SIAM Conference on APPLIED LINEAR ALGEBRA

Program Changes

Changes on the following Minisymposia:

MS04 Part II,	MS06 Part I,	MS06 Part II,	MS06 Part III,
MS09 Part I,	MS09 Part II,	MS10 Part II,	MS16,
MS25 Part I,	MS25 Part II,	MS30 Part II,	MS34 Part II
MS37 Part I,	MS37 Part II		

Changes on the following Contributed Sessions:
CS02, CS04

Friday May 4

CS02
Contributed Session 02
10:45 AM - 11:45 AM
WLB208

TALK CANCELED
~~**10:45-11:15 Positivity Properties of Some Non-Negative Matrices**~~
~~*Isha Garg, National Institute of Technology, Jalandhar*~~

CHANGE OF TIME
10:45-11:15 Upper and Lower Bounds for Sines of Canonical Angles
Zoran Tomljanovic, J. J. Strossmayer University of Osijek

11:15-11:45 Spectral Decomposition of Selfadjoint Matrices in Positive Semi-Definite Inner Product Spaces and Its Applications
Pingping Zhang, Chongqing University of Posts and Telecommunications

Friday May 4

MS10 Part II
Generalized Inverses and the Linear Least Squares
3:00 PM - 5:00 PM
WLB104

Within this minisymposium we will consider some actual problems of the generalized inverses, generalized invertibility of operators, representations of the Drazin inverse, least squares problem, and computing generalized inverses using gradient neural networks and using database stored procedures. We will develop the relationship between generalized inverses and the linear least squares problem with applications in signal processing.

Organizers:
Dragana Cvetkovic Ilic, Facuty of Science and Mathematics, University of Nis, dragana@pmf.ni.ac.rs
Ken Hayami, Principles of Informatics Research Division, National Institute of Informatics, hayami@nii.ac.jp
Yimin Wei, School of Mathematical Sciences, Fudan University, ymwei@fudan.edu.cn

3:00-3:30 Randomized Algorithms for Core Problem and TLS Problem
Liping Zhang, Zhejiang University of Technology

3:30-4:00 Condition Numbers of the Multidimensional Total Least Squares Problem
Bing Zheng, Lanzhou University

4:00-4:30 Fast Solution of Nonnegative Matrix Factorization via a Matrix-Based Active Set Method
Ning Zheng, National Institute of Informatics

NEW TALK
4:30-5:00 Computing the Inverse and Pseudoinverse of Time-Varying Matrices by the Discretization of Continuous-Time ZNN Models
Marko D. Petković, University of Niš

Friday May 4

CS04
Contributed Session 04
3:00 PM - 4:30 PM
WLB211

3:00-3:30 Log-determinant Non-Negative Matrix Factorization via Successive Trace Approximation
Andersen Ang, Université de Mons

CHANGE OF TIME
3:30-4:00 A Low-Rank Approach to the Solution of Weak Constraint Variational Data Assimilation Problems
Daniel L.H. Green, University of Bath

4:00-4:30 Optimization Methods on Problems with Generalized Orthogonality Constraints
Hong Zhu, Jiangsu University

UPDATED INFORMATION
CHANGE OF LOCATION
4:30-5:00 Computing the Inverse and Pseudoinverse of Time-Varying Matrices by the Discretization of Continuous-Time ZNN Models
Marko D. Petković, University of Niš
Move to Friday May 4, MS10 Part II, 4:30-5:00, WLB104

Saturday May 5

MS06 Part I
Discovery from Data
10:45 AM - 12:45 PM
AAB201

The number of large-scale high-dimensional datasets recording different aspects of interrelated phenomena is growing, accompanied by a need for mathematical frameworks for discovery from data arranged in structures more complex than that of a single matrix. In the three sessions of this minisymposium we will present recent studies demonstrating "Discovery from Data," in "I: Systems Biology," and "II: Personalized Medicine," by developing and using the mathematics of "III: Tensors."

