii of nonnegative tensors.

Ngai-Ching Wong

wong@math.nsysu.edu.tw

National Sun Yat-sen University

Title: Random Toeplitz Operators and eigenvalue distribution

Abstract: We give a characterization of random Toeplitz operators as random linear operators on Hilbert spaces given by multiplications. Their properties are studied in term of their generating functions. Our results, when applied with the preconditioned conjugate gradient method, gives a new technique for finding numerical solutions of linear systems associated with a random Toeplitz coefficient matrices. We also investigate the Weyl equidistribution of eigenfunctions of random Toeplitz matrices.
This is joint work with King-Fai Lai, Tsung-Lin Lee and Wen-Fong Ke.

Yaokun Wu

ykwu@sjtu.edu.cn

Shanghai Jiao Tong University

Title: A simple multibody system on a discrete circle

Abstract: Consider a circular track with n stations. Suppose k cars stay in different stations at present and will move around randomly in the same direction to another k stations in discrete time steps. We study the structure of the underlying linear spaces and cones for this simple dynamical system. This work generalizes some previous work on split systems.
This is ongoing joint work with Chengyang Qian.

Jianhong Xu

jhxu@siu.edu

Southern Illinois University Carbondale, USA

Title: Some Characterizations for the Existence of Diagonal Lyapunov Solutions

Abstract: A diagonal Lyapunov solution (DLS) for a real square matrix A refers to a positive diagonal D such that

$$AD + DA^T \succ 0.$$

First, we revisit and extend a result of Redheffer. It characterizes a DLS for A via a DLS which is shared by a principal submatrix of A of order one less and the associated Schur complement. It also leads to the problem of a common diagonal Lyapunov solution (CDLS) for a set $\mathcal{A} = \{A^{(1)}, \ldots, A^{(m)}\}$ of real square matrices of the same size, i.e. whether there exists a positive diagonal D such that

$$A^{(k)}D + D(A^{(k)})^T \succ 0,\ k = 1, \ldots, m.$$

Next, generalizing a result of Kraaijevanger on DLS's, we present a number of equivalent conditions that concern the existence of a CDLS for $\mathcal{A}$ via Hadamard products of the matrices in $\mathcal{A}$ with certain positive semidefinite matrices. One of these conditions, for example, can be stated as $A^{(k)}_{i,i} > 0$ for all k, i and $\det\left(\sum_{k=1}^{m} A^{(k)} \circ S^{(k)}\right) > 0$ for all $S^{(k)} \succeq 0$, provided that for any i, $S^{(k)}_{i,i} \neq 0$ for some k.

Finally, we talk about results relevant to a structured CDLS. Two characterizations can be developed in this regard: one via the trace of a principal submatrix of $\sum_{k=1}^{m} X^{(k)}A^{(k)}$ with any $X^{(k)} \succeq 0$ but not all zero, while the other via similar Kraaijevanger type Hadamard products. The former strengthens the results of Barker, Berman, and Plemmons, and Hershkowitz and Mashal. It also paves the way for the latter.

This is joint work with Dr. Mehmet Gumus of Department of Mathematics and Statistics at Auburn University.

Qingxiang Xu

qingxiang_xu@126.com

Shanghai Normal University

Title: A new kind of common upper bound of two Hermitian positive semi-definite matrices

Abstract: Let A and B be two Hermitian matrices of the same order. A new kind of common upper bound of A and B is introduced recently by using certain C^*-algebraic technique. In this talk, we will talk about the detailed construction of this new common upper bound, together with its application to the study of the perturbation analysis for the parallel sum.

