2021 China-Korea-USA International Conference on Matrix Theory (IRCTMT-AORC Joint Meeting)

The 6th International Conference on Matrix Equations and Matrix Inequalities with Applications (MIME 2021)

2021 年中韩美矩阵论国际会议暨第六届矩阵方程与矩阵不等式及其应用国际会议

Hainan Normal University, Haikou, China

Shanghai University, China

November 26-27, 2021

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Program

Friday, November 26

Chair: Xiaohui Fu VooV Meeting （腾讯会议）ID: 289 558 981 Passcode: 1126

8:10-8:30 Opening Ceremony

Opening remarks by Professor Chun Li. Secretary of School of Mathematics and Statistics, Hainan Normal University, Haikou, China.

Opening remarks by Professor Qing-Wen Wang. Director of the International Research Center for Tensor and Matrix Theory of Shanghai University, Shanghai, China.

Opening remarks by Professor Gi-Sang Cheon. Director of Applied Algebra and Optimization Research Center of Sungkyunkwan University, Korea.

Opening remarks by Professor Tin-Yau Tam. Department Chair in Mathematics and Statistics, University of Nevada, Reno, USA.

Opening remarks by Professor Xianfeng Chen. Vice President of Hainan Normal University, China.

Chair: Yang Zhang

8:35-9:15 Speaker: Delin Chu, National University of Singapore, Singapore (p. 13)

Title: Alternating Nonnegative Least Squares for Nonnegative Matrix Factorization

Parallel morning sessions for November 26. Session One

Chair: Zheng-Jian Bai VooV meeting (腾讯会议) ID：289558981 Passcode: 1126

9:20-9:50 Speaker: Gi-Sang Cheon, Sungkyunkwan University, Korea (p. 13)
Title: Riordan posets and associated incidence matrices

9:50-10:20 Speaker: Ren-Cang Li, Hong Kong Baptist University (p. 19)
Title: Recent Progresses on Highly Entrywise Accurate Methods for Matrix Equations

10:20-10:30 Coffee Break

10:30-11:00 Speaker: Yang Zhang , University of Manitoba, Canada (p. 27)
Title: The upper bonds of quaternion tensors

11:00-11:30 Speaker: Lei Cao, Nova Southeastern University, Florida, USA (p. 10)
Title: Blockers of Pattern Avoiding Permutation Matrices

11:30-12:00 Speaker: Woocheol Choi, Sungkyunkwan University, Korea (p. 13)
Title: Convergence results of a nested decentralized gradient method for non-strongly convex problems

12:00-13:30 Lunch

Parallel morning sessions for November 26. Session two

Chair: Zhuo-Heng He VooV meeting (腾讯会议) ID：770739654 Passcode: 1126

9:20-9:50 Speaker: Tin Yau Tam, University of Nevada, Reno, USA (p. 23)
Title: So-Thompson's conjectures on products of matrix exponentials and beyond

9:50-10:20 Speaker: Weiguo Gao, Fudan University (p. 15)
Title: Some matrix computations in signal processing

10:20-10:30 Coffee Break

10:30-11:00 Speaker: Bomi Shin, Sungkyunkwan University, Korea (p. 22)
Title: Global attractor and limit points for nonsmooth ADMM

11:00-11:30 Speaker: Xiaodong Zhang, Shanghai Jiaotong University (p. 26)
Title: The signless Laplacian spectral radius of graphs without intersecting odd cycles

11:30-12:00 Speaker: Jianzhou Liu, Xiangtan University (p. 21)
Title: Exponential type locally generalized strictly double diagonally tensors and eigenvalue localization

12:00-13:30 Lunch

Parallel afternoon sessions for November 26. Session One

Chair: Zhi Chen VooV meeting (腾讯会议) ID：289558981 Passcode: 1126

13:30-14:00 Speaker: M.S. Moslehian, Ferdowsi University of Mashhad, Iran (p. 21)
Title: Operator Equation $XHX = K$

14:00-14:30 Speaker: Jang Soo Kim, Sungkyunkwan University, Korea (p. 18)
Title: Refined canonical stable Grothendieck polynomials and their duals

14:30-15:00 Speaker: Zhuo-Heng He, Shanghai University (p. 15)
Title: Decompositions for tensors and their applications in signal processing

15:00-15:30 Speaker: Huihui Zhu, Hefei University of Technology (p. 28)
Title: Suitable elements, $*$-clean elements and Sylvester equations in rings with involution

15:30-15:40 Coffee Break

Chair: Gang Wu VooV meeting (腾讯会议) ID：289558981 Passcode: 1126

15:40-16:10 Speaker: Peng Cao, Beijing Institute of Technology (p. 10)
Title: Derivations mapping into compact operators

16:10-16:40 Speaker: Dragana Cvetković Ilić, University of Niš, Serbia (p. 11)
Title: Redundant conditions in results that use generalized inverses

16:40-17:10 Speaker: Yu-Jiang Wu, Lanzhou University (p. 25)
Title: A two-parameter block triangular preconditioner for double saddle point problem arising from liquid crystal directors modeling

17:10-17:40 Speaker: Qing-Wen Wang, Shanghai University (p. 24)
Title: New proofs of some theorems in linear algebra

17:40- Dinner

Parallel afternoon sessions for November 26. Session Two

Chair: Hanyu Li VooV meeting (腾讯会议) ID：770739654 Passcode: 1126

13:30-13:55 Speaker: Minru Bai, Hunan University (p. 9)
Title: Nonlocal Robust Tensor Recovery with Nonconvex Regularization

13:55-14:20 Speaker: Gaohang Yu, Hangzhou Dianzi University (p. 25)
Title: A Practical Sketching Algorithm for Low Tensor Tubal Rank Approximation

14:20-14:45 Speaker: Changjiang Bu, Harbin Engineering University (p. 10)
Title: The spectrum of hypergraph and the high order spectral characterizations of graphs

14:45-15:10 Speaker: Zejun Huang, Shenzhen University (p. 16)
Title: The stable index of 0-1 matrices

15:10-15:35 Speaker: Tai-Xiang Jiang, Southwestern University of Finance and Economics (p. 17)
Title: Third-Order Tensor Completion via Framelet Representation and Tensor Dictionary Learning

15:35-15:45 Coffee Break

Chair: Huihui Zhu VooV meeting (腾讯会议) ID：770739654 Passcode: 1126

15:45-16:10 Speaker: Jianmin Chen, Xiamen University (p. 12)
Title: Frobenius-Perron theory of endofunctors