Organizers:
Sri Priya Ponnapalli, Scientific Computing and Imaging Institute, University of Utah, priya@sci.utah.edu
Katherine A. Aiello, Scientific Computing and Imaging Institute, University of Utah, kaiello@sci.utah.edu
Orly Alter, Scientific Computing and Imaging Institute, University of Utah, orly@sci.utah.edu

UPDATED INFORMATION

10:45-11:15 Patterns of DNA Copy-Number Alterations Revealed by the GSVD and Tensor GSVD Encode for Cell Transformation and Predict Survival and Response to Platinum in Adenocarcinomas
Orly Alter, University of Utah

11:15-11:45 Systems Biology of Drug Resistance in Cancer
Antti Hakkinen, University of Helsinki

11:45-12:15 Single-Cell Entropy for Estimating Differentiation Potency in Waddington's Epigenetic Landscape
Andrew E. Teschendorff, Shanghai CAS-MPG Computational Biology Institute and University College London

12:15-12:45 Dimension Reduction for the Integrative Analysis of Multilevel Omics Data
Gerhard G. Thallinger, Graz University of Technology

Sunday May 6

MS16
Machine Learning: Theory and Practice
10:45 AM - 12:45 PM
`WLB204`

Machine learning is experiencing a period of rising impact on many areas of the sciences and engineering such as imaging, advertising, genetics, robotics, and speech recognition. On the other hand, it has deep roots in various aspects in mathematics, from optimization, approximation theory, to statistics, etc. This mini-symposium aims to bring together researchers in different aspects of machine learning for discussions on the state-of-the-art developments in theory and practice. The mini-symposium has a total of four talks, which are about fast algorithms solving linear inequalities, genetic data analysis, theory and practice of deep learning.

Organizers:
Haixia Liu, Department of Mathematics, The Hong Kong University of Science and Technology, `mahxliu@ust.hk`
Yuan Yao, Department of Mathematics, The Hong Kong University of Science and Technology, `yuany@ust.hk`

10:45-11:15 Approximation of Inconsistent Systems of Linear Inequalities: Fast Solvers and Applications
Mila Nikolova, CMLA, CNRS, ENS Cachan, University Paris-Saclay

11:15-11:45 Theory of Distributed Learning
Ding-Xuan Zhou, City University of Hong Kong

11:45-12:15 Scattering Transform for the Analysis and Classification of Art Images
Roberto Leonarduzzi, Lab de Physique, Ecole Normale Superieure de Lyon, CNRS

TALK CANCELED
~~**12:15-12:45 TBA**~~
~~*Can Yang, The Hong Kong University of Science and Technology*~~

NEW TALK
12:15-12:45 REMI: Regression with Marginal Information and Its Application in Genome-Wide Association Studies
Yuling Jiao, Zhongnan University of Economics and Law

Sunday May 6

MS06 Part II
Discovery from Data
1:45 PM - 3:45 PM
`AAB201`

The number of large-scale high-dimensional datasets recording different aspects of interrelated phenomena is growing, accompanied by a need for mathematical frameworks for discovery from data arranged in structures more complex than that of a single matrix. In the three sessions of this minisymposium we will present recent studies demonstrating "Discovery from Data," in "I: Systems Biology," and "II: Personalized Medicine," by developing and using the mathematics of "III: Tensors."

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Orly Alter, Scientific Computing and Imaging Institute, University of Utah, `orly@sci.utah.edu`

UPDATED INFORMATION
1:45-2:15 Mathematically Universal and Biologically Consistent Astrocytoma Genotype Encodes for Transformation and Predicts Survival Phenotype
Sri Priya Ponnapalli, University of Utah

2:15-2:45 Statistical Methods for Integrative Clustering Analysis of Multi-Omics Data
Qianxing Mo, Baylor College of Medicine

2:45-3:15 Structured Convex Optimization Method for Orthogonal Nonnegative Matrix Factorization with Applications to Gene Expression Data
Junjun Pan, Hong Kong Baptist University

3:15-3:45 Mining the ECG

Using Low Rank Tensor Approximations with Applications in Cardiac Monitoring
Sabine Van Huffel, KU Leuven

Sunday May 6

MS30 Part II
Rank Structured Methods for Challenging Numerical Computations
4:15 PM - 6:15 PM
`WLB204`

Rank-structured methods have demonstrated significant advantages in improving the efficiency and reliability of some large-scale computations and engineering simulations. These methods extend the fundamental ideas of multipole and panel-clustering methods to general non-local solution operators. While there exist various more or less closely related methods, the unifying aim of these methods is to explore efficient structured low-rank approximations, especially those exhibiting hierarchical or nested forms. These help the methods to achieve nearly linear complexity.
In this minisymposium, we aim to present and exchange recent new developments on rank structured methods for some challenging numerical problems such as high frequencies, ill conditioning, eigenvalue perturbation, and stability. Studies of structures, algorithm design, and accuracy control will be discussed. The minisymposium will include experts working on a broad range of rank structured methods.

