2018 China-Korea International Conference on Matrix Theory with Applications (ICMTA2018)

2018中韩矩阵论及其应用国际会议

Shanghai University

Shanghai, China

December 17-20, 2018

Sponsors

International Research Center for Tensor and Matrix Theory (IRCTMT)

Applied Algebra and Optimization Research Center (AORC), Sungkyunkwan University, Korea.

Gaoyuan Discipline of Shanghai –Mathematics, Shanghai University

SHANGHAI UNIVERSITY IRCTMT

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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:

聚丰园宾馆，上海大学西门附近
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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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From Shanghai Railway Station to Shanghai University (Baoshan Campus)

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.)

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Program

Monday, December 17

9:00-19:00 Registration

Lobby of the Lehu Hotel 乐乎新楼1号楼一楼

17:30-19:30 Dinner

Tuesday, December 18

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

8:20-8:50 Opening Ceremony

Opening remarks by Professor Qing-Wen Wang

Opening remarks by Professor Gi-Sang Cheon

Opening remarks by Professor Steve Kirkland

Opening remarks by Professor Chi-Kwong Li

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

8:50-9:30 Speaker: Steve Kirkland, University of Manitoba, Canada (p. 17)

Title: Kemeny's Constant for Markov Chains

9:30-9:45 Group Photo and Coffee Break

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

9:45-10:15 Speaker: Man-Duen Choi, University of Toronto, Canada (p. 10)

Title: Two by two matrix theory made simple but difficult

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

Title: Mertens equimodular matrices related to the Riemann hypothesis

10:45-11:15 Speaker: Ying-Fen Lin, Queen's University Belfast, UK (p. 21)

Title: The characterisation of Schur multiplicative and Schur null maps

11:15-11:45 Speaker: Bojan Kuzma, University of Primorska, Slovenia (p. 19)

Title: Matrices with extremal commutants and beyond

11:45-12:15 Speaker: Musheng Wei, Shanghai Normal University (p. 25)

Title: Quaternion Matrix Computations

12:15-13:30 Lunch

Parallel afternoon sessions for December 18. Session One

Chair: Sejong Kim Daxue Hall(大学厅)-乐乎新楼2号楼二楼

13:30-14:00 Speaker: Chi-Kwong Li, College of William and Mary, USA (p. 20)
Title: Maps between rectangular matrix spaces preserving disjointness, JB^*-triple products, norms

14:00-14:30 Speaker: Jang Soo Kim, Sungkyunkwan University, Korea (p. 16)
Title: Lecture hall tableaux

14:30-15:00 Speaker: Jianlong Chen, Southeast University (p. 9)
Title: The generalized inverse of a companion matrix

15:00-15:30 Speaker: Zhigang Jia, Jiangsu Normal University (p. 13)
Title: Lanczos method for large-scale quaternion singular value decomposition

15:30-15:45 Coffee Break

Chair: Yiu-Tung Poon Daxue Hall(大学厅)-乐乎新楼2号楼二楼

15:45-16:15 Speaker: Yoon Mo Jung, Sungkyunkwan University, Korea (p. 14)
Title: A Coordinate Descent Homotopy Method for Linearly Constrained Nonsmooth Convex Minimization

16:15-16:45 Speaker: Gang Wu, China University of Mining and Technology (p. 25)
Title: Randomized GLRAM-type algorithms for high dimensionality reduction and image reconstruction

16:45-17:15 Speaker: Kyoungmin Kim, Sungkyunkwan University, Korea (p. 16)
Title: A sum of squares not divisible by a prime

17:15-17:45 Speaker: Yan Zhu, Shanghai University (p. 27)
Title: Relative t-designs in binary Hamming association schemes

17:45-19:00 Dinner

Parallel afternoon sessions for December 18. Session Two

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

13:30-14:00 Speaker: Chang Heon Kim, Sungkyunkwan University, Korea (p. 16)
Title: Weakly holomorphic Hecke eigenforms and Hecke eigenpolynomials

14:00-14:30 Speaker: Junfeng Yin, Tongji University (p. 26)
Title: Recent progresses on matrx splitting methods for the solution of linear equations

14:30-15:00 Speaker: Zhongyun Liu, Changsha University of Science and Technology, (p. 21)
Title: On inexact ADI iteration for continuous Sylvester equations

15:00-15:30 Speaker: Olga Kushel, Shanghai University (p. 18)
Title: New problems of matrix theory with a view to applications

15:30-15:45 Coffee Break

Chair: Raymond Nung-Sing Sze Xuehai Hall(学海厅)-乐乎新楼2号楼二楼

15:45-16:15 Speaker: Nhan-Phu Chung, Sungkyunkwan university, Korea (p. 10)
Title: Cocycles over a minimal base and the spectra of Schrödinger operators

16:15-16:45 Speaker: Wen Li, South China Normal University (p. 20)
Title: Preconditioned Splitting Iterations for Solving Multilinear Systems

16:45-17:15 Speaker: Ho Yun Jung, Sungkyunkwan University, Korea (p. 14)
Title: Modularity of Galois traces of ray class invariants

17:15-17:45 Speaker: Yaokun Wu, Shanghai Jiao Tong University (p. 25)
Title: Sparse tensor and perfect phylogeny

17:45-19:00 Dinner

Wednesday, December 19

Parallel morning sessions for December 19. Session One

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

8:00-8:30 Speaker: Tongsong Jiang, Heze University (p. 14)
Title: Algebraic techniques for least squares problem over generalized quaternion algebras: A unified approach in quaternionic and split quaternionic theory

8:30-9:00 Speaker: Namhun Koo, Sungkyunkwan University, Korea (p. 17)
Title: Introduction to algebraic key recovery attack using good key against MQ-based signature scheme

9:00-9:30 Speaker: Muralitharan Krishnan, Sungkyunkwan University, Korea (p. 18)
Title: Analysis of energy load forecasting using neural networks in smart grid

9:30-10:00 Speaker: Soonhak Kwon, Sungkyunkwan University, Korea (p. 19)
Title: On APN functions and their properties

10:00-10:15 Coffee Break

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

10:15-10:45 Speaker: Seok-Zun Song, Jeju National University, Korea (p. 23)
Title: Symmetric arctic rank of Boolean matrix and its linear preservers

10:45-11:15 Speaker: Qingxiang Xu, Shanghai Normal University (p. 26)
Title: Norm estimations for the Moore-Penrose inverse of the weak perturbation of Hilbert C^*-module operators