16:10-16:35 Speaker: Zhi Chen, Nanjing Agricultural University (p. 12)
Title: Faces of the Polytope of Doubly Substochastic Matrices

16:35-17:00 Speaker: Lizhu Sun, Harbin Engineering University (p. 23)
Title: Estrada index of hypergraphs via eigenvalues of tensors

17:00-17:25 Speaker: Zhenhua Lyu, Shenyang Aerospace University (p. 21)
Title: 0-1 matrices whose squares have bounded entries

17:25- Dinner

Parallel afternoon sessions for November 26. Session Three

Chair: Guangjing Song VooV meeting (腾讯会议) ID：861586627 Passcode: 1126

13:30-13:55 Speaker: Tie-Xiang Li, Southeast University (p. 20)
Title: Fast Algorithms for Maxwell’s Equations for 3D Photonic Crystal

13:55-14:20 Speaker: Zheng-Jian Bai, Xiamen University (p. 9)
Title: Single-pass randomized QLP decomposition for low-rank approximation

14:20-14:45 Speaker: Gang Wu, China University of Mining and Technology (p. 24)
Title: On the convergence of the generalized lanczos trust-region method for the trust-region subproblem

14:45-15:10 Speaker: Zhigang Jia, Jiangsu Normal University (p. 17)
Title: Structure Preserving Quaternion Generalized Minimal Residual Method with Applications to Color Image Processing

15:10-15:35 Speaker: Bo Dong, Dalian University of Technology (p. 14)
Title: Numerical Methods for the complete solution of the multiparameter eigenvalue problem

15:35-15:45 Coffee Break

Chair: Zhigang Jia VooV meeting (腾讯会议) ID：861586627 Passcode: 1126

15:45-16:10 Speaker: Yan-Fei Jing, University of Electronic Science and Technology of China (p. 18)
Title: Recent progress on block Krylov solvers for solving sequences of linear systems

16:10-16:35 Speaker: Hanyu Li, Chongqing University (p. 19)
Title: Practical Sketching-Based Randomized Tensor Ring Decomposition

16:35-17:00 Speaker: Xiaohui Fu, Hainan Normal University (p. 15)
Title: Inequalities on partial traces of positive semidefinite block matrices

17:00-17:25 Speaker: Hongjia Chen, Nanchang University (p. 11)
Title: Backward error and condition number for polynomial eigenvalue problems solved by linearizations

17:25- Dinner

Saturday, November 27

Chair: Jianlong Chen VooV meeting (腾讯会议) ID: 770442999 Passcode: 1127

8:10-8:50 Speaker: Jinyun Yuan, Universidade Federal do Parana, Brazil (p. 26)
Title: Matrix Decompositions vs Iterative Methods and Applications to Data Science

Parallel morning sessions for November 27. Session One

Chair: Yan-Fei Jing VooV meeting (腾讯会议) ID: 770442999 Passcode: 1127

9:00-9:30 Speaker: Zhongshan Li, Georgia State University, USA (p. 20)
Title: Minimum rank and cycle conditions for sign patterns that allow diagonalizability

9:30-10:00 Speaker: Jianlong Chen, Southeast University (p. 11)
Title: The generalized inverses of linear combinations of two generalized invertible elements

10:00-10:30 Speaker: Donghyun Kim, SungKyunKwan University, Korea (p. 18)
Title: Negative moments of orthogonal polynomials and reciprocity

10:30-10:40 Coffee Break

10:40-11:10 Speaker: Hualin Huang, Huaqiao University (p. 16)
Title: On centres and direct sum decompositions of higher degree forms

11:10-11:40 Speaker: Guangjing Song, Weifang University (p. 23)
Title: Nonnegative Low Rank Tensor Approximation with Applications to Multi-dimensional Images

Goodbye

Parallel morning sessions for November 27. Session Two

Chair: Delin Chu VooV meeting (腾讯会议) ID：726856225 Passcode: 1127

9:00-9:30 Speaker: Yiu-Tung Poon, Iowa State University, USA (p. 22)
Title: Joint numerical ranges and communtativity of matrices

9:30-10:00 Speaker: Cheolwon Heo, Sungkyunkwan University, Korea (p. 16)
Title: Recognizing Even-cycle matroids

10:00-10:30 Speaker: Zhaobing Fan, Harbin Engineering University (p. 14)
Title: i-quantum groups and their geometric realization

10:30-10:40 Coffee Break

10:40-11:10 Speaker: Xiaomin Tang, Heilongjiang University (p. 24)
Title: Modules of free commutative non-unital Rota-Baxter algebras

11:10-11:40 Speaker: Xuefeng Duan, Guilin University of Electronic Technology (p. 14)
Title: An efficient algorithm for solving the nonnegative tensor least squares problem

Parallel morning sessions for November 27. Session Three

Chair: Xiaohui Fu VooV meeting (腾讯会议) ID：748996883 Passcode: 1127

9:00-9:20 Speaker: Xuzhou Zhan, Beijing Normal University at Zhuhai (p. 26)
Title: On generalization of classical Hurwitz stability criteria for matrix polynomials

9:20-9:40 Speaker: Tao Li, Hainan University (p. 19)
Title: Numerical algorithms for solving discrete Lyapunov tensor equation

9:40-10:00 Speaker: Xin-Fang Zhang, Hainan University (p. 27)
Title: Developing iterative algorithms to solve Sylvester tensor equations

10:00-10:20 Speaker: Qiming Luo, Hainan Normal University (p. 21)
Title: Quantum nonlocality cannot be shared under bilateral measurement

10:20-10:30 Coffee Break

10:30-10:50 Speaker: Chen Zhang, Hainan Normal University (p. 26)
Title: The numerical range of projection operators

10:50-11:10 Speaker: Chicheng Zhu, Hainan Normal University (p. 27)
Title: The random periodic solution of linear stochastic differential equations and its EM numerical approximation.

11:10-11:30 Speaker: Huan Xu, Hainan Normal University (p. 25)
Title: Several inequalities for sector matrices

Goodbye

Abstracts

Minru Bai

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Hunan University

Title: Nonlocal Robust Tensor Recovery with Nonconvex Regularization

Abstract: The robust tensor recovery problem consists in reconstructing a tensor from a sample of entries corrupted by noise, which has attracted great interest in a wide range of practice situations such as image processing and computer vision. In this paper, we study robust tensor recovery for third-order tensors with different degradations, which aims to recover a tensor from partial observations corrupted by Gaussian noise and sparse noise simultaneously. In contrast to traditional approaches based on the tensor nuclear norm penalty for the low-rank component and the tensor ℓ_1 norm penalty for the sparse component, we propose a nonlocal robust low-rank tensor recovery model with nonconvex regularization (NRTRM) to explore the global low-rankness and nonlocal self-similarity of the underlying tensor. The NRTRM method is first to extract similar patched-tubes to form a third-order sub-tensor. Then a class of nonconvex low-rank penalties and nonconvex sparse penalties are employed to exploit the low transformed multi-rank component and the sparse corruptions for such sub-tensor, respectively. Moreover, a proximal alternating linearized minimization algorithm is developed to solve the resulting model in each group and its convergence is established under very mild conditions. Extensive numerical experiments on both multispectral images and video datasets demonstrate the superior performance of NRTRM in comparison with several state-of-the-art methods. This is the joint work with Duo Qiu, Michael K. Ng, Xiongjun Zhang.