Organizers:
Sabine Le Borne, Institute of Mathematics, Hamburg University of Technology, `leborne@tuhh.de`
Jianlin Xia, Department of Mathematics, Purdue University, `xiaj@math.purdue.edu`

UPDATED INFORMATION

4:15-4:45 Analytical Compression via Proxy Point Selection and Contour Integration
Jianlin Xia, Purdue University

4:45-5:15 The Perfect Shift and the Fast Computation of Roots of Polynomials
Nicola Mastronardi, Istituto per le Applicazioni del Calcolo "Mauro Picone"

5:15-5:45 Structured Matrices in Polynomial System Solving
Simon Telen, KU Leuven

5:45-6:15 Preserving Positive Definiteness in HSS Approximation and Its Application in Preconditioning
Xin Xing, Georgia Tech

Sunday May 6

MS34 Part II
Recent Applications of Rank Structures in Matrix Analysis
4:15 PM - 6:15 PM
WLB109

The development of applied science and engineering raised attention on large scale problems, generating an increasing demand of computational effort. In many practical situations, the only way to satisfy this request is to exploit obvious and hidden structures in the data. In this context, rank structures constitute a powerful tool for reaching this goal. Many real-world problems are analyzed by means of algebraic techniques that exploit low-rank structures: fast multipole methods, discretization of PDEs and integral equations, efficient solution of matrix equations, and computation of matrix functions.
The representation and the theoretical analysis of these algebraic objects is of fundamental importance to devise fast algorithms. Several representations have been proposed in the literature: $\mathcal{H}$, $\mathcal{H}^2$, and HSS matrices, quasiseparable and semiseparable structures. The design of fast methods relying on these representations is currently an active branch of numerical linear algebra. The talks in this minisymposium present some recent advances in this field.

Organizers:
Thomas Mach, Department of Mathematics, School of Science and Technology Nazarbayev University, thomas.mach@nu.edu.kz
Stefano Massei, EPF Lausanne, stefano.massei@epfl.ch
Leonardo Robol, ISTI, Area della ricerca CNR, Pisa, leonardo.robol@isti.cnr.it

UPDATED INFORMATION

4:15-4:45 The Exact Fine Structure of the Inverse of Discrete Elliptic Linear Operators
Shiv Chandrasekaran, UC Santa Barbara

4:45-5:15 Fast Direct Solvers for Boundary Value Problems on Globally Evolving Geometries
Adrianna Gillman, CAAM, Rice University

5:15-5:45 Matrix Aspects of Fast Multipole Method
Xiaofeng Ou, Department of Mathematics, Purdue University

5:45-6:15 Adaptive Cross Approximation for Ill-Posed Problems
Thomas Mach, Nazarbayev University

Monday May 7

MS06 Part III

Discovery from Data

10:35 AM - 12:35 PM

AAB201

The number of large-scale high-dimensional datasets recording different aspects of interrelated phenomena is growing, accompanied by a need for mathematical frameworks for discovery from data arranged in structures more complex than that of a single matrix. In the three sessions of this minisymposium we will present recent studies demonstrating "Discovery from Data," in "I: Systems Biology," and "II: Personalized Medicine," by developing and using the mathematics of "III: Tensors."