11:15-11:45 Speaker: Ricky Wai Hin Ng, The Hong Kong Polytechnic University (p. 22)
Title: Projective Limits and Matrix-ordered Duals of Operator Systems

11:45-13:15 Lunch

Parallel morning sessions for December 19. Session Two

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

8:00-8:30 Speaker: Yiu-Tung Poon, Iowa State University, USA (p. 23)
Title: Numerical Range Inclusion and Dilation

8:30-9:00 Speaker: Jor-Ting Chan, The University of Hong Kong (p. 9)
Title: The cone of nonnegative c-numerical range

9:00-9:30 Speaker: Raymond Nung-Sing Sze, The Hong Kong Polytechnic University (p. 23)
Title: The generalized numerical range of a set of matrices

9:30-10:00 Speaker: Pan-Shun Lau, The Hong Kong Polytechnic University (p. 19)
Title: Intersection of generalized numerical ranges under similarity

10:00-10:15 Coffee Break

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

10:15-10:45 Speaker: Sukmoon Huh, Sungkyunkwan University, Korea (p. 12)
Title: Wildness of algebraic varieties with nonnegative Kodaira dimension

10:45-11:15 Speaker: Seyed Ahmad Mojallal, Sungkyunkwan University, Korea (p. 22)
Title: Subgraph characterizations of Toeplitz graphs

11:15-11:45 Speaker: Bumtle Kang, Sungkyunkwan University, Korea (p. 15)
Title: Study on (oriented) Toeplitz graphs

11:45-13:15 Lunch

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

13:15-13:45 Speaker: Fumio Hiai, Tohoku University, Japan (p. 11)
Title: Log-majorization related to Rényi divergences

13:45-14:15 Speaker: Yongdo Lim, Sungkyunkwan University, Korea (p. 21)
Title: Geometric Mean Matrices

14:15-14:45 Speaker: Tingran Gao, University of Chicago, USA (p. 11)
Title: Semi-Riemannian Manifold Optimization

14:45-15:15 Speaker: Dijana Ilišević, University of Zagreb, Croatia (p. 12)
Title: On surjective linear isometries with finite spectrum

15:15-15:45 Speaker: Tamás Titkos, Rényi Institute and BBS University of Applied Sciences, Hungary (p. 24)
Title: Positive operators on anti-dual pairs

15:45-16:00 Coffee Break

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

16:00-16:30 Speaker: Zhuo-Heng He, Shanghai University (p. 11)
Title: General solutions to some systems of matrix equations

16:30-17:00 Speaker: Edward Poon, Embry-Riddle University, USA (p. 22)
Title: Complexifications and isometries

17:00-17:30 Speaker: Yang Zhang, University of Manitoba, Canada (p. 27)
Title: Matrices over Non-commutative Rings

17:30-18:00 Speaker: Fuzhen Zhang, Nova Southeastern University, USA (p. 27)
Title: What does it really mean by eigenvalue continuity?

18:00-18:15 Concluding remarks

18:15-19:00 Dinner

Goodbye

Abstracts

Jor-Ting Chan

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The University of Hong Kong

Title: The cone of nonnegative c-numerical range

Abstract: Let H be a complex Hilbert space and $B(H)$ the Banach algebra of all bounded operators on H. For any array $c = (c_1, \ldots, c_n)$ of numbers, the c-numerical range of an $A \in B(H)$ is the set

$$W_c(A) = \left\{ \sum_{k=1}^{n} c_k \langle Ax_k, x_k \rangle : \{x_1, \ldots, x_k\} \text{ is an orthonormal set in } H \right\}.$$

Let $P_c = \{A \in B(H) : W_c(A) \subseteq [0, \infty)\}$. Then P_c is a cone in $B(H)$. Generally speaking, P_c can be quite different from the cone of all positive semi-definite operators. In this talk, we shall look at some properties of such cones.
This is joint work with Kong Chan (HKU).

Jianlong Chen

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Southeast University

Title: The generalized inverse of a companion matrix

Abstract: In this talk, I will talk about the Moore-Penrose inverse , group inverse and core inverse of a companion matrix. We investigate the existence and representations of these generalized inverses of a companion matrix in a ring.

Gi-Sang Cheon

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Sungkyunkwan University, Korea

Title: Mertens equimodular matrices related to the Riemann hypothesis

Abstract: The Mertens function $M(n)$ is defined as the cumulative sum of the Möbius function: $M(n) = \sum_{k=1}^{n} \mu(k)$. It is well-known that the *Riemann hypothesis* is true if and only if

$$M(n) = O(n^{1/2+\epsilon}), \quad \epsilon > 0.$$

The first matrix theoretical approach to the Riemann hypothesis was done by Redheffer in 1977. He introduced the $n \times n$ (0,1)-matrix $R_n = [r_{ij}]_{1 \leq i,j \leq n}$ called the ***Redheffer matrix*** where $r_{ij} = 1$ if either $i = 1$ or i divides j, and $r_{ij} = 0$ otherwise. It is proved that for all $n \geq 1$,

$$\det(R_n) = M(n)$$

The asymptotic behavior of $M(n)$ is now equivalent to that of the determinant of R_n. There were several attempts to study $M(n)$ by means of the eigenvalues or singular values of R_n to solve the RH.

In this talk, we are interested to the $n \times n$ matrices called the *Mertens equimodular matrices* with the same determinant of the Redheffer matrix for all $n \geq 1$. We use Riordan matrices to find a large class of the Mertens equimodular matrices. Moreover, the generating function for the characteristic polynomials of the matrices is also given and a sufficient condition for the Riemann hypothesis is obtained by using singular values of the matrices.
This is joint work with Hana Kim (Sungkyunkwan University).

Man-Duen Choi

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University of Toronto, Canada

Title: Two by two matrix theory made simple but difficult

Abstract: What on earth does a quantum channel mean? With pride and prejudice in quantum information, we seek sense and sensibility of the non-commutative geometry, from practical point of view. There are many deep (but simple) aspects as shown in the down-to-earth structure of two by two matrices. In particular, we see that the quantum entanglement effect is sophisticated on the algebra of 4 x 4 matrices, in terms of the tensor products of two by two matrices.

Nhan-Phu Chung

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Sungkyunkwan university, Korea

Title: Cocycles over a minimal base and the spectra of Schrödinger operators

Abstract: In this talk, we will present a uniform dichotomy for generic $GL(n, R)$ cocycles over a general minimal base. We also apply it to study the spectra of discrete Schrödinger's operators. These extends some results of Avila, Bochi and Damanik.