Takeaki Yamazaki

t-yamazaki@toyo.jp

Toyo University, Japan

Title: On a generalization of the Aluthge transform in the viewpoint of the operator means

Abstract: Let $T = U|T|$ be a polar decomposition of a bounded linear operator on a complex Hilbert space. The Aluthge transform is defined by $\Delta(T) := |T|^{\frac{1}{2}}U|T|^{\frac{1}{2}}$. In the recent research, S. H. Lee, W. Y. Lee and J. Yoon defined the mean transform as $\hat{T} := \frac{U|T|+|T|U}{2}$. In this talk, we shall generalize the above operator transforms. In fact, we will introduce a generalization of the Aluthge transform in the viewpoint of the operator means. It contains the Aluthge and the mean transforms. Then we shall consider iteration of the mean transform.

Fuzhen Zhang

zhang@nova.edu

Nova Southeastern University, USA

Title: Eigenvalue inequalities of the product of a Hermitian matrix and a positive definite matrix

Abstract: Eigenvalue problem of matrices is of central importance in matrix theory, matrix computation, linear algebra and related areas. Traditionally, eigenvalue inequalities in partial sums involve two Hermitian matrices for sum and a pair of positive semidefinite matrices for product. We show some eigenvalue inequalities of the product of a Hermitian matrix and a positive definite (Hermitian) matrix; we use the results to study perturbation problems of generalized eigenvalues.
This is joint work with Bo-Yan Xi.）

Yang Zhang

yang.zhang@umanitoba.ca

University of Manitoba, Canada

Title: Automated reasoning in (semi-) groups with power-maps

Abstract: In group theory, semigroups, and cancellative semigroups, various theorems for commutativity have been explored. For example, n-abelian groups by Baer, Alperin, Kaluzhnin and others; some power products by Padmanabhan and Neumann. All most of these results were proved by human being using some pure algebraic technical knowledge. The methods are often unique and it is difficult to apply for other questions.

Recently, we develop a new concept of "power-like functions" which allows people to deal with

an abstract positive integer powers instead of giving an exact number. It is clear that all power-maps in a group or a semigroup are power-like. Hence this new idea can be applied for a large of classes of commutativity conditions. Our proof belongs to first-order logic and uses a first-order theorem-prover "Prover9". This is the first time that Prover9 has been augmented by power-like functions to enable the first-order theorem-prover to prove theorems in this area.

In this paper, using Prover9 and power-like functions, we prove and extend a well-known result by Neumann (2001). In these automated proofs, the integer power never explicitly appears and hence the lengths of the proofs as well as the lengths of the longest clause in these proofs remain the same. It is also possible to use similar automated proofs in equational theory of rings.
This is joint work with R. Padmanabhan.