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Orly Alter, Scientific Computing and Imaging Institute, University of Utah, orly@sci.utah.edu

UPDATED INFORMATION

10:35-11:05 Tensor Higher-Order GSVD: A Comparative Spectral Decomposition of Multiple Column-Matched But Row-Independent Large-Scale High-Dimensional Datasets
Sri Priya Ponnapalli, University of Utah

11:05-11:35 The GSVD: Where are the ellipses?
Alan Edelman, Massachusetts Institute of Technology

11:35-12:05 Tensor Convolutional Neural Networks (TCNN): Improved Featurization Using High-Dimensional Frameworks
Elizabeth Newman, Tufts University

12:05-12:35 Three-Way Generalized Canonical Correlation Analysis
Arthur Tenenhaus, CentraleSupélec

Monday May 7

MS09 Part I

Exploiting Low-Complexity Structures in Data Analysis: Theory and Algorithms

10:35 AM - 12:35 PM

WLB104

Low-complexity structures are central to modern data analysis — they are exploited to tame data dimensionality, to rescue ill-posed problems, and to ease and speed up hard numerical computation. In this line, the past decade features remarkable advances in theory and practice of estimating sparse vectors or low-rank matrices from few linear measurements. Looking ahead, there are numerous fundamental problems in data analysis coming with more complex data formation processes. For example, the dictionary learning and the blind deconvolution problems have intrinsic bilinear structures, whereas the phase retrieval problem and variants pertain to quadratic measurements. Moreover, many of these applications can be naturally formulated as nonconvex optimization problems, which are ruled to be hard by the worst-case theory. In practice, however, simple numerical methods are surprisingly effective in solving them. Partial explanation of this curious gap has started to appear very recently.
This minisymposium highlights the intersection between numerical linear algebra/numerical optimization and the mathematics of modern signal processing and data analysis. Novel results on both theoretical and algorithmic sides of exploiting low-complexity structures will be discussed, with an emphasis on addressing the new challenges.

Organizers:
Ju Sun, Department of Mathematics, Stanford University, sunju@stanford.edu
Ke Wei, School of Data Science, Fudan University, weike1986@gmail.com

TALK CANCELED

~~**10:35-11:05 When are**~~

~~**nonconvex optimization problems not scary?**~~
~~*Ju* Sun, Stanford University~~

NEW TALK
10:35-11:05 Geometry and Algorithm for Sparse Blind Deconvolution
Yuqian Zhang, Columbia University

11:05-11:35 The Scaling Limit of Online Lasso, Sparse PCA and Related Algorithms
Yue M. Lu, Harvard University

11:35-12:05 Accelerated Alternating Projection for Robust Principle Component Analysis
Jian-Feng Cai, Hong Kong University of Science and Technology

12:05-12:35 Numerical Integrators for Rank-Constrained Differential Equations
Bart Vandereycken, University of Geneva

Monday May 7

MS25 Part I

Polynomial and Rational Matrices
10:35 AM - 12:35 PM
`WLB205`

Polynomial and rational matrices have attracted much attention in the last years. Their appearance in numerous modern applications requires revising and improving known as well as developing new theories and algorithms concerning the associated eigenvalue problems, error and perturbation analyses, efficient numerical implementations, etc. This Mini-Symposium aims to give an overview of the recent research on these topics, focusing on numerical stability of quadratic eigenvalue problem; canonical forms, that reveal transparently the complete eigenstructures; sensitivity of complete eigenstructures to perturbations; low-rank matrix pencils and matrix polinomials; block-tridiagonal linearizations.

Organizers:
Javier Pérez, Department of Mathematical Sciences, University of Montana, `javier.perez-alvaro@mso.umt.edu`
Andrii Dmytryshyn, Department of Computing Science, Umeå University, `andrii@cs.umu.se`

UPDATED INFORMATION
10:35-11:05 Stratifying Complete Eigenstructures: From Matrix Pencils to Polynomials and Back
Andrii Dmytryshyn, Umeå University

11:05-11:35 Block-Symmetric Linearizations of Odd Degree Matrix Polynomials with Optimal Condition Number and Backward Error
Maria Isabel Bueno, University of California, Santa Barbara

11:35-12:05 Transparent Realizations for Polynomial and Rational Matrices
Steve Mackey, Western Michigan University

12:05-12:35 Generic Eigenstructures of Matrix Polynomials with Bounded Rank and Degree
Andrii Dmytryshyn, Umeå University

Monday May 7

MS37 Part I
Tensor Analysis, Computation, and Applications II
10:35 AM - 12:35 PM
WLB211

The term *tensor* has both meanings of a geometric object and a multi-way array. Applications of tensors include various disciplines in science and engineering, such as mechanics, quantum information, signal and image processing, optimization, numerical PDE, and hypergraph theory. There are several hot research topics on tensors, such as tensor decomposition and low-rank approximation, tensor spectral theory, tensor completion, tensor-related systems of equations, and tensor complementarity problems. Researchers in all these mentioned areas will give presentations to broaden our perspective on tensor research. This is one of a series minisymposia and focuses more on tensor analysis and algorithm design.