Zheng-Jian Bai

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Xiamen University

Title: Single-pass randomized QLP decomposition for low-rank approximation

Abstract:

The QLP decomposition is an effective algorithm to approximate singular value decomposition in numerical linear algebra. In this paper, we propose a single-pass randomized QLP decomposition algorithm for computing the low-rank matrix approximation. Compared with the randomized QLP decomposition, the complexity of the proposed algorithm does not increase significantly and the data matrix needs to be accessed only once. Therefore, our algorithm is suitable for a large data matrix stored outside of memory or generated by stream data. In the error analysis, we give the bounds of matrix approximation error and singular value approximation error, which can track the singular values and the numerical rank of the data matrix approximately. Numerical experiments are also reported to verify our results.

Changjiang Bu

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Harbin Engineering University

Title: The spectrum of hypergraph and the high order spectral characterizations of graphs

Abstract: The spectrum of the k-power hypergraph of a graph G is called the k-ordered spectrum of G. If graphs G_1 and G_2 have same k-ordered spectrum for all positive integer $k \geq 2$, G_1 and G_2 are said to be high-ordered cospectral. If all graphs who are high-ordered cospectral with the graph G are isomorphic to G, we say that G is determined by the high-ordered spectrum. In this paper, we use the high-ordered spectrum of graphs to study graph isomorphism and show that all Smith's graphs are determined by the high-ordered spectrum. And we give infinitely many pairs of trees with same spectrum but different high-ordered spectrum by high-ordered cospectral invariants of trees, it means that we can use the high-ordered spectrum to determine that these cospectral trees are not isomorphism.

Co-author(s): Lixiang Chen, Lizhu Sun.

Lei Cao

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Title: Blockers of Pattern Avoiding Permutation Matrices

Abstract: We investigate $n \times n$ $(0,1)$-matrices A such that no permutation matrix $P \leq A$ belongs to a prescribed subset $\mathcal{Q}_n$ of the set $\mathcal{P}_n$ of all $n \times n$ permutation matrices. The subsets $\mathcal{Q}_n$ considered are those defined by avoiding a given pattern σ_k where σ_k is a permutation of $\{1, 2, \ldots, k\}$. This gives rise to consideration of (minimal) blockers which are certain subsets of the positions of an $n \times n$ matrix that intersect every permutation matrix that avoids the pattern σ. The classical case is that where $\mathcal{Q}_n = \mathcal{P}_n$ and thus our investigations can be viewed as a generalization of the well-known Frobenius-Kőnig theorem. By this theorem the positions of any $r \times s$ submatrix with $r + s = n + 1$ is a minimal blocker of $\mathcal{P}_n$; in particular rows and columns are not only minimal blockers but are minimum cardinality blockers; the maximum size of a minimal blocker occurs when r and s are (nearly) equal. The case $k = 3$ is considered in some detail. In case $k \geq 4$, we show that every minimum blocker for any given pattern σ_k with cardinality equal to n is a row or column.

Peng Cao

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Beijing Institute of Technology University

Title: Derivations mapping into compact operators

Abstract: A scattered operator on Hilbert space is a bounded linear operator with at most countable spectrum. In this talk, we will show that if the range of an inner derivation on all the bounded linear operators on the Hilbert space is contained in the set of scattered operators, then the range is contained in the set of compact

operators. As a corollary, for a quasinilpotent operator, if the perturbation of every quasinilpotent operator is scattered, then this operator is compact. The similar result is true for the direct product case. This is a joint work with Prof. Zhu Sen.

Dragana Cvetkovic Ilic

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University of Nis, Serbia

Title: Redundant conditions in results that use generalized inverses

Abstract: Most of the published results that involve the use of generalized inverses in the setting of operators or any other except the matrix setting, are very restrictive in the sense that they have been proved only under certain additional assumptions. In fact it is rarely the case that we do have a general result. One of the reasons why this is so, is that generalized inverses of operators (usually the MP or the (1,3)- inverse) which, although powerful tools used when working on many problems, must be assumed to exist and to be bounded. This makes the results obtained applicable only under this rather restrictive assumption of the closedness of the range. The motivation for this talk is our desire to point to the increasing number of results of this type which are valid only under many restrictive assumptions, without there ever being any attempts to solve problems in the general case. Through certain examples of operator equations and reverse order laws we will demonstrate that it is possible to eliminate quite a few of the additional assumptions and find solutions to certain problems in the general case.

Hongjia Chen

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Nanchang University

Title: Backward error and condition number for polynomial eigenvalue problems solved by linearizations

Abstract: In this presentation, we investigate the backward error and condition number of the solution of polynomial eigenvalue problems expressed in monomial and non-monomial basis. One of the most common strategies to solve polynomial eigenvalue problems is via linearization. We establish bounds for the backward error and condition number of an approximate eigenpair of the original eigenvalue problem relative to those of an approximate eigenpair of the linearizations. These bounds suggest scaling strategies to reduce the backward error and condition number of the computed eigenpairs. Numerical experiments show that the actual backward errors and condition number are successfully reduced by scaling and the errors, before and after scaling, are both well bounded by the bounds.

Jianlong Chen

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Southeast University

Title: The generalized inverses of linear combinations of two generalized invertible elements

Abstract: In this talk, we talk about the generalized inverses of linear combinations of two generalized invertible elements. (1) We give the existence criterion and formulae of Drazin inverses of elements in a certain finite-dimensionalalgebra generated by two idempotents, under some prescribed conditions.(2) In Dedekind-finite ring, we present the group inverse of sum of two group invertible elements under different conditions. Then, the core inverse of a sum of two core invertible elements is investigated. Furthermore, the core inverse of the difference of two core invertible elements is presented.These results generalized the corresponding results of complex matrices. (3) We present the core inverses of linear combinations of two core invertible complex matrices. Furthermore, sufficient conditions, which guarantee that the difference of two core invertible matrices is core invertible, are presented.