Tingran Gao

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University of Chicago, USA

Title: Semi-Riemannian Manifold Optimization

Abstract: We introduce in this paper a manifold optimization framework that utilizes semi-Riemannian structures on the underlying smooth manifolds. Unlike in Riemannian geometry, where each tangent space is equipped with a positive definite inner product, a semi-Riemannian manifold allows the metric tensor to be indefinite on each tangent space, i.e., possessing both positive and negative definite subspaces; differential geometric objects such as geodesics and parallel-transport can be defined on non-degenerate semi-Riemannian manifolds as well, and can be carefully leveraged to adapt Riemannian optimization algorithms to the semi-Riemannian setting. In particular, we discuss the metric independence of manifold optimization algorithms, and illustrate that the weaker but more general semi-Riemannian geometry often suffices for the purpose of optimizing smooth functions on smooth manifolds in practice.

Zhuo-Heng He

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Shanghai University

Title: General solutions to some systems of matrix equations

Abstract: In this talk, we consider some systems of matrix equations. We give some necessary and sufficient solvability conditions for some systems of matrix equations in terms of ranks and generalized inverses of matrices. We also derive the general solutions to these systems when they are solvable.

This is joint work with Qing-Wen Wang (Shanghai University, China) and Yang Zhang (University of Manitoba, Canada).

Fumio Hiai

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Tohoku University, Japan

Title: Log-majorization related to Rényi divergences

Abstract: For $\alpha, z > 0$ with $\alpha \neq 1$, motivated by comparison between different kinds of Rényi divergences in quantum information, we consider log-majorization between the matrix functions

$$P_\alpha(A, B) := B^{1/2}(B^{-1/2}AB^{-1/2})^\alpha B^{1/2},$$

$$Q_{\alpha,z}(A,B) := (B^{\frac{1-\alpha}{2z}} A^{\frac{\alpha}{z}} B^{\frac{1-\alpha}{2z}})^z$$

of two positive (semi)definite matrices A, B. We precisely determine the parameters α, z for which $P_\alpha(A,B) \prec_{\log} Q_{\alpha,z}(A,B)$ and $Q_{\alpha,z}(A,B) \prec_{\log} P_\alpha(A,B)$ hold, respectively, as follows:

Theorem. Let $\alpha, z > 0$ with $\alpha \neq 1$.

(a) The following conditions are equivalent:

(i) $P_\alpha(A,B) \prec_{\log} Q_{\alpha,z}(A,B)$ for every $A, B \in \mathbb{M}_n^+$, $n \in \mathbb{N}$, with $B > 0$;

(ii) $\operatorname{Tr} P_\alpha(A,B) \leq \operatorname{Tr} Q_{\alpha,z}(A,B)$ for every $A, B \in \mathbb{M}_n^+$, $n \in \mathbb{N}$, with $B > 0$;

(iii) $P_\alpha(A,B) \prec_{\log} Q_{\alpha,z}(A,B)$ for every $A, B \in \mathbb{M}_2^+$ with $A, B > 0$;

(iv) either $0 < \alpha < 1$ and $z > 0$ is arbitrary, or $\alpha > 1$ and $0 < z \leq \min\{\alpha/2, \alpha - 1\}$.

(b) The following conditions are equivalent:

(i)′ $Q_{\alpha,z}(A,B) \prec_{\log} P_\alpha(A,B)$ for every $A, B \in \mathbb{M}_n^+$, $n \in \mathbb{N}$, with $B > 0$;

(ii)′ $\operatorname{Tr} Q_{\alpha,z}(A,B) \leq \operatorname{Tr} P_\alpha(A,B)$ for every $A, B \in \mathbb{M}_n^+$, $n \in \mathbb{N}$, with $B > 0$;

(iii)′ $Q_{\alpha,z}(A,B) \prec_{\log} P_\alpha(A,B)$ for every $A, B \in \mathbb{M}_2^+$ with $A, B > 0$;

(iv)′ $\alpha > 1$ and $z \geq \max\{\alpha/2, \alpha - 1\}$.

Sukmoon Huh

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Sungkyunkwan University, Korea

Title: Wildness of algebraic varieties with nonnegative Kodaira dimension

Abstract: Arithmetically Cohen-Macaulay (for short, aCM) sheaves are, roughly speaking, the coherent sheaves with no intermediate cohomology, and the category of aCM sheaves provides a measurement of the complexity of its base variety. In this talk, we show the wildness of a number of varieties with nonnegative Kodaira dimension by constructing arbitrary dimensional families of indecomposable and pairwise non-isomorphic aCM vector bundles via Hartshorne-Serre construction. This is joint work with Edoardo Ballico (Trento), Joan Pons-Llopis (L'Aquila).

Dijana Ilišević

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University of Zagreb, Croatia

Title: On surjective linear isometries with finite spectrum

Abstract: Let $\mathcal{X}$ be a complex Banach space and let $T\colon \mathcal{X} \to \mathcal{X}$ be a surjective linear isometry with the spectrum $\sigma(T) = \{\lambda_1, \ldots, \lambda_n\}$. Every λ_i is an eigenvalue of T and if P_i is the projection onto the kernel of $T - \lambda_i I$ (the so-called eigenprojection) then

$$P_1 \oplus \cdots \oplus P_n = I \quad \text{and} \quad \lambda_1 P_1 + \lambda_2 P_2 + \cdots + \lambda_n P_n = T.$$

An important class of surjective linear isometries with finite spectrum is the class of periodic linear isometries: T is periodic of period m if $T^m = I$ and $T^k \neq I$ for $k = 1, \ldots, m-1$. The point spectrum of T consists of (not necessarily all) mth roots of unity.

We shall discuss eigenvalues and eigenprojections of surjective linear isometries on a large class of complex Banach spaces, including various matrix spaces, JB*-triples and $C_0(\Omega)$, the Banach space of continuous complex-valued functions on a locally compact Hausdorff space Ω vanishing at infinity.

This talk is based on several papers. The work of Dijana Ilišević has been fully supported by the Croatian Science Foundation under the project IP-2016-06-1046.
This is joint work with Fernanda Botelho (University of Memphis, USA), Maja Fošner (University of Maribor, Slovenia), Chi-Kwong Li (College of William and Mary, USA), Chih-Neng Liu (National Sun Yat-sen University, Taiwan), Ngai-Ching Wong (National Sun Yat-sen University, Taiwan).