Organizer:
Shenglong Hu, School of Mathematics, Tianjin University,
timhu@tju.edu.cn

10:35-11:05 The Fiedler Vector of a Laplacian Tensor for Hypergraph Partitioning
Yannan Chen, The Hong Kong Polytechnic University and Zhengzhou University

11:05-11:35 Solving Tensor Problems via Continuation Methods
Lixing Han, University of Michigan-Flint

TALK CANCELED
~~**11:35-12:05 Local Convergence Rate Analysis for the Higher-Order Power Method in Best Rank One Approximations of Tensors**~~
~~*Guoyin Li, The University of New South Wales*~~

NEW TALK
11:35-12:05 The Rank of $W \otimes W$ is Eight
Shmuel Friedland, University of Illinois at Chicago

TALK CANCELED
~~**12:05-12:35 Tensor Splitting Methods for Solving the Multi-Linear System**~~
~~*Wen Li, South China Normal University*~~

NEW TALK
12:05-12:35 Randomized Algorithms for the Approximations of Tucker and the Tensor Train Decomposition
Maolin Che, Southwestern University of Finance and Economics

Monday May 7

MS09 Part II
Exploiting Low-Complexity Structures in Data Analysis: Theory and Algorithms
3:30 PM - 5:00 PM
WLB104

Low-complexity structures are central to modern data analysis — they are exploited to tame data dimensionality, to rescue ill-posed problems, and to ease and speed up hard numerical computation. In this line, the past decade features remarkable advances in theory and practice of estimating sparse vectors or low-rank matrices from few linear measurements. Looking ahead, there are numerous fundamental problems in data analysis coming with more complex data formation processes. For example, the dictionary learning and the blind deconvolution problems have intrinsic bilinear structures, whereas the phase retrieval problem and variants pertain to quadratic measurements. Moreover, many of these applications can be naturally formulated as nonconvex optimization problems, which are ruled to be hard by the worst-case theory. In practice, however, simple numerical methods are surprisingly effective in solving them. Partial explanation of this curious gap has started to appear very recently.
This minisymposium highlights the intersection between numerical linear algebra/numerical optimization and the mathematics of modern signal processing and data analysis. Novel results on both theoretical and algorithmic sides of exploiting low-complexity structures will be discussed, with an emphasis on addressing the new challenges.

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Ju Sun, Department of Mathematics, Stanford University,
sunju@stanford.edu
Ke Wei, School of Data Science, Fudan University,
weike1986@gmail.com

3:30-4:00 Foundations of Nonconvex and Nonsmooth Robust Subspace Recovery

Tyler Maunu, University of Minnesota

UPDATED INFORMATION
CHANGE OF TIME

4:00-4:30 Geometry and Algorithm for Sparse Blind Deconvolution
Yuqian Zhang, Columbia University
Move to Monday 7 May, MS09 Part I, 10:35-11:05, WLB104

NEW TALK

4:00-4:30 On Mathematical Theories of Deep Learning
Yuan Yao, The Hong Kong University of Science & Technology

4:30-5:00 Convergence of the Randomized Kaczmarz Method for Phase Retrieval
Halyun Jeong, Courant Institute of Mathematical Sciences

TALK CANCELED

~~**5:00-5:30 Nonconvex Optimization for High-Dimensional Learning**~~
~~*Mahdi Soltanolkotabi, University of Southern California*~~

Monday May 7

MS25 Part II
Polynomial and Rational Matrices
3:30 PM - 5:00 PM
WLB205

Polynomial and rational matrices have attracted much attention in the last years. Their appearance in numerous modern applications requires revising and improving known as well as developing new theories and algorithms concerning the associated eigenvalue problems, error and perturbation analyses, efficient numerical implementations, etc. This Mini-Symposium aims to give an overview of the recent research on these topics, focusing on numerical stability of quadratic eigenvalue problem; canonical forms, that reveal transparently the complete eigenstructures; sensitivity of complete eigenstructures to perturbations; low-rank matrix pencils and matrix polinomials; block-tridiagonal linearizations.