Jianmin Chen

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Xiamen University

Title: Frobenius-Perron theory of endofunctors

Abstract: The spectral radius (also called the Frobenius-Perron dimension) of a matrix is an elementary and extremely useful invariant in linear algebra, combinatorics, topology, probability and statistics. The Frobenius-Perron dimension has become a crucial concept in the study of fusion categories and representations of semisimple weak Hopf algebras since it was introduced by Etingof-Nikshych-Ostrik in early 2000. In this talk, I will generalize the Frobenius-Perron dimension of an object in a fusion category, introduce the Frobenius-Perron dimension of an endofunctor of a category, and show that the Frobenius-Perron dimension has strong connections with the representation type of a category. The talk is based on joint works with Zhibin Gao, Elizabeth Wicks, James Zhang, Xiaohong Zhang and Hong Zhu.

Zhi Chen

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Nanjing Agricultural University

Title: Faces of the Polytope of Doubly Substochastic Matrices

Abstract: We study the faces of the convex polytope of all $n \times n$ doubly substochastic matrices, denoted by ω_n. We give the necessary and sufficient conditions of a face being nonempty. We also describe all 1-dimensional faces, 2-dimensional faces, and facets of ω_n. Moreover, we explore the relation between the faces of ω_n and the faces of Ω_n, the convex polytope of all $n \times n$ doubly stochastic matrices.

Co-author(s): Lei Cao (lcao@nova.edu, Department of Mathematics, Nova Southeastern University, FL, 33314, USA).

Gi-Sang Cheon

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Sungkyunkwan University, Korea

Title: Riordan posets and associated incidence matrices

Abstract: This talk introduces a new class of partially ordered sets represented as binary Riordan matrices referred to as 'Riordan posets'. This notion extends the theory of Riordan matrices into the domain of poset theory. We establish the criterion for a given binary Riordan matrix to be defined as a Riordan poset matrix. It is also shown that every Riordan poset is a locally finite poset. This leads to the construction of various matrix algebras obtained from incidence algebras of Riordan posets. Many structural properties of Riordan posets are studied and various families of Riordan posets are introduced. A class of series-parallel posets is derived by extending the notion of Riordan posets to include exponential Riordan matrices, and it is obtained from Sheffer sequences of classical orthogonal polynomials.

This is a joint work with Bryan Curtis, Gukwon Kwon, and Arnauld Mesinga Mwafise.

Woocheol Choi

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Sungkyunkwan University, Korea

Title: Convergence results of a nested decentralized gradient method for non-strongly convex problems

Abstract: In this talk, we are concerned with the convergence of NEAR-DGD+ (Nested Exact Alternating Recursion Distributed Graident Descent) method introduced to solve the distributed optimization problems. Under the assumption of strong convexity and Lipschitz continuous gradient, the linear convergence is established in [**?**]. In this work, we investigate the convergence property of NEAR-DGD+ in the absence of strong convexity. More precisely, we establish the convergence result in the case where only the convexity or the quasi-strong convexity is assumed on the objective function in place of the strong convexity. Numerical results are provided to support the convergence results. This is a joint work with Doheon Kim and Seok-Bae Yun.

Delin Chu

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National University of Singapore, Singapore

Title: Alternating Nonnegative Least Squares for Nonnegative Matrix Factorization

Abstract: Nonnegative matrix factorization (NMF) is a prominent technique for data dimensionality reduction that has been widely used for text mining, computer vision, pattern discovery, and bioinformatics. In this talk, a framework called ARkNLS (Alternating Rank-k Nonnegativity constrained Least Squares) is introduced for computing NMF. First, a recursive formula for the solution of the rank-k nonnegativity-constrained least squares (NLS) is established. This recursive formula can be used to derive the closed-form solution for the Rank-k NLS problem for any integer $k \geq 1$. As a result, each subproblem for an alternating rank-k nonnegative least squares

framework can be obtained based on this closed form solution. Assuming that all matrices involved in rank-k NLS in the context of NMF computation are of full rank, two of the currently best NMF algorithms HALS (hierarchical alternating least squares) and ANLS-BPP (Alternating NLS based on Block Principal Pivoting) can be considered as special cases of ARkNLS with $k = 1$ and $k = r$ for rank-r NMF, respectively. This talk is then focused on the framework with $k = 3$, which leads to a new algorithm for NMF via the closed-form solution of the rank-3 NLS problem. Furthermore, a new strategy that efficiently overcomes the potential singularity problem in rank-3 NLS within the context of NMF computation is also presented. Extensive numerical comparisons using real and synthetic data sets demonstrate that the proposed algorithm provides state-of-the-art performance in terms of computational accuracy and cpu time.

Bo Dong

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Dalian University of Technology

Title: Numerical Methods for the complete solution of the multiparameter eigenvalue problem

Abstract: The multiparameter eigenvalue problem arises naturally in a variety of applications, especially in certain boundary value problems when the technique of separation of variables is applied. In this talk, I will introduce some numerical methods for finding all solutions of this problem. These methods can be classified into two categories: those that deal with the problems directly and those that compute the eigenvalues of the transformed simultaneous eigenvalue problems. Also I will give some numerical results and the applications in the delay differential equations to illustrate the effectiveness and efficiency of these methods.

Xuefeng Duan

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Guilin University of Electronic Technology

Title: An efficient algorithm for solving the nonnegative tensor least squares problem

Abstract: In this talk, we consider the nonnegative tensor least squares problem, which arises in the color image restoration. Based on the BB stepsize technique, we design a nonmonotonic descent stepsize and then derive a new gradient projection algorithm to solve this problem. The convergence analysis of the new gradient projected algorithm is given. Some numerical examples show that the new method is feasible and effective. Especially, some simulation experiments in the color image restoration problems illustrate that our algorithm is more effective than the existed algorithms.

Zhaobing Fan

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Harbin Engineering University

Title: i-quantum groups and their geometric realization

Abstract: i-quantum group is a nontrivil generalization of quantum group, which has similar properties as quantum groups, such as canonical basis etc. In this talk, I will introduce i-quantum groups, their geometric realization, and their recent developments.