Zhigang Jia

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Jiangsu Normal University

Title: Lanczos method for large-scale quaternion singular value decomposition

Abstract: In many color image processing and recognition applications, one of the most important targets is to compute the optimal low-rank approximations to color images, which can be reconstructed with a small number of dominant singular value decomposition (SVD) triplets of quaternion matrices. All existing methods are designed to compute all SVD triplets of quaternion matrices at first and then to select the necessary dominant ones for reconstruction. This way costs quite a lot of operational flops and CPU times to compute many superfluous SVD triplets. In this paper, we propose a Lanczos-based method of computing partial (several dominant) SVD triplets of the large-scale quaternion matrices. The partial bidiagonalization of large-scale quaternion matrices is derived by using the Lanczos iteration, and the reorthogonalization and thick-restart techniques are also utilized in the implementation. An algorithm is presented to compute the partial quaternion singular value decomposition. Numerical examples, including principal component analysis, color face recognition, video compression and color image completion, illustrate that the performance of the developed Lanczos-based method for low-rank quaternion approximation is better than that of the state-of-the-art methods.

This is joint work with Michael K. Ng and Guangjing Song.

Tongsong Jiang

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Heze University

Title: Algebraic techniques for least squares problem over generalized quaternion algebras: A unified approach in quaternionic and split quaternionic theory

Abstract: This paper aims to present, in a unified manner, algebraic techniques for least squares problem in quaternionic and split quaternionic mechanics. This paper, by means of a complex representation and a real representation of a generalized quaternion matrix, studies generalized quaternion least squares (GQLS) problem of generalized quaternion linear equations AX~B, and derives two algebraic methods for solving the GQLS problem. This paper gives not only algebraic techniques for least squares problem over generalized quaternion algebras, but also a unification of algebraic techniques for least squares problem in quaternionic and split quaternionic theory.

Ho Yun Jung

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Sungkyunkwan University, Korea

Title: Modularity of Galois traces of ray class invariants

Abstract: After Zagier's significant work on traces of singular moduli, Bruinier and Funke generalized his result to the traces of singular values of modular functions on modular curves of arbitrary genus. In class field theory, the extended ring class field is a generalization of the ray class field over an imaginary quadratic field. By using Shimura's reciprocity law, we construct primitive generators of the extended ring class fields by using Siegel functions of arbitrary level $N \geq 2$ and identify their Galois traces with Fourier coefficients of weight $3/2$ harmonic weak Maass forms. This would extend the results on ring class invariants.

Yoon Mo Jung

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Sungkyunkwan University, Korea

Title: A Coordinate Descent Homotopy Method for Linearly Constrained Nonsmooth Convex Minimization

Abstract: A problem in optimization, with a wide range of applications, entails finding a solution of a linear equation $Ax = b$ with various minimization properties. Such applications include compressed sensing, which requires an efficient method to find a minimal ℓ_1 norm solution. We propose a

coordinate descent homotopy method to solve the linearly constrained convex minimization problem $\min\{P(x) \mid Ax = b,\ x \in \Re^n\}$ where P is proper, convex and lower semicontinuous. A well-known special case is the basis pursuit problem $\min\{\|x\|_1 \mid Ax = b,\ x \in \Re^n\}$. The coordinate descent method is applied to solve the regularized linear least squares problem, which arises as a sequence of subproblems for the proposed method, and we show global linear convergence. We also test for solving large-scale basis pursuit problem. Comparison with other algorithms suggests that the proposed method can be used as an efficient method for ℓ_1 minimization problem.
This is joint work with Sangwoon Yun (Sungkyunkwan University).

Bumtle Kang

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Sungkyunkwan University, Korea

Title: Study on (oriented) Toeplitz graphs

Abstract: An $n \times n$ matrix $T = (t_{ij})_{1 \le i,j \le n}$ is called a *Toeplitz matrix* if $t_{i,j} = t_{i+1,j+1}$ for each $i, j = 1, \ldots, n-1$. Toeplitz matrices are precisely those matrices that are constant along all diagonals parallel to the main diagonal, and thus a Toeplitz matrix is determined by its first row and column. Toeplitz matrices occur in a large variety of areas in pure and applied mathematics. For example, they often appear when differential or integral equations are discretized, they arise in physical data-processing applications, and in the theories of orthogonal polynomials, stationary processes, and moment problems.

A *Toeplitz graph* $T = (V, E)$ is a undirected graph with a symmetric Toeplitz adjacency matrix $A(T)$. i.e. identical on all its diagonals parallel to the main diagonal of $A(T)$. A Toeplitz graph T is therefore uniquely defined by the first row of $A(T)$, a (0,1)-sequence. If the 1's in the first row of a Toeplitz matrix are placed at positions $1 + t_1$, $1 + t_2$, ..., $1 + t_k$ with $1 \le t_1 < t_2 < \ldots < t_k < n = |V(T)|$, we may simply write $G_n = T_n\langle t_1, t_2, \ldots, t_k\rangle$, two vertices x, y are adjacent if and only if $|x - y| \in \{t_1, t_2, \ldots, t_k\}$. In this talk, we first see structural properties of Toeplitz graphs through the variables $t_1, \ldots, t_k$.

An *oriented Toeplitz graph* $D = (V, A)$ is a directed graph with an asymmetric Toeplitz adjacency matrix $A(D)$. In a similar way to a Toeplitz graph, we may simply write an oriented Toeplitz graph

$$G_n^\sigma = D_n\langle t_1, t_2, \ldots, t_{k_1}; s_1, s_2, \ldots, s_{k_2}\rangle$$

so that there is an arc (i, j) in D if $j - i \in \{t_1, \ldots, t_{k_1}\}$ or $i - j \in \{s_1, \ldots, s_{k_1}\}$. Through the variables $t_1, \ldots, t_{k_1}, s_1, \ldots, s_{k_2}$, we represent graph structural properties and matrix properties as a linear combination of those such as strong connectivity, girth, primitivity, and exponents.

Chang Heon Kim

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Title: Weakly holomorphic Hecke eigenforms and Hecke eigenpolynomials

Abstract: In the work of Bringmann, Guerzhoy, Kent and Ono weakly holomorphic Hecke eigenforms were dened and constructed in the level one case by making use of harmonic weak Maass forms. In this talk I will extend their results to higher level cases and give an explicit construction in terms of weakly holomorphic modular forms without relying on the theory of harmonic weak Maass forms. Moreover I will find a basis for the space of period polynomials consisting of Hecke eigenpolynomials.
This is joint work with SoYoung Choi (Gyeongsang National University).