Organizers:
Javier Pérez, Department of Mathematical Sciences, University of Montana, javier.perez-alvaro@mso.umt.edu
Andrii Dmytryshyn, Department of Computing Science, Umeå University, andrii@cs.umu.se

TALK CANCELED

~~**3:30-4:00 A Backward Stable Quadratic Eigenvalue Solver**~~
~~*Françoise* Tisseur, The University of Manchester~~

CHANGE OF TIME

3:30-4:00 A Geometric Description of the Sets of Palindromic and Alternating Matrix Pencils with Bounded Rank
Fernando De Terán, Universidad Carlos III de Madrid

4:00-4:30 Strong Linearizations of Rational Matrices with Polynomial Part Expressed in an Orthogonal Basis
M. Carmen Quintana, Universidad Carlos III de Madrid

4:30-5:00 On the Stability of the Two-Level Orthogonal Arnoldi Method for Quadratic Eigenvalue Problems
Javier Pérez, University of Montana

Monday May 7

MS37 Part II

Tensor Analysis, Computation, and Applications II
3:30 PM - 5:30 PM
WLB211

The term *tensor* has both meanings of a geometric object and a multi-way array. Applications of tensors include various disciplines in science and engineering, such as mechanics, quantum information, signal and image processing, optimization, numerical PDE, and hypergraph theory. There are several hot research topics on tensors, such as tensor decomposition and low-rank approximation, tensor spectral theory, tensor completion, tensor-related systems of equations, and tensor complementarity problems. Researchers in all these mentioned areas will give presentations to broaden our perspective on tensor research. This is one of a series minisymposia and focuses more on tensor analysis and algorithm design.

Organizer:
Shenglong Hu, School of Mathematics, Tianjin University, timhu@tju.edu.cn

3:30-4:00 Sparse Tucker Decomposition Completion for 3D Facial Expression Recognition
Ziyan Luo, Beijing Jiaotong University

CHANGE OF TIME
4:00-4:30 Hankel Tensor Decompositions and Ranks
Ke Ye, Chinese Academy of Science and University of Chicago

TALK CANCELED
~~**4:00-4:30 Tensor Ranks and Secant Varieties**~~
~~*Yang Qi, University of Chicago*~~

~~**4:30-5:00 S-lemma of the Fourth Order Tensor Systems**~~
~~*Qingzhi Yang, Nankai University*~~

NEW TALK
4:30-5:00 Polytopes of Stochastic Tensors
Xiaodong Zhang, Shanghai Jiaotong University

5:00-5:30 Some Spectral Bounds and Properties on Non-Uniform Hypergraphs
Chen Ouyang, The Hong Kong Polytechnic University

Tuesday May 8

MS04 Part II
Constrained Low-Rank Matrix and Tensor Approximations
3:00 PM - 5:00 PM
WLB103

Constrained low rank matrix and tensor approximations are extremely useful in large-scale data analytics with applications across data mining, signal processing, statistics, and machine learning. Tensors are multidimensional arrays, or generalizations of matrices to more than two dimensions. The talks in this minisymposium will span various matrix and tensor decompositions and discuss applications and algorithms, as well as available software, with a particular focus on computing solutions that satisfy application-dependent constraints.

Organizers:
Grey Ballard, Wake Forest University, ballard@wfu.edu
Ramakrishnan Kannan, Oak Ridge National Laboratory, kannanr@ornl.gov
Haesun Park, Georgia Institute of Technology, hpark@cc.gatech.edu

3:00-3:30 Accelerating the Tucker Decomposition with Compressed Sparse Tensors
George Karypis, University of Minnesota

UPDATED INFORMATION
3:30-4:00 Efficient CP-ALS and Reconstruction from CP Form
Jed Duersch, Sandia National Laboratories

4:00-4:30 Non-Negative Sparse Tensor Decomposition on Distributed Systems
Jiajia Li, Georgia Institute of Technology