Xiaohui Fu

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Hainan Normal University

Title: Inequalities on partial traces of positive semidefinite block matrices

Abstract: Inequalities on partial traces of positive semidefinite matrices are studied. Extensions of several existing inequalities on the determinant of partial traces are then obtained. Particularly, we improve a determinantal inequality given by Lin [Canad. Math. Bull. 59 (2016)]. Co-author(s): Pan Shun Lau, Tin-Yau Tam

Weiguo Gao

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Fudan University

Title: Some matrix computations in signal processing

Abstract: In this talk, I will present my recent work on matrix computations in signal processing with my collaborators. First, we study matrix completion based on the low rank Hankel structure in the Fourier domain. It is shown that matrices with this structure can be exactly recovered by solving a convex optimization program provided the sampling complexity is nearly optimal. Then, we consider the problem of resolving point sources from given samples at the low end of the spectrum when the point spread functions lie in low dimensional subspace, which can be reformulated as a matrix recovery problem. By exploiting the low rank structure of the vectorized Hankel matrix associated with the target matrix, a convex approach called Vectorized Hankel Lift is proposed for the matrix recovery. Finally, we study the spectral estimation problem of estimating the locations of a fixed number of point sources given multiple snapshots of Fourier measurements collected by a uniform array of sensors. We prove novel non-asymptotic stability bounds for MUSIC and ESPRIT as a function of the noise standard deviation, number of snapshots, source amplitudes, and support. This is joint work with Jinchi Chen, Weilin Li, Wenjing Liao, Sihan Mao, Ke Wei and Zengying Zhu.

Zhuo-Heng He

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Shanghai University

Title: Decompositions for tensors and their applications in signal processing

Abstract: In this talk, we establish some simultaneous decomposition for tensors via different tensor products. These simultaneous decompositions transforms the tensors into some nice forms. We conclude with

applications in the color video signal processing and color watermark processing.

Co-author(s): Michael K. Ng, Chao Zeng

Cheolwon Heo

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Sungkyunkwan University, Korea

Title: Recognizing Even-cycle matroids

Abstract: A matroid is graphic if its circuits are precisely the cycles of some graph. Even-cycle matroids are elementary lifts of graphic matroids. In 1960, Tutte proved that one can recognize if a binary matroid is graphic in polynomial time. In this talk, we give a polynomial-time algorithm to check if a binary matroid is an even-cycle matroid. The bound on the running time depends on a constant c that arises from the Matroid Minors Project and that has no explicit bound. However, the algorithm does not use the value c for its computation.

This is joint work with Bertrand Guenin.

Hualin Huang

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Huaqiao University

Title: On centres and direct sum decompositions of higher degree forms

Abstract: Higher degree forms are homogeneous polynomials of degree d>2, or equivalently symmetric d-linear spaces. We are mainly concerned about the algebraic structure of the centres of higher degree forms with applications specifically to direct sum decompositions, namely expressing higher degree forms as sums of forms in disjoint sets of variables. We show that the centre algebra of almost every form is the ground field, consequently almost all higher degree forms are absolutely indecomposable. If a higher degree form is decomposable, then we provide simple criteria and algorithms for direct sum decompositions by its centre algebra. It is shown that the direct sum decomposition problem can be boiled down to some standard tasks of linear algebra, in particular the computations of eigenvalues and eigenvectors. We also apply the structure results of centre algebras to provide a complete answer to the classical problem of whether a higher degree form can be reconstructed from its Jacobian ideal. The talk is based on joint works with Huajun Lu, Yu Ye and Chi Zhang.

Zejun Huang

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Shenzhen University

Title: The stable index of 0-1 matrices

Abstract: Let A be a 0-1 square matrix. If A^k is a 0-1 matrix for every positive integer k, then the stable index of A is defined to be infinity; otherwise, the stable index of A is defined to be the smallest positive integer k

such that A^{k+1} is not a 0-1 matrix. In this talk, we will characterize the set of stable indices of 0-1 matrcies with a given order.

This talk is based on joint work with Zhibing Chen and Jingru Yan.

Zhigang Jia

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Jiangsu Normal University

Title: Structure Preserving Quaternion Generalized Minimal Residual Method with Applications to Color Image Processing

Abstract: In this talk, we mainly develop the quaternion generalized minimal residual method (QGMRES) for solving quaternion linear systems. Quaternion linear systems arise from three-dimensional or color imaging filtering problems. The proposed quaternion Arnoldi procedure can preserve quaternion Hessenberg form during the iterations. The main advantage is that the storage of the proposed iterative method can be reduced by comparing with the Hessenberg form constructed by the classical GMRES iterations for the real representation of quaternion linear systems. The convergence of the proposed QGMRES is also established. Numerical examples are presented to demonstrate the effectiveness of the proposed QGMRES compared with the traditional GMRES in terms of storage and computing time. Co-author(s): Michael K. Ng (HKU).

Tai-Xiang Jiang

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Southwestern University of Finance and Economics

Title: Third-Order Tensor Completion via Framelet Representation and Tensor Dictionary Learning

Abstract: In the literature, the tensor nuclear norm can be computed by using tensor singular value decomposition based on the discrete Fourier transform (DFT) matrix, and tensor completion can be performed by the minimization of the tensor nuclear norm which is the relaxation of the sum of matrix ranks from all Fourier transformed matrix frontal slices. These Fourier transformed matrix frontal slices are obtained by applying the discrete Fourier transform on the tubes of the original tensor. However, the DFT maintains several drawbacks. Thus, we adopt the tight wavelet frame (framelet) and the data-adaptive dictionary as substitutes for the DFT and develop two low-rank tensor completion (LRTC) models. For the framelet-based one, we directly employ the alternating direction method of multipliers (ADMM), while designing a multi-block proximal alternating minimization algorithm to solve the dictionary-based model. The experimental results illustrate that our methods can effectively recovery many types of real-world third-order tensor data.

Co-author(s): Xi-Le Zhao, Michael K. Ng, and Ting-Zhu Huang.

Yan-Fei Jing

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University of Electronic Science and Technology of China

Title: Recent progress on block Krylov solvers for solving sequences of linear systems

Abstract: In this talk, some recent progress on recycling block minimun residual norm subspace methods will be reported for solving a set of large linear systems with several right-hand sides given in sequence, which is at the core of many problems in the computational sciences. Also a recently developed software package is introduced with the name of The Fast Accurate Block Linear krylOv Solver (fabulous) library.

Donghyun Kim

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SungKyunKwan University, Korea

Title: Negative moments of orthogonal polynomials and reciprocity

Abstract: It is well known that the moments of orthogonal polynomials are given as a weighted sum over Moztkin paths. Given a sequence $\{a_n\}_{n\geq 0}$ that satisfies a linear recurrence, we may extend the sequence to negative indices $\{a_{-n}\}_{n\geq 1}$ by applying the recurrence "backwards". We first explore the reciprocity results by Cigler and Krattenthaler when a_n is the number of bounded Dyck paths of length n and discuss how their results extend to the case when a_n is the number of bounded Motzkin paths of length n. We use production matrix and continued-fraction methods.