Participants

No	Name	Institute	Email
1	Guoliang Chen	East China Normal University	glchen@math.ecnu.edu.cn
2	Jianlong Chen	Southeast University	jlchen@seu.edu.cn
3	Zhi Chen	Nanjing Agricultural University	chenzhi@njau.edu.cn
4	Guanghui Cheng	niversity of Electronic Science&Technology of Chi	ghcheng@uestc.edu.cn
5	Gi-Sang Cheon	Sungkyunkwan University	gscheon@skku.edu
6	Man-Duen Choi	University of Toronto, Canada	choi@math.utoronto.ca
7	Delin Chu	National University of Singapore, Singapore	matchudl@nus.edu.sg
8	Xiankun Du	Jilin University	duxk@jlu.edu.cn
9	Mei Feng	Nanchang University	604152276@qq.com
10	Meiping Gao	Wenshan University	382248459@qq.com
11	Daryl Q. Granario	Auburn University	dqg0001@auburn.edu
12	Peichang Guo	China University of Geosciences	peichang@cugb.edu.cn
13	Mahendra Kumar Gupta	Indian Institute of Technology Madras	mahendra14389@gmail.com
14	Zhuo-Heng He	Shanghai University	hzh19871126@126.com
15	Fumio Hiai	Tohoku University	hiai.fumio@gmail.com
16	Hualin Huang	Huaqiao University	hualin.huang@foxmail.com
17	Peng-Ruei Huang	Hirosaki University	h16ds202@hirosaki-u.ac.jp
18	Yunying Huang	East China Normal University	yingzi8869@163.com
19	Dragana Cvetkovic Ilic	University of Nis, Serbia	gagamaka@ptt.rs
20	Zhigang Jia	Jiangsu Normal University	hgjia@jsnu.edu.cn
21	Zhaolin Jiang	Linyi University	jzh1208@sina.com
22	Xiaoqing Jin	University of Macau	xqjin@umac.mo
23	Yifen Ke	University of Chinese Academy of Sciences	keyifen2017@163.com
24	Seung-Hyeok Kye	Seoul National University, Korea	kye@snu.ac.kr
25	Pan-Shun Lau	The Hong Kong Polytechnic University	panlau@connect.hku.hk
26	Chaoqian Li	Yunnan University	lichaoqian@ynu.edu.cn
27	Chi-Kwong Li	College of William and Mary, USA	ckli@math.wm.edu
28	Honghai Li	Jiangxi Normal University	lhh@jxnu.edu.cn
29	Jicheng Li	Xi'an Jiaotong University	jcli@mail.xjtu.edu.cn
30	Libin Li	Yangzhou University	lbli@yzu.edu.cn
31	Ren-Cang Li	University of Texas at Arlington, USA	rcli@uta.edu
32	Wen Li	South China Normal University	liwen@m.scnu.edu.cn
33	Yanyan Li	Wenshan University	liyanyan409@126.com
34	Zhizhi Li	University of Chinese Academy of Sciences	zzli9016@gmail.com
35	Zhongshan Li	Georgia State University, USA	zli@gsu.edu
36	Yongdo Lim	Sungkyunkwan University, Korea	ylim@skku.edu
37	Dayan Liu	Jilin University	liudayan@jlu.edu.cn
38	Aijing Liu	Qufu Normal University	ajliuliu@163.com
39	Xifu Liu	Chongqing Normal University	liuxifu211@hotmail.com
40	Xin Liu	Macao University of Science and Technology	xiliu@must.edu.mo
41	Linzhang Lu	Xiamen University	lzlu@xmu.edu.cn
42	Haifeng Ma	Harbin Normal University	haifengma@aliyun.com