Jang Soo Kim

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Title: Lecture hall tableaux

Abstract: We introduce lecture hall tableaux, which are fillings of a skew Young diagram satisfying certain conditions. Lecture hall tableaux generalize both lecture hall partitions and anti-lecture hall compositions, and also contain reverse semistandard Young tableaux as a limit case. We show that the coefficients in the Schur expansion of multivariate little q-Jacobi polynomials are generating functions for lecture hall tableaux. Using a Selberg-type integral we show that the moment of multivariate little q-Jacobi polynomials, which is equal to a generating function for lecture hall tableaux of a Young diagram, has a product formula. We also explore various combinatorial properties of lecture hall tableaux.
This is joint work with Sylvie Corteel.

Kyoungmin Kim

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Title: A sum of squares not divisible by a prime

Abstract: Let p be a prime. We define $S(p)$ the smallest number k such that every positive integer is a sum of at most k squares of integers that are not divisible by p. In this talk, we prove that $S(2) = 10$, $S(3) = 6$, $S(5) = 5$, and $S(p) = 4$ for any prime p greater than 5. In particular, it is proved that every

positive integer is a sum of at most four squares not divisible by 5, except the unique positive integer 79.

Steve Kirkland

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Title: Kemeny's Constant for Markov Chains

Abstract: Markov chains are a much-studied class of stochastic processes, and it is well-known that if the transition matrix A associated with a Markov chain possesses a certain property (called primitivity), then the long-term behaviour of the Markov chain is described by a particular eigenvector of A, known as the stationary distribution vector. Rather less well-known is Kemeny's constant for a Markov chain, which can be interpreted in terms of the expected number of time steps taken to arrive at a randomly chosen state, starting from initial state i. In particular, if Kemeny's constant is small, then we can think of the Markov chain as possessing good mixing properties. In this talk, we will give a short overview of Kemeny's constant, and discuss some results dealing with the problem of minimising Kemeny's constant over transition matrices that are subject various constraints. We will also describe some results showing that Kemeny's constant can exhibit surprising behaviour when the transition matrix is perturbed. Throughout, the techniques used rely on matrix theory and graph theory.

Namhun Koo

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Title: Introduction to algebraic key recovery attack using good key against MQ-based signature scheme

Abstract: The attack to find a good key is a generalization of Rainbow band separation attack. This algebraic key recovery attack is one of the strongest attack against signature scheme based on multivariate quadratic system. In this presentation, we introduce the basic concept of MQ based signature scheme and the good key. We also introduce several results applying good key finding attack.

Muralitharan Krishnan

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Title: Analysis of energy load forecasting using neural networks in smart grid

Abstract: The future smart grid is expected to provide flexible support for energy generation, distribution, transmission and management of energy resources. To achieve these features, power companies should have an ability to forecast the short-term electricity load accurately. Hence, we present a short-term energy load forecasting method with the use of neural networks and prove the superiority performance of the proposed approach against the existing established load forecasting models. In addition, we provide a straightforward approach to select the parameters with different types of activation functions to make the proposed model practical for use in real time environment. The analysis of the model with real time data from pecan street shows the effectiveness of our proposed approach. This is joint work with Sangwoon Yun and Yoonmo Jung.

Olga Kushel

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Title: New problems of matrix theory with a view to applications

Abstract: Nowadays the attention to the study of robust stability of dynamical systems rapidly grows. New types of systems has been studied and new approaches have been discovered. In this talk, we consider several matrix problems, which are based on the analysis of dynamical systems, e.g.

- generalizations of diagonally dominant matrices, with a view to the matrix spectra localization inside a given region of the complex plane;
- generalizations of M-matrices with a view to diagonal stability and its applications to the global stability of different system models;
- generalizations of P-matrices with a view to necessary conditions of different types of robust stability.

Some of the methods of analyzing the above problems are also considered.

Bojan Kuzma

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Title: Matrices with extremal commutants and beyond

Abstract: Matrices whose commutant is either maximal or minimal with respect to set-inclusion were classified in 2005 by Dolinar and Šemrl in their pursuit towards classification of bijections which preserve zeros of Lie product. The classification which they obtained is valid only for complex matrices. Recently, we extended their classification in several directions:
(a) For matrices over an arbitrary field. Besides the classes that were obtained in the complex case some new possibilities are here possible.
(b) We also investigated the problems of these kind within certain subclasses of (complex) matrices, in particular within doubly stochastic matrices.
(c) Instead of commutativity one may further consider the commutativity up to a factor ξ, defined by $AB = \xi BA$ and classify matrices which are extremal with respect to this relation.

The aim of the talk is to present the obtained results. This is a joint work with many collaborators.

Soonhak Kwon

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Title: On APN functions and their properties

Abstract: In this talk we will discuss APN(Almost Perfect Nonlinear) functions and their properties. Especially we will concentrate on local properties like pointwise APN property which was introduced by Stanica. We will derive some connections between local APN property and global APN property.

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Title: Intersection of generalized numerical ranges under similarity

Abstract: In 1952, W. Givens proved that for an $n \times n$ complex matrix A,

$$\text{co}(\sigma(A)) = \bigcap \{W(T^{-1}AT) : T \text{ is invertible}\},$$

where $\text{co}(\sigma(A))$ and $W(A)$ are the convex hull of eigenvlaues of A and the numerical range of A respectively. In this talk, we generalize this result to the C-numerical range. Relevant results on the

higher-rank numerical range will be discussed.
This is joint work Raymond Nung-Sing Sze (PolyU).

Chi-Kwong Li

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Title: Maps between rectangular matrix spaces preserving disjointness, JB^*-triple products, norms

Abstract: Let $M_{m,n}$ be the set of $m \times n$ real or complex matrices. Two matrices $A, B \in M_{m,n}$ are disjoint if $A^*B = 0_n$ and $AB^* = 0_m$. In this paper, characterization is given for linear maps $\Phi : M_{m,n} \to M_{r,s}$ sending disjoint matrix pairs to disjoint matrix pairs. In particular, it is shown that Φ preserves disjointness if and only if Φ is of the form

$$\Phi(A) = U \begin{pmatrix} A \otimes Q_1 & 0 & 0 \\ 0 & A^t \otimes Q_2 & 0 \\ 0 & 0 & 0 \end{pmatrix} V$$

for some unitary (orthogonal in the real case) matrices $U \in M_r, V \in M_s$ and diagonal matrices Q_1, Q_2 with positive diagonal entries, where Q_1 or Q_2 may be vacuous. The result is used to study homomorphisms on JB^*triples, and linear maps between matrix spaces preserving the norms of low rank matrices.
This is joint work with Ming-Cheng Tsai (Taipei University of Technology), Ya-Shu Wang (National Chung Hsing University), Ngai-Ching Wong (National Sun Yat-sen).