Based on a joint work with Jihyeug Jang, Jang Soo Kim, Minho Song, and U-Keun Song.

Jang Soo Kim

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Sungkyunkwan University, Korea

Title: Refined canonical stable Grothendieck polynomials and their duals

Abstract: In this talk we introduce refined canonical stable Grothendieck polynomials and their duals with two infinite sequences of parameters. These polynomials unify several generalizations of Grothendieck polynomials including canonical stable Grothendieck polynomials due to Yeliussizov, refined Grothendieck polynomials due to Chan and Pflueger, and refined dual Grothendieck polynomials due to Galashin, Liu, and Grinberg. We give Jacobi-Trudi-type formulas, combinatorial models, Schur expansions, Schur positivity, and dualities of these polynomials. We also consider flagged versions of Grothendieck polynomials and their duals with skew shapes. This is joint work with Byung-Hak Hwang, Jihyeug Jang, Minho Song, And U-Keun Song.

Co-author: Jorge Antezana.

Hanyu Li

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Chongqing University

Title: Practical Sketching-Based Randomized Tensor Ring Decomposition

Abstract: Based on sketching technique, we present two randomized algorithms for tensor ring (TR) decomposition. Specifically, by defining new tensor products and investigating their properties, we apply the sub-sampled randomized Fourier transform (SRFT) and TensorSketch to the alternative least squares problems from the minimization problem of TR decomposition to devise the randomized algorithms. From the former, we find a framework of algorithm based on random projection for randomized TR decomposition. Theoretical sketch sizes for achieving $O\varepsilon$-relative error and complexity analysis for the two algorithms are provided. We compare our proposals with the state-of-the-art method using both the synthetic and real data. Numerical results show that they have almost the same performance in accuracy and computing time and our method based on the SRFT performs better in accuracy for some special data.

Ren-Cang Li

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Title: Recent Progresses on Highly Entrywise Accurate Methods For Matrix Equations

Abstract: In 2002, Alfa, Xue, and Ye showed that the inverse of a nonsingular M-matrix can be determined to highly relative entrywise accuracy by a triplet representation of the M-matrix, and devised the so-called GTH-like algorithm, a variant of Gaussian elimination, to deliver a numerical inverse with comparable entrywise relative accuracy. The breakthrough forms the foundation of later developments in numerical solutions of the M-matrix algebraic Riccati equation (MARE) and the Quasi-Birth-and-Death (QBD) equation with guaranteed high relative entrywise accuracy. In this talk, we will survey those developments, including recent ones on the shifted M-matrix algebraic Riccati equation and the structured M-matrix algebraic Riccati equation.

Tao Li

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Hainan University

Title: Numerical algorithms for solving discrete Lyapunov tensor equation

Abstract: In this talk, we propose several numerical algorithms for solving the discrete Lyapunov tensor equation, which is the generalized form of the discrete Lyapunov matrix equation. Based on the structure of the tensor equation, we firstly propose a simple iterative method to consider its numerical solution. Then we extend the gradient based iterative method and the residual norm steepest descent iterative method to study the tensor equation, respectively. To improve their performance, a residual norm conjugate gradient iterative method is established. Some numerical examples are provided to illustrate the efficiency and validity of these

methods proposed.

Tie-Xiang Li

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Southeast University

Title: Fast Algorithms for Maxwell's Equations for 3D Photonic Crystal

Abstract: In this work, we propose the Fast Algorithms for Maxwell's Equations (FAME) package for solving Maxwell's equations for modeling three-dimensional photonic crystals. FAME combines the null-space free method with fast Fourier transform (FFT)-based matrix-vector multiplications to solve the generalized eigenvalue problems (GEPs) arising from Yee's discretization. A GEP is transformed into a null-space free standard eigenvalue problem with a Hermitian positive-definite coefficient matrix. The computation times for FFT-based matrix-vector multiplications with 7 million matrix dimensions are only 0.33 and 3.6×10^{-3} seconds using MATLAB and a single NVIDIA Tesla P100 GPU, respectively. Such multiplications significantly reduce the computational costs of the conjugate gradient (CG) method for solving linear systems. We successfully use FAME on a single P100 GPU to solve a set of GEPs with more than 19 million dimensions in 127 to 191 seconds per problem. These results demonstrate the potential of our proposed package to enable large-scale numerical simulations for novel physical discoveries and engineering applications of photonic crystals.

Zhongshan Li

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Title: Minimum rank and cycle conditions for sign patterns that allow diagonalizability

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 $\mathcal{A}$. We consider the cycles of the digraph of a sign pattern. It is known that for every sign pattern that allows diagonalization, its maximum composite cycle length is greater than or equal to its minimum rank. It is also known that a sign pattern allows diagonalization if and only if it allows rank-principality. Characterization of sign patterns that allow diagonalization has been a long-standing open problem. 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 have a composite cycle consisting of 1-cycles, 2-cycles, and at most one 3-cycle, with total length equal to the maximum rank; for such sign patterns, the maximum composite cycle length is invariant under row and column permutations.

Jianzhou Liu

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Xiangtan University

Title: Exponential type locally generalized strictly double diagonally tensors and eigenvalue localization

Abstract: In this paper, we introduce exponential type locally generalized strictly double diagonally dominant tensors. This concept extends the concept of strictly diagonally dominant tensors. It is shown that exponential type locally generalized strictly double diagonally dominant tensors must be H -tensors. Furthermore, as applications of exponential type locally generalized strictly double diagonally dominant tensors, we present some new eigenvalue localization sets and checkable sufficient condition for the positive definiteness of even-order real symmetric tensors. Appropriate numerical examples are proposed to illustrate that our new tensors eigenvalue locali -zation sets are more precise than some existing sets in some cases.

Qiming Luo

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Hainan Normal University

Title: Quantum nonlocality cannot be shared under bilateral measurement

Abstract: Nonlocality, one of the most puzzling features of multipartite quantum correlation, has been identified as a useful resource for device-independent quantum information processing. Recently, the sharing ability of quantum nonlocality has been widely studied. In this work, we consider the sharing ability of quantum nonlocality under bilateralmeasurement. Through the selection of a specific class of projection operators, we find that in the sense of average measurement, quantum nonlocality can not be shared for a limited number of times as in unilateral measurement, and it does not show quantum nonlocality even after bilateral measurement once.