43	Linglei Meng	Cambridge University Press	jmeng@cambridge.org
44	Shuxin Miao	Northwest Normal University	miaosx205@163.com
45	Hiromichi Ohno	Shinshu University, Japan	h_ohno@shinshu-u.ac.jp
46	Hiroyuki Osaka	Ritsumeikan University, Japan	osaka@se.ritsumei.ac.jp
47	Zhen-yun Peng	Guilin University of Electronic Technology	yunzhenp@163.com
48	Edgar Pereira	Federal University of Rio Grandedo Norte, Brazil	edgar@ccet.ufrn.br
49	Diane Christine Pelejo	University of the Philippines Diliman, Philippines	dcpelejo@math.upd.edu.ph
50	Yiu-Tung Poon	Iowa State University, USA	ytpoon@iastate.edu
51	Huan Ren	Nanchang University	841993258@qq.com
52	Abbas Salemi	Shahid Bahonar University of Kerman, Iran	salemi@uk.ac.ir
53	Jian Shi	Hebei University	shijianmath@qq.com
54	Wenyan Shi	China University of Mining and Technology	shiwenyaer@163.com
55	Seok-zun Song	Jeju National University, Korea	szsong@jejunu.ac.kr
56	Yangfeng Su	Fudan University	yfsu@fudan.edu.cn
57	Xiaosong Sun	Jilin University	sunxs@jlu.edu
58	Tin-Yau Tam	Auburn University, USA	tamtiny@auburn.edu
59	Ming-Cheng Tsai	National Taipei University of Technology	mctsai2@mail.ntut.edu.tw
60	Chuan-Long Wang	Taiyuan Normal University	clwang218@126.com
61	Jin Wang	Shangdong University	wangjinxingfu@126com
62	Long Wang	Taizhou University	wanglseu@163.com
63	Teng Wang	Nanchang University	spring0920@163.com
64	Zengqi Wang	Shanghai Jiao Tong University	wangzengqi@sjtu.edu.cn
65	Musheng Wei	Liaocheng University	mwei@shnu.edu.cn
66	Yimin Wei	Fudan University	ymwei@fudan.edu.cn
67	Chaoping Xing	Nanyang Technological University	matxcp@nus.edu.sg
68	Ngai-Ching Wong	National Sun Yat-sen University	wong@math.nsysu.edu.tw
69	Gang Wu	China University of Mining and Technology	gangwu76@126.com
70	Yaokun Wu	Shanghai Jiao Tong University	ykwu@sjtu.edu.cn
71	Changqing Xu	Suzhou University of Science and Technology	cqxuiit@yahoo.com
72	Jianhong Xu	Southern Illinois University Carbondale, USA	jhxu@siu.edu
73	Qingxiang Xu	Shanghai Normal University	qingxiang_xu@126.com
74	Jungong Xue	Fudan University	xuej@fudan.edu.cn
75	Takeaki Yamazaki	Toyo University	t-yamazaki@toyo.jp
76	Chaojun Yang	Suzhou University	cjyangmath@163.com
77	Huihui Yin	Nanchang University	898293848@qq.com
78	Guihai Yu	Guizhou University of Finance and Economics	yuguihai@126.com
79	Shaowen Yu	East China University of Science and Technology	yushaowen@ecust.edu.cn
80	Xingzhi Zhan	East China Normal University	zhan@math.ecnu.edu.cn
81	Daochang Zhang	Northeast Electric Power University	daochangzhang@126.com
82	Fuzhen Zhang	Nova Southeastern University, USA	zhang@nova.edu
83	Leihong Zhang	Shanghai University of Finance and Economics	hang.leihong@mail.shufe.edu.c
84	Yang Zhang	University of Manitoba, Canada	yang.zhang@umanitoba.ca
85	Ruju Zhao	Yangzhou University	zrj0115@126.com
86	Xiangui Zhao	Huizhou University	xiangui.zhao@foxmail.com
87	Bing Zheng	Lanzhou University	bzheng@lzu.edu.cn
88	Yanpeng Zheng	Linyi University	zhengyanpeng0702@sina.com
89	Hongxiu Zhong	Jiangnan University	zhonghongxiu@126.com
90	Duanmei Zhou	Gannan Normal University	gzzdm2008@163.com

91	Ping Zhou	Wenshan University	646504832@qq.com
92	Huihui Zhu	Hefei University of Technology	hhzhu@hfut.edu.cn
93	Sanmei Zhu	Shangdong University	787560354@qq.com
94	Qing-Wen Wang	Shanghai University	wqw@shu.edu.cn
95	Guang-Da Hu	Shanghai University	ghu@hit.edu.cn
96	Chuanqing Gu	Shanghai University	cqgu@shu.edu.cn
97	Tao Li	Shanghai University	ttaoli123@126.com
98	Yuchao Wang	Shanghai Unviersity	yuchaowang@shu.edu.cn
99	Juntong Liu	Shanghai Unviersity	juntongliu82@163.com
100	Xiangjian Xu	Shanghai Unviersity	xu.xj@ntu.edu.cn
101	Adda Farouk	Shanghai Unviersity	adda-farouk@hotmail.com
102	Mengyan Xie	Shanghai Unviersity	814032276@qq.com
103	Ye Deng	Shanghai Unviersity	690605153@qq.com
104	Jialing Liu	Shanghai Unviersity	liujialing@i.shu.edu.cn
105	Huihui Wang	Shanghai Unviersity	2463265146@qq.com
106	Yiling Wu	Shanghai Unviersity	1099193856@qq.com
107	Boer Li	Shanghai Unviersity	boitalauriane@gmail.com
108	Yanpei Wang	Shanghai Unviersity	wangyanoei2008@163.com
109	Chongquan Zhang	Shanghai University	marcaszhang@gmail.com
110	Yun Ye	Shanghai University	yeyun_shu@126.com
111	Qingqing Zhao	Shanghai University	1013645602@qq.com
112	Hongyan Chen	Shanghai University	CHY0423@i.shu.edu.cn
113	Minghua Lin	Shanghai University	m_lin@i.shu.edu.cn
114	Olga Kushel	Shanghai University	kushel@mail.ru
115	Jiancai Sun	Shanghai University	jcsun@shu.edu.cn
116	Anwa Zhou	Shanghai University	zhouanwa@shu.edu.cn
117	Jingjing Peng	Shanghai University	jjpeng2012@163.com
118	Ligang Kuai	Shanghai University	897199209@qq.com
119	Zhongyang Li	Shanghai University	lzy16720043@t.shu.edu.cn