Wen Li

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South China Normal University

Title: Preconditioned Splitting Iterations for Solving Multilinear Systems

Abstract: It is known that the spectral radius of the iterative tensor can be seen as an approximate convergence rate for solving the multilinear system by the tensor splitting iterative methods. So in this talk, first we give some spectral radius comparisons between two different iterative tensors. Then, we propose the preconditioned tensor splitting method for solving the multilinear system, which provides an alternative algorithm with the choice of the preconditioner. In particular, also we give some spectral radius comparisons between the preconditioned iterative tensor and the original one. Numerical examples are given to demonstrate the efficiency of the proposed preconditioned methods.
This is joint work with Dongdong Liu and Seakweng Vong.

Yongdo Lim

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Title: Geometric Mean Matrices

Abstract: We consider an $m \times m$ block matrix M with entries $A_i \# A_j$ where $A_1, \ldots, A_m$ are positive definite matrices of fixed size and $A \# B$ is the geometric mean of positive definite matrix A and B. We show that M is positive semidefinite if and only if the family of $A_1, \ldots, A_m$ is Γ-commuting; it can be transformed to a commuting family of positive definite matrices by a congruence transformation. This result via Γ-commuting families provides not only a kind of positive semidefinite block matrices but also a new extremal characterization of two variable geometric mean in terms of multivariate block matrices.

Ying-Fen Lin

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Title: The characterisation of Schur multiplicative and Schur null maps

Abstract: In this talk, I will first define two linear maps associated with Schur product on the matrices, namely, the Schur multiplicative and the Schur null map. I will present some characterisations of those maps in both finite and infinite dimensional matrix spaces.
This is joint work with Donal O'Cofaigh.

Zhongyun Liu

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Changsha University of Science and Technology

Title: On inexact ADI iteration for continuous Sylvester equations

Abstract: In this paper, we study the alternating direction implicit (ADI) iteration for solving the continuous Sylvester equation A X + X B = C, where the coefficient matrices A and B are assumed to be positive semi-definite matrices (not necessarily Hermitian), and at least one of them to be positive definite. We first analyze the convergence of the ADI iteration for solving such a class of Sylvester equations, then derive a upper bound of the contraction factor of this ADI iteration. To reduce its computational complexity, we further propose an inexact variant of the ADI iteration, which employs some Krylov subspace methods as its inner iteration processes at each step of the outer ADI iteration. The convergence is also analyzed in detail. The numerical experiments are given to illustrate the

effectiveness of both ADI and inexact ADI iterations.
This is joint work with Yang Zhou.

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Title: Subgraph characterizations of Toeplitz graphs

Abstract: Let K_q be the complete graph of order q. In this talk, we describe several classes of finite Toeplitz graphs such as K_q-free Toeplitz graphs, chordal Toeplitz graphs, perfect Toeplitz graphs and regular Toeplitz graphs. Moreover, we present a result on decomposition of a Toeplitz graph and using it we characterize several subclasses of Toeplitz graphs.

Ricky Wai Hin Ng

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The Hong Kong Polytechnic University

Title: Projective Limits and Matrix-ordered Duals of Operator Systems

Abstract: A concrete operator system $\mathcal{S}$ is a unital $*$-closed subspace of $B(\mathcal{H})$. By the Choi-Effros abstract characterization theorem, $\mathcal{S}$ is nothing than a matrix-ordered $*$-vector space with Archimedean matrix order unit. Generalizing results on partially-ordered real normed spaces, Paulsen and Tomforde provided an order-theoretic foundation for operator systems. Based on that, Todorov and Mawhinney have started a systematic investigation of limit of inductive sequence $\{\mathcal{S}_n\}$ of operator systems. In this talk, we explore their dual picture via a categorical construction of projective limit. We will also go over partial results on matrix-ordered dual of $\mathcal{S}$.

Edward Poon

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Title: Complexifications and isometries

Abstract: Given a norm $\|\cdot\|$ on $\mathbf{R}^n$, there is a smallest reasonable complexification norm $\|\cdot\|_C$ on $\mathbf{C}^n$, defined by

$$\|x+iy\|_C = \sup\{\|x\cos\theta + y\sin\theta\| : \theta \in [0,2\pi]\}$$

for $x, y \in \mathbf{R}^n$. We shall characterize the isometries for $\|\cdot\|_C$ in terms of the isometries for $\|\cdot\|$.

This is joint work with D. Ilisevic, B. Kuzma, C.-K. Li.

Yiu-Tung Poon

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Title: Numerical Range Inclusion and Dilation

Abstract: Denote by $W(A)$ the numerical range of a $A \in \mathcal{B}(\mathcal{H})$, where $\mathcal{B}(\mathcal{H})$ is the set of bounded linear operators acting on the Hilbert space $\mathcal{H}$ and $\mathcal{B}(\mathcal{H})$ is identified with the set M_n of $n \times n$ complex matrices if $\mathcal{H}$ has dimension n. Choi and Li showed that if $A \in M_3$ has an reducing eigenvalue, then any bounded linear operator B satisfying $W(B) \subseteq W(A)$ will admit a dilation of the form $I \otimes A$. This extends some earlier results of Ando and Mirman. In this paper, a stronger converse of the result of Choi and Li is established. It is shown that $A \in M_3$ has a reducing eigenvalue if any $B \in M_2$ satisfying $W(B) \subseteq W(A)$ admits a dilation of the form $I \otimes A$. Moreover, a unified proof is given to the results of Ando, Mirman, Choi and Li.
This is joint work with Chi-Kwong Li.

Seok-Zun Song

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Title: Symmetric arctic rank of Boolean matrix and its linear preservers

Abstract: A Boolean rank one matrix can be factored as $\mathbf{u}\mathbf{v}^t$ for vectors $\mathbf{u}$ and $\mathbf{v}$ of appropriate orders. The perimeter of this Boolean rank one matrix is the number of nonzero entries in $\mathbf{u}$ plus the number of nonzero entries in $\mathbf{v}$. A Boolean matrix of Boolean rank k is the sum of k Boolean rank one matrices, a rank one decomposition. The perimeter of a Boolean matrix A of Boolean rank k is the minimum over all Boolean rank one decompositions of A of the sums of perimeters of the Boolean rank one matrices. The arctic rank of a Boolean matrix is one half the perimeter. In this talk, we show that the arctic rank is an upper bound of other rank function and we characterize the linear operators that preserve the symmetric arctic rank of symmetric Boolean matrices.
This is joint work with LeRoy B. Beasley (Utah State University, USA).