Zhenhua Lyu

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Shenyang Aerospace University

Title: 0-1 matrices whose squares have bounded entries

Abstract: Let $\Gamma(n,k,t)$ be the set of 0-1 matrices of order n such that each entry of the k-th powers of these matrices is bounded by t. Let $\gamma(n,k,t)$ be the maximum number of nonzero entries of a matrix in $\Gamma(n,k,t)$. Given any positive integer t, we determine the values of $\gamma(n,2,t)$ when n is sufficiently large. In addition, we discuss the structure of the matrices in $\Gamma(n,2,t)$ attaining the maximum number of ones.

M.S. Moslehian

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Ferdowsi University of Mashhad, Iran

Title: Operator Equation $XHX = K$

Abstract: In this talk, we first present an overview of the Douglas lemma in the setting of Hilbert spaces and Hilbert C^*-modules. We then show how Douglas lemma does not hold in the setting of Hilbert C^*-modules in its general form. In addition, we investigate the operator equation $XHX = K$ and give some equivalent conditions for the existence of a positive solution of it. Several examples are given to illustrate the results.

Co-author(s): Rasoul Eskandari, Xiaochun Fang, and Qingxiang Xu

Yiu-Tung Poon

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Title: Joint numerical ranges and communtativity of matrices

Abstract: The connection between the commutativity of a family of $n \times n$ matrices and the generalized joint numerical ranges is studied. For instance, it is shown that $\mathcal{F}$ is a family of mutually commuting normal matrices if and only if the joint numerical range $W_k(A_1, \ldots, A_m)$ is a polyhedral set for some k satisfying $|n/2-k| \leq 1$, where $\{A_1, \ldots, A_m\}$ is a basis for the linear span of the family; equivalently, $W_k(X, Y)$ is polyhedral for any two $X, Y \in \mathcal{F}$. More generally, characterization is given for the c-numerical range $W_c(A_1, \ldots, A_m)$ to be polyhedral for any $n \times n$ matrices $A_1, \ldots, A_m$. Other results connecting the geometrical properties of the joint numerical ranges and the algebraic properties of the matrices are obtained.

Co-author(s): Chi-Kwong Li and Ya-Shu Wang.

Bomi Shin

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Title: Global attractor and limit points for nonsmooth ADMM

Abstract: The alternating direction method of multipliers (ADMM) is frequently used to solve optimization problems derived from machine learning and statistics. Most works in this direction deal with smooth objective functions excluding important applications in the nonsmooth case.

In this talk, we study the asymptotic behavior of the solutions of differential inclusions arising from ADMM applied to nonsmooth objective functions.

More precisely, we associate a multiflow to this differential inclusion and analyze the structure of both ω-limit points and global attractors for this multiflow. **Co-author(s):** Yoon Mo Jung (SKKU), Sangwoon Yun(SKKU) .

Guangjing Song

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Weifang University

Title: Nonnegative Low Rank Tensor Approximation with Applications to Multi-dimensional Images

Abstract: The main aim of this paper is to develop a new algorithm for computing nonnegative low rank tensor approximation for nonnegative tensors that arise in many multi-dimensional imaging applications. Nonnegativity is one of the important property as each pixel value refers to nonzero light intensity in image data acquisition. Our approach is different from classical nonnegative tensor factorization (NTF) which requires each factorized matrix and/or tensor to be nonnegative. In this paper, we determine a nonnegative low Tucker rank tensor to approximate a given nonnegative tensor. We propose an alternating projections algorithm for computing such nonnegative low rank tensor approximation, which is referred to as NLRT. The convergence of the proposed manifold projection method is established. Experimental results for synthetic data and multi-dimensional images are presented to demonstrate the performance of NLRT is better than state-of-the-art NTF methods.

Lizhu Sun

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Harbin Engineering University

Title: Estrada index of hypergraphs via eigenvalues of tensors

Abstract: A uniform hypergraph $\mathcal{H}$ is corresponding to an adjacency tensor $\mathcal{A}_{\mathcal{H}}$. We define an Estrada index of $\mathcal{H}$ by using all the eigenvalues $\lambda_1, \ldots, \lambda_k$ of $\mathcal{A}_{\mathcal{H}}$ as $\sum_{i=1}^{k} e^{\lambda_i}$. The bounds for the Estrada indices of uniform hypergraphs are given. And we characterize the Estrada indices of m-uniform hypergraphs whose spectra of the adjacency tensors are m-symmetric. Specially, we give the Estrada indices of uniform hyperstars.

Co-author(s): Hong Zhou and Changjiang Bu.

Tin-Yau Tam

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Title: So-Thompson's conjectures on products of matrix exponentials and beyond

Abstract: In 1991 Wasin So and Robert C. Thompson conjectured two formulas of matrix exponential products.

Conjecture 1: For Hermitian matrices $X, Y \in \mathbb{H}_n$, there exist $n \times n$ unitary matrices U, V such that

$$e^{X/2} e^{Y} e^{X/2} = e^{UXU^{-1} + VYV^{-1}}.$$

Conjecture 2: Let S, T be $n \times n$ complex symmetric matrices in a neighborhood of zero. Then there exist

$n \times n$ complex orthogonal matrices P, Q such that

$$e^{S/2} e^{T} e^{S/2} = e^{USU^{\top} + VTV^{\top}}.$$

The first conjecture was proved by So in 2004 and his proof makes use a result of Alexander A. Klyachko. We will discuss its generalization in the context of Lie group, which was obtained by Luyining Gan, Xuhua Liu and Tin-Yau Tam in 2021. The second conjecture remains open.

Xiaomin Tang

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Heilongjiang University

Title: Modules of free commutative non-unital Rota-Baxter algebras

Abstract: In this talk, we study the free commutative non-unital Rota-Baxter algebra (R, P) which is the algebra of polynomials in one variable without constant term with Rota-Baxter operators of nonzero weight. The main result shows that every module over the Rota-Baxter algebra (R, P) is equivalent to the modules over a plane $k\langle x, y\rangle / I$ where I is some ideal of free algebra $k\langle x, y\rangle$. Furthermore, we provide the classifification of modules (R, P) of weight nonzero through solution to the matrix equation

$$\alpha AB = BAB + (\alpha + 1)BA.$$

Co-author(s): Na Liu (Heilongjiang University).

Qing-Wen Wang

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Shanghai University

Title: New proofs of some theorems in linear algebra

Abstract: In this talk, I give several new proofs of the uniqueness of the equivalence canonical form of a matrix and Sylvester's law of inertia. I also establish new methods of finding the basis of the solution space of a system of homogeneous linear equations, and the general solution of a system of non-homogeneous linear equations.