上海大学数学系简介

上海大学是国家“211 工程”重点建设高校之一。上海大学数学系现有教职工 116 人，专职教师 100 人，其中教授 26 名、博士生导师 25 人、副教授 35 人、院士 1 名、国家千人计划专家 2 名、上海千人 1 名、教育部长江学者 1 名、杰青 1 名、中国科学院百人计划 1 名、上海领军人才 1 名、曙光学者 1 名、上海浦江人才计划 4 名、上海青年东方学者 3 名，45 岁以下博士比例 100%，获得海外学位或有海外研究经历的人员比例为 95%；在校本科生 500 多人、硕士研究生 200 多人、博士研究生 60 多人。

数学系有数学一级学科博士点、数学博士后流动站，数学、统计学两个一级学科硕士点；有上海市教委重点学科、上海市重点学科、上海高校一流学科、上海市高校高原学科。上海市应用数学与系统科学研究所、上海大学核心数学研究所、上海大学优化开放实验室、上海大学数学与编码密码研究所、上海大学张量与矩阵研究中心、上海大学系统科学研究所均挂靠数学系；上海市青少年科技人才培养基地—上海大学数学科学实践工作站是全国首家数学工作站。

2017 年 USNEWS（《美国新闻和世界报导》）全球最佳大学数学学科排名上海大学位居第 80；美国 ESI 数据库最新数据，全球前 1%的数学研究机构有 241 个，上海大学排第 119，进入全球前 5‰行列。近年来数学系每年有近 300 位国内外著名专家学者前来讲学交流，包括菲尔兹奖得主 Zelmanov 及杨乐等 30 多位海内外院士来上海大学数学系访问和科学合作研究。主办或承办了包括“第 14 届国际线性代数协会年会”在内的大型国内外学术会议 40 多次。