Raymond Nung-Sing Sze

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Title: The generalized numerical range of a set of matrices

Abstract: For a given set of $n \times n$ matrices $\mathcal{F}$, we study the union of the C-numerical ranges of the matrices in the set $\mathcal{F}$, denoted by $W_C(\mathcal{F})$. In this talk, we present some 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 $\mathcal{F}$. Furthermore, we consider the starshapedness and convexity of the set $W_C(\mathcal{F})$. In particular, we show that if $\mathcal{F}$ is the convex hull of two matrices such that $W_C(A)$ and $W_C(B)$ are convex, then the set $W_C(\mathcal{F})$ is star-shaped. We also investigate the extensions of the results to the joint C-numerical range of an m-tuple of matrices.
This is joint work with P.S. Lau (HK PolyU), C.K. Li (William & Mary), Y.T. Poon (Iowa State U).

Tamás Titkos

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Rényi Institute and BBS University of Applied Sciences, Hungary

Title: Positive operators on anti-dual pairs

Abstract: The problem of extending suboperators (or completing block operator matrices) goes back among others to Halmos, Krein, and von Neumann. The original question of Halmos is the following: assume that a positive linear map from a subspace of a Hilbert space into the whole space is given, can it be extended to a positive total operator? Our aim is to investigate this question in a different setting, namely we are dealing with positive suboperators defined on anti-dual pairs. The main result is to provide necessary and sufficient conditions under which a positive suboperator possesses a positive extension to the whole space. As an application, we will show that how this generality can be used to introduce parallel addition (a well-known operation in matrix theory) for positive elements in various settings.
This is joint work with Zsigmond Tarcsay (Eötvos Loránd University, Hungary).

Musheng Wei

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Title: Quaternion Matrix Computations

Abstract: In this talk we present state-of-the-art technique for quaternion matrix computations, promote the further development of these kinds of problems, and meet the practical requirement of applications, in this monograph we describe real structure-preserving methods for commonly used factorizations such as the LUD, QRD, SVD, direct and iterative methods for solving quaternion linear system, generalized least squares problems, and right eigenvalue problems.

This is joint work with Ying Li, Fengxia Zhang, and Jianli Zhao.

Gang Wu

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China University of Mining and Technology

Title: Randomized GLRAM-type algorithms for high dimensionality reduction and image reconstruction

Abstract: High-dimensionality reduction techniques are very important tools in information retrieval and image processing. The method of generalized low rank approximations of matrices (GLRAM) and its variations are a popular methods for dimensionality reduction and image reconstruction. However, they may suffer from heavily computational overhead in practice, especially for data with high dimensionality. In order to reduce the computational complexities of this type of algorithms, we apply randomized singular value decomposition (RSVD) on them and propose three randomized GLRAM-type algorithms. The key is to efficiently reduce the singular value decomposition of large matrices to that of small matrices. Theoretical results are given to show the validity and rationality of our proposed algorithms. Numerical experiments on some real-world images illustrate the superiority of our randomized GLRAM-type algorithms over their original counterparts.

Yaokun Wu

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Title: Sparse tensor and perfect phylogeny

Abstract: For any positive integer a, we use $[a]$ for the set $\{1, \ldots, a\}$. Given positive integers $a_1, \ldots, a_n$, let M be an n-dimensional $(0,1)$ array of size $a_1 \times \cdots \times a_n$. We say that M has the sparse property Q_n if for all nonempty subsets $I_1 \subseteq [a_1], \ldots, I_n \subseteq [a_n]$, it holds

$$\sum_{(\alpha_1,\ldots,\alpha_n)\in I_1\times\cdots\times I_n} M(\alpha_1,\ldots,\alpha_n) \leq \sum_{j=1}^{n}(|I_j|-1)+1;$$

For any positive integer $k \leq n$, we say that M has the sparse property Q_k if every k-dimensional projection of M has the sparse property Q_k. We say that M has the sparse property $\overline{Q}_n$ if

$$\sum_{(\alpha_1,\ldots,\alpha_n)\in [a_1]\times\cdots\times [a_n]} M(\alpha_1,\ldots,\alpha_n) = \sum_{j=1}^{n}(a_j-1)+1;$$

For any positive integer $k \leq n$, we say that M has the sparse property $\overline{Q}_k$ if every k-dimensional projection of M has the sparse property $\overline{Q}_k$. An n-dimensional $(0,1)$ array M' of size $a_1 \times \cdots \times a_n$

is called a sparse completion of M provided

$$M \leq M'$$

and that M' satisfies

$$\begin{cases} \overline{Q}_1, & \text{if } n = 1; \\ Q_2 \; and \; \overline{Q}_n, & \text{if } n \geq 2. \end{cases}$$

In this work, we try to analyze how different sparsity properties specified as above are related to each other and how those sparse $(0, 1)$ arrays can be represented by tree structures. Our measure of sparseness of $(0, 1)$ tensors is motivated by the study of perfect phylogeny.
This is joint work with Yanzhen Xiong (Shanghai Jiao Tong University).

Qingxiang Xu

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Title: Norm estimations for the Moore-Penrose inverse of the weak perturbation of Hilbert C^*-module operators

Abstract: Let $\mathfrak{A}$ be a C^*-algebra, H and K be Hilbert $\mathfrak{A}$ modules and $\mathcal{L}(H, K)$ be the set of all adjointable operators from H to K. A multiplicative perturbation M of a Moore-Penrose invertible operator $T \in \mathcal{L}(H, K)$ has the form $M = ETF^*$ with $E \in \mathcal{L}(K, K)$ and $F \in \mathcal{L}(H, H)$, which can be expressed alternately as $M = ETT^\dagger \cdot T \cdot (FT^\dagger T)^* = L_{E,T} \cdot T \cdot R^*_{F,T}$, where $T^\dagger$ is the Moore-Penrose inverse of T and

$$L_{E,T} = ETT^\dagger + I_K - TT^\dagger, \; R_{F,T} = FT^\dagger T + I_H - T^\dagger T.$$

In view of the above $ETT^\dagger$, $FT^\dagger T$, $L_{E,T}$ and $R_{F,T}$, the relationship between various types of multiplicative perturbations are investigated, and formulas for $M^\dagger$, $MM^\dagger$ and $M^\dagger M$ are derived in the case that M is a weak perturbation of T. Based on these derived formulas, some norm computations are carried out by using certain C^*-algebraic techniques, through which new norm estimations for $M^\dagger - T^\dagger$ are obtained. As applications, perturbation estimations for the solutions to the least squares problems are provided. The sharpness of the newly obtained estimations are illustrated by several numerical examples.
This is joint work with Chunhong Fu, Chuanning Song and Guorong Wang.