4:30-5:00 Communication-Optimal Algorithms for CP Decompositions of Dense Tensors
Grey Ballard, Wake Forest University

Abstracts of Minisymposia Talks

MS04
Efficient CP-ALS and Reconstruction from CP Form

The Canonical Polyadic (CP) decomposition is an essential tool in the analysis of multi-way datasets. Just as the singular value decomposition (SVD) can be used to analyze and approximate matrices, the CP decomposition generalizes the SVD to multi-dimensional arrays. It can be used for data compression, for feature extraction, and to fill in missing entries. The alternating least-squares algorithm CP-ALS is the standard means of computing the CP decomposition. We present a high-performance reformulation of CP-ALS that substantially reduces memory requirements and improves performance on large dense tensors. This is accomplished by reformulating a critical kernel called matricized-tensor times Khatri-Rao product (MTTKRP). This operation is restructured to avoid large intermediate Khatrio-Rao products. We then exploit the restructured formulation to reuse partial computations as the algorithm alternates through factor matrix updates. This new approach runs up to 20 times faster. We apply the same technique to reconstruct the full tensor from the CP formulation. The new reconstruction mechanism also reduces both memory requirements and run time by an order of magnitude over the previous approach.

Jed Duersch, Sandia National Laboratories,
jaduers@sandia.gov

MS06
Patterns of DNA Copy-Number Alterations Revealed by the GSVD and Tensor GSVD Encode for Cell Transformation and Predict Survival and Response to Platinum in Adenocarcinomas

GSVD and tensor GSVD comparisons of patient-matched lung, ovarian, and uterine adenocarcinoma and normal genomes reveal technology-independent tumor-exclusive patterns of DNA copy-number alterations that predict survival, both in general and in response to platinum. A quarter or more of these tumors are resistant to platinum, the first-line systemic treatment, yet no other diagnostic distinguishes resistant from sensitive tumors. This demonstrates the mathematically universal ability of comparative spectral decompositions to find in data what other methods miss.

Orly Alter, University of Utah, orly@sci.utah.edu
Katherine A. Aiello, University of Utah
Cody A. Maughan, University of Utah
Sri Priya Ponnapalli, University of Utah
Heidi A. Hanson, University of Utah

MS06
Mathematically Universal and Biologically Consistent Astrocytoma Genotype Encodes for Transformation and Predicts Survival Phenotype

DNA alterations have been observed in astrocytoma genomes for decades. A copy-number genotype predictive of survival phenotype was only detected by using the GSVD. In comparisons of sets of patient-matched astrocytoma tumor and normal genomes, profiled by different technologies, the GSVD separates the biologically consistent genotype and phenotype from changing experimental variations. This demonstrates the mathematically universal ability of the GSVD, formulated as a comparative spectral decomposition, to find in data what other methods miss.

Sri Priya Ponnapalli, University of Utah,
priya@sci.utah.edu
Katherine A. Aiello, University of Utah
Orly Alter, University of Utah

MS06
Tensor Higher-Order GSVD: A Comparative Spectral Decomposition of Multiple Column-Matched But Row-Independent Large-Scale High-Dimensional Datasets

The number of interrelated large-scale high-dimensional datasets is growing, accompanied by a need for decompositions that can simultaneously identify the similar and dissimilar among multiple tensors. We define a tensor higher-order GSVD (HO GSVD), which preserves the exactness of the GSVD. We prove that the tensor HO GSVD exists, generalizes the uniqueness properties of, and reduces to the GSVD. We also prove that the common tensor HO GSVD subspace, like the GSVD, maintains orthogonality of the corresponding column basis vectors.