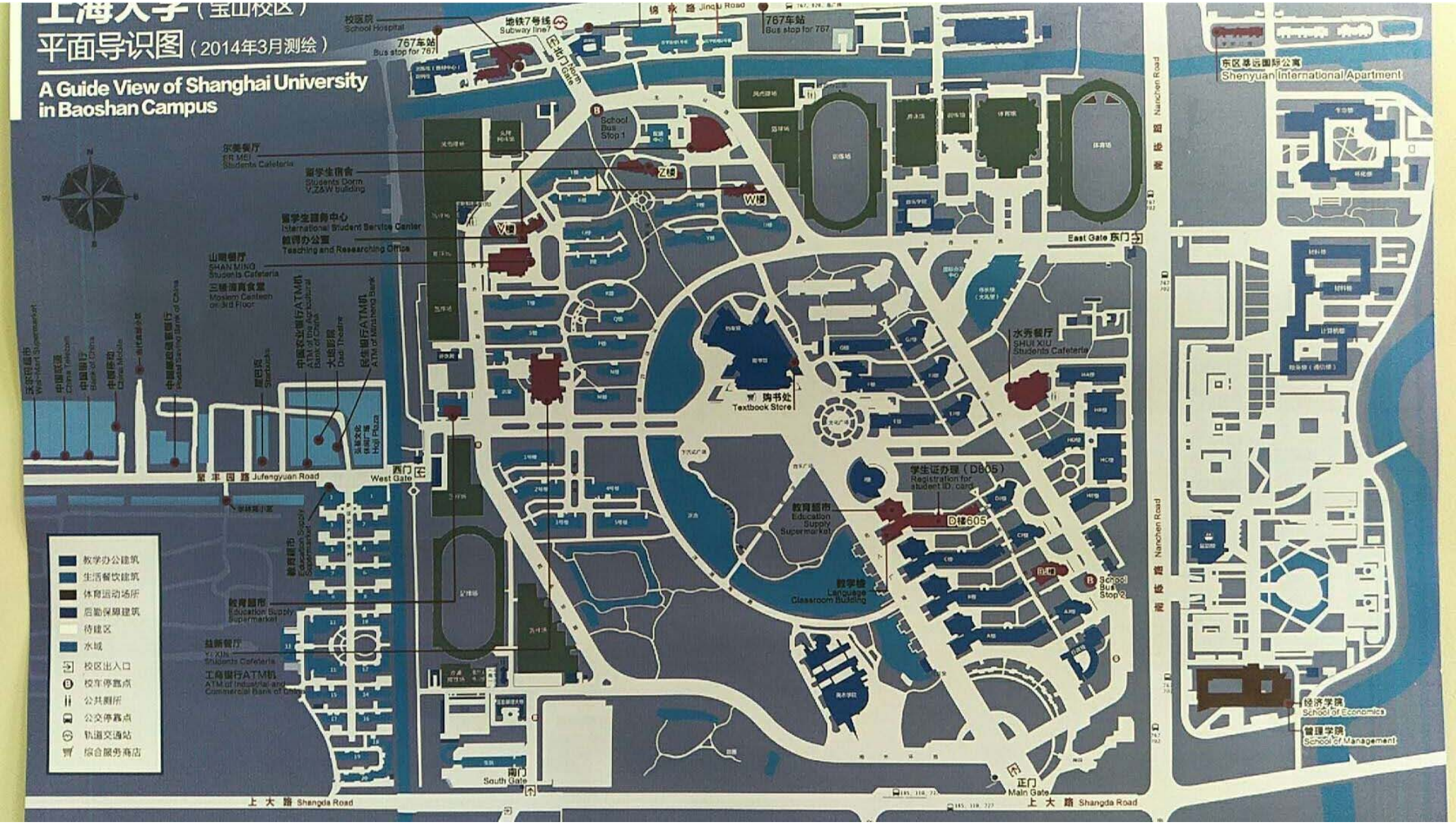
The Department of Mathematics, Shanghai University

Shanghai University (SHU) is one of China's key universities of 'Project 211'. The Department of Mathematics is the home of 116 well qualified people, among them 100 are full-time faculty members. The team of faculty members is formed by 26 professors, 25 doctoral advisors, 35 associate professors, 1 academician, 2 National Thousand Talent Plan, 1 Shanghai Thousand Talent Plan, 1 Chang Jiang Scholars Program, 1 National Science Fund for Distinguished Young Scholars Program, 1 Chinese Academy of Sciences Hundred Talents Program, 1 Shanghai Leading Talent, 1 Dawn Program of Shanghai Education Commission, 4 Shanghai Pujiang Talent Program, 3 Shanghai Oriental distinguished professors, 100% of doctors under the age of 45, 95% of overseas graduates or staff with overseas research experience. It has over 500 undergraduates, 200 graduates, and 60 doctoral candidates.

The Department of Mathematics consists of one first-level doctoral program in mathematics, one mathematics postdoctoral research station , two first-level graduate programs in mathematics and statistics; and Shanghai municipal education commission key disciplines, Shanghai key disciplines, Shanghai first-class discipline, Shanghai plateau discipline. In addition, Shanghai Institute of Applied Mathematics and Systems Science,

Institute of Core Mathematical Research of Shanghai University, Shanghai University Open Laboratory for Operations Research & Optimization, Institute of Mathematics and Coding & Cryptography of Shanghai University, International Research Center for Tensor and Matrix Theory of Shanghai University, Institute of Systems Science of Shanghai University are all affiliated to the Department of Mathematics. Shanghai youth talent training base — the work station on mathematics practice workstation of Shanghai University is a pioneering under taking for the national mathematics workstation.