Junfeng Yin

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Tongji University

Title: Recent progresses on matrx splitting methods for the solution of linear equations

Abstract: Matrx splitting methods play very important roles for the solution of linear equations. After reviewing the SOR, HSS(Hermitian and skew-Hermitian splitting), NSS(Normal and skew-Hermitian splitting) and PSS(Positive and skew-Hermitian splitting) iteration methods, a class of positive definite spliting iteration method is established. Theoretical analyses guarantee the convergenece performance. Numerial experiment verify our analyses and domenstrate that the proposed approach is efficient for the solution of dicrete fractional PDE.

Fuzhen Zhang

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Title: What does it really mean by eigenvalue continuity?

Abstract: The statement that *eigenvalues are continuous functions of the entries of matrices* is often seen in the literature. What does it really mean? We take a close look at the definition(s) of *eigenvalue continuity*. We also examine and discuss a standard proof of the Geršgorin theorem using eigenvalue continuity.

Yang Zhang

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Title: Matrices over Non-commutative Rings

Abstract: Studying matrices over non-commutative rings is one of fundamental research subjects in non-commutative algebra. In the past decades, many applications have been found in other areas such as computer science, coding theory and engineering. In particular, matrices over some special rings (like differential/difference operators and quaternion) have attracted more and more attentions. In this talk, we will introduce some recent developments in computing normal forms, generalized inverses, solving matrix equations and Maple packages.
This is joint work with Qing-Wen Wang and Zhuoheng He (Shanghai University).

Yan Zhu

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Shanghai University

Title: Relative t-designs in binary Hamming association schemes

Abstract: A relative t-design in binary Hamming association scheme $H(n, 2)$ known as a weighted

regular t-wise balanced design, is a generalization of combinatorial t-design by allowing several sizes of blocks and assigning positive weight function on each block. In particular, a pairwise balanced design is equivalent to a relative 2-design in $H(n, 2)$ with constant weight.

In this talk, we will discuss our generalization on Delsarte's interpretation of Assmus-Mattson theorem for $H(n, 2)$. We prove that if the weight function is constant on each shell of a relative t-design on p shells then the subset in each shell must be a combinatorial $(t + 1 - p)$-design. We study the existence problem of tight relative t-designs on two shells in $H(n, 2)$ and obtain many new examples.

This is joint work with Eiichi Bannai, Etsuko Bannai.

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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。

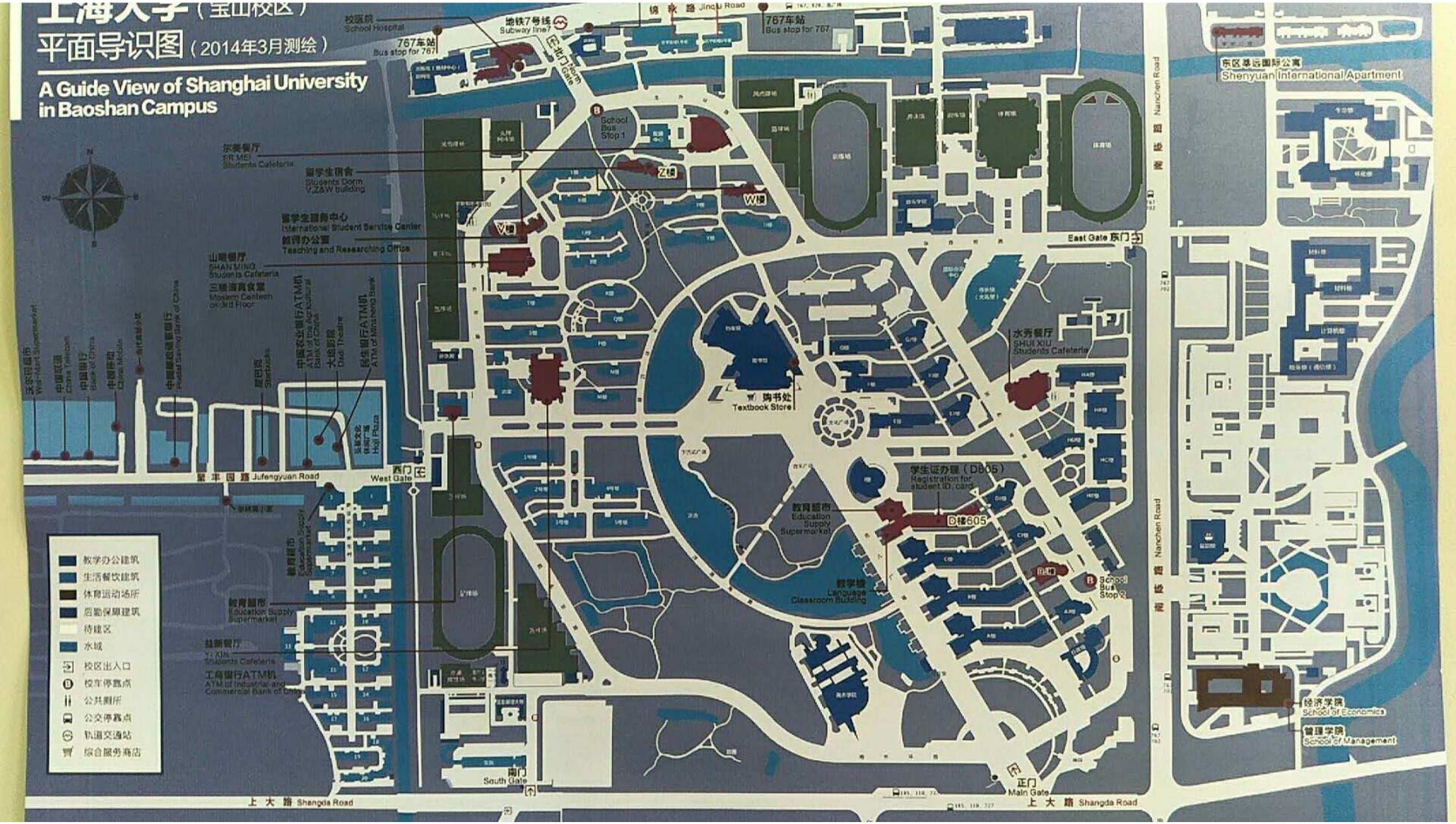
The Department of Mathematics, Shanghai University

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