Sri Priya Ponnapalli, University of Utah,
priya@sci.utah.edu
Katherine A. Aiello, University of Utah
Orly Alter, University of Utah

MS09 Geometry and Algorithm for Sparse Blind Deconvolution

Blind deconvolution is a ubiquitous problem aiming to recover a convolution kernel $a_0 \in \Re^k$ and an activation signal $x_0 \in \Re^m$ from their convolution $y \in \Re^m$. This is an ill-posed problem in general. This talk focuses on the *short and sparse* blind deconvolution problem, where the convolution kernel is short ($k \ll m$) and the activation signal is sparsely and randomly supported ($normx_00 \ll m$). This variant captures the structure of the convolutional signals in several important application scenarios.
The observation y is invariant up to some mutual scaling and shift of the convolutional pairs. Such *scaled-shift symmetry* is intrinsic to the convolution operator and imposes challenges for reliable algorithm design. We normalize the convolution kernel to have unit Frobenius norm and then cast the blind deconvolution problem as a nonconvex optimization problem over the kernel sphere. We demonstrate that (i) under conditions, every local optimum is close to some shift truncation of the ground truth, and (ii) for a generic filter $a_0 \in S^{k-1}$, when the sparsity of activation signal satisfies $\theta \lesssim k^{-2/3}$ and number of measurements $m \gtrsim polyparenk$, provable recovery of some shift truncation of the ground truth kernel can be obtained.

Yuqian Zhang, Columbia University,
yuqian.yqzhang@gmail.com

MS09
On Mathematical Theories of Deep Learning

Deep learning has recently undergone a tremendous success in a variety of applications, such as speech recognition, computer vision, natural language processing, and games against human players. However there are still lots of theoretical puzzles in understanding its empirical success. Interesting questions include but are not limited to: A. what kind of geometric properties holds for deep networks architectures that avoid the curse of dimensionality; B. how deep learning can generalise well without suffering the overfitting even in over-parametric models; C. what are the landscapes of empirical risks or objective functions that deep learning may efficiently optimise. This talk presents some state-of-the-art results around these explorations toward a deeper understanding of deep learning.

Yuan Yao, The Hong Kong University of Science & Technology, yuany@ust.hk

MS10
Computing the Inverse and Pseudoinverse of Time-Varying Matrices by the Discretization of Continuous-Time ZNN Models

We consider discretizations of continuous-time Zhang Neural Network (ZNN) for computing time-varying matrix inverse and/or pseudoinverse. These discretizations incorporate scaled Hyperpower methods as well as the Newton method. We apply the most general linear multi-step method based scheme, including all known discretization schemes. Particularly, 4th order Adams-Bashforth method based scheme is proposed and numerically compared with known iterative schemes. In addition, the ZNN model for matrix inversion is extended to the pseudoinverse computation. Convergence properties of these extensions are also investigated.

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MS16
REMI: Regression with Marginal Information and Its Application in Genome-Wide Association Studies

In this paper we consider the problem of variable selection and estimation in high-dimensional linear regression models when the complete data are not accessible, but only certain marginal information or summary statistics are available. This problem is motivated from Genome-wide association studies (GWAS) with millions of genotyped single nucleotide polymorphisms (SNPs) that have been widely used to identify risk variants among complex human traits/diseases. With a large number of completed GWAS, statistical methods using summary statistics become more and more important because of inaccessibility to individual-level data. In this study, we propose a penalized approach to variable selection and estimation using Lasso based on estimated marginal effects and an estimated covariance matrix of the predictors with an external panel data. The proposed method is highly scalable and capable of analyzing multiple GWAS data sets from hundreds of thousands individuals and a large number of SNPs. We also establish an upper bound on the error of the REMI estimator, which has the same order as that of the minimax error bound of Lasso with complete individual- level data. In addition, we develop an efficient algorithm based on coordinate descent. We conduct simulation studies to evaluate the performance of the proposed method. An interesting finding is that when there is a large number of marginal estimates available with a small number of reference samples as is in GWAS, the proposed method yields good estimation and prediction results, and outperforms the Lasso with complete data but with a relatively small sample size. We also demonstrated the application of the proposed method on the GWAS data from the Northern Finland Birth Cohorts program.

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MS25
Stratifying Complete Eigenstructures: From Matrix Pencils to Polynomials and Back

The classical approach to analyze and determine the complete eigenstructure of matrix polynomials is to study their linearizations, which, in turn, requires some analysis and methods for matrix pencils. In this presentation, we study how small perturbations of matrix polynomials may change their elementary divisors and minimal indices by constructing the closure hierarchy graphs (stratifications) of orbits and bundles of matrix polynomial Fiedler linearizations. The stratifications of the Fiedler linearizations are constructed using the stratifications of general matrix pencils. The results are illustrated by examples using the software tool StratiGraph.

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