Gang Wu

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China University of Mining and Technology

Title: On the convergence of the generalized lanczos trust-region method for the trust-region subproblem

Abstract: In this work, we reconsider the convergence of the generalized Lanczos method for the trust-region (GLTR) method. New results are established for all the factors including the optimal value, the optimal solution, as well as the Lagrange multiplier. Numerical experiments illustrate the effectiveness of our theoretical results.

Yu-Jiang Wu

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Lanzhou University

Title: A two-parameter block triangular preconditioner for double saddle point problem arising from liquid crystal directors modeling

Abstract: To improve the performance of block triangular (BT) preconditioner, we develop a two-parameter BT (TPBT) preconditioner for a double saddle point problem arising from liquid crystal directors modeling. Theoretical analysis shows that all the eigenvalues of the TPBT preconditioned coefficient matrix are real and located in an interval (0, 2) no matter which value the spectral radius of matrix $D^{-1}CA^{-1}C^T$ is chosen. Moreover, an upper bound of the degree of the minimal polynomial of the TPBT preconditioned coefficient matrix is also obtained. Inasmuch as the efficiencyof the TPBT preconditioner depends on the values of its parameters, we further derive a class of fast and effective formulas to compute the quasi-optimal values ofthe parameters involved in the TPBT preconditioner. Finally, numerical results are reported to illustrate the feasibility and the efficiency of the TPBT preconditioner.

Huan Xu

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Hainan normal University

Title: Several inequalities for sector matrices

Abstract: In this paper, we generalize several inequalities of positive semidefinite matrices to the class of sector matrices whose numerical range is contained sector region.

Gaohang Yu

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Hangzhou Dianzi University

Title: A Practical Sketching Algorithm for Low Tensor Tubal Rank Approximation

Abstract: This talk looks at a practical sketching algorithm for low rank approximation of third order tensor. We define T-singular values of third order tensors. T-singular values of third order tensors are nonnegative scalars. The number of nonzero T-singular values is the tensor tubal rank of the given tensor. We then use T-singular values to define the tail energy of a third order tensor, and apply it to the error estimation of a tensor sketching algorithm for low tensor tubal rank approximation. Numerical experiments on synthetic data and real world data show that our algorithm is efficient.

Co-author(s): Liqun Qi (Hong Kong PolyU).

Jinyun Yuan

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Universidade Federal do Parana, Brazil

Dongguan university of Technology, Guangdong

Title: Matrix Decompositions vs Iterative Methods and Applications to Data Science

Abstract: In this talk we shall give a new version on numerical methods for solving systems of linear equations, specially the relationship between the direct methods and iterative methods. What we want to say is that the matrix decomposition methods can be implemented in iterative form, while the iterative methods can result in the new matrix decomposition which might be useful for some real applications. Finally we mention some issues of matrix analysis used in data science.

Xuzhou Zhan

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Beijing Normal University at Zhuhai

Title: On generalization of classical Hurwitz stability criteria for matrix polynomials

Abstract: In this talk, we are concerned with an extension of three classical criteria of Hurwitz stability for real polynomials to matrix polynomials: tests for Hurwitz stability via positive definiteness and total positivity of block-Hankel matrices built from matricial Markov parameters, and via matricial Stieltjes continued fractions. This talk is based on joint work with Alexander Dyachenko.

Chen Zhang

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Hainan Normal University

Title: The numerical range of projection operators

Abstract: In this talk, we shall present some basic concepts of numerical range theory and report our recent research progress involving the closure of the numerical range of oblique projection and the sum of two orthogonal projections.

Xiaodong Zhang

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Shanghai Jiaotong University

Title: The signless Laplacian spectral radius of graphs without intersecting odd cycles

Abstract: Let $F_{a_1,\ldots,a_k}$ be a graph consisting of k cycles of odd length $2a_1+1,\ldots,2a_k+1$, respectively which intersect in exactly a common vertex, where $k \geq 1$ and $a_1 \geq a_2 \geq \cdots \geq a_k \geq 1$. In this paper, we present a sharp upper bound for the signless Laplacian spectral radius of all $F_{a_1,\ldots,a_k}$-free graphs and characterize

all extremal graphs which attain the bound. The stability methods and structure of graphs associated with the eigenvalue are adapted for the proof. This talk is joined with Ming-Zhu Chen, A-Ming Liu (Hainan University).

Xin Fang Zhang

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Hainan University

Title: Developing iterative algorithms to solve Sylvester tensor equations

Abstract: In this talk, we propose the tensor forms of the bi-conjugate gradient and bi-conjugate residual methods for solving the Sylvester tensor equation. To improve their performance, two preconditioned iterative algorithms based on the nearest Kronecker product are developed for finding its iterative solution. We also prove that the proposed algorithms are convergent to an exact solution within finite iteration steps for any initial tensor in the absence of round-off errors. At last, some numerical examples are provided to illustrate the feasibility and validity of the algorithms proposed.

Yang Zhang

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Title: The upper bonds of quaternion tensors

Abstract: We provide nontrivial bounds on the ranks of any tensor T over the quaternions $\mathbb{H}$ in the $n_1 \times n_2 \times n_3$ cases where $2 \leq n_i \leq 3$. We show that the upper bounds are the best possible for some of the cases. As applications, we discuss various tensor decompositions over $\mathbb{C}$ and $\mathbb{H}$.

This is a joint work with Yonggang Liang.

Chicheng Zhu

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Hainan normal University

Title: The random periodic solution of linear stochastic differential equations and its EM numerical approximation.

Abstract: In this paper, we verify the existence of the random periodic solution of linear stochastic differential equations (LSDEs) with one-sided Lipschitz and quadratic inner-boundedness conditions.We consider numerical solution of the random periodic solution by Euler-Maruyama scheme.Finally, we prove that the error between the exact random periodic solution and the approximated random periodic solution in Euler-Maruyama method at the rate $\sqrt{}$ tin the mean square sense.

Huihui Zhu

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Hefei University of Technology

Title: Suitable elements, $*$-clean elements and Sylvester equations in rings with involution

Abstract: Let R be a $*$-ring. In this paper, we introduce good $*$-clean elements and left $*$-suitable elements in R, respectively. An element $a \in R$ is good $*$-clean if it can be written as the sum of a projection and a unitary element. An element $a \in R$ is left $*$-suitable if there exists a projection $p \in Ra$ such that $1 - p \in R(1 - a)$. Several properties of them are given and their characterizations are derived by the solvability of the Sylvester equation $XA - BX = C$ in a ring. Finally, we use generalized inverses to give the existence criterion of left $*$-suitable elements.