In 2017, SHU was ranked at the 80th place in the USNEWS World's Best University Mathematics Ranking. According to the latest data from the US ESI database, there are 241 mathematics research institutions are recognized as world's top 1% , among which, Shanghai University ranks 119, entering the top 5‰ in the world. In recent years, there are nearly 300 famous experts every year coming to the Department of Mathematics for extensive academic exchange and research cooperation. Among them, more than 30 domestic and foreign academicians including Fields Medal winner – Zelmanov and Professor Yang Le have visited the department. Besides, the Department of Mathematics hosted or undertook more than 40 large-scale international academic conferences including the 14th Conference of the International Linear Algebra Society.


上海大学（宝山校区）
平面导识图（2014年3月测绘）
A Guide View of Shanghai University in Baoshan Campus
校医院 School Hospital
地铁7号线 Subway line7
767车站 Bus stop for 767
锦秋路 Jinqiu Road
北门 North Gate
School Bus Stop 1
尔美餐厅 ER MEI Students Cafeteria
留学生宿舍 Students Dorm V,Z&W building
留学生服务中心 International Student Service Center
教师办公室 Teaching and Researching Office
山明餐厅 SHAN MING Students Cafeteria
三楼清真食堂 Moslem Canteen on 3rd Floor
中国移动 China Mobile
中国银行 Bank of China
中国电信 China Telecom
沃尔玛超市 Wal-Mart Supermarket
中国邮政储蓄银行 Postal Saving Bank of China
星巴克 Starbucks
中国农业银行ATM机 ATM of the Agricultural Bank of China
大地影院 Dadi Theatre
民生银行ATM机 ATM of Minsheng Bank
Hejili Plaza
军工路 Jufengyuan Road
西门 West Gate
教育超市 Education Supply Supermarket
丝新餐厅 Yi Xin Students Cafeteria
工商银行ATM机 ATM of Industrial and Commercial Bank of China
南门 South Gate
上大路 Shangda Road
教学办公建筑
生活餐饮建筑
体育运动场所
后勤保障建筑
待建区
水域
校区出入口
校车停靠点
公共厕所
公交停靠点
轨道交通站
综合服务商店
East Gate 东门
水秀餐厅 SHUI XIU Students Cafeteria
陶书处 Textbook Store
学生证办理（D805） Registration for student ID card
D楼605
教学楼 Language Classroom Building
School Bus Stop 2
正门 Main Gate
南陈路 Nanchen Road
东区申远国际公寓 Shenyuan International Apartment
经济学院 School of Economics
管理学院 School of Management

Tip:

Passengers holding public transportation cards are entitled to free transfer and uninterrupted fare charging within 30 minutes after getting out of the following stations :

1.Shanghai Railway Station (Line1,Line3 and Line4),

2.West NanjingRoad (Line2 , Line12 and Line13) ,

3.Hongqiao Airport Terminal2 (Line2 and Line10,in-station transfer is only allowed between a train of line 2 bound for Pudong international Airport and that of line 10 bound for Xinjiangwancheng or Hangzhong Road at this station).

4.Longhua (Line11 and Line12) ,

those holding single journey tickets need to pay for new tickets if they should exit the above stations.

Airport | Railway Station | Maglev Line | Metro Line | Huangpu River | Single-line Station | Interchange Station | Out-of-system Transfer Station

Line 1 | Line 3 | Line 5 | Line 7 | Line 9 | Line 11 | Line 13

Line 2 | Line 4 | Line 6 | Line 8 | Line 10 | Line 12 | Line 16

Line 17 | Pujiang Line

SHANGHAI METRO NETWORK MAP