SIAM Student Chapter @NUS

8th Symposium on Applied and Computational Mathematics

Date & Venue

- 26 February 2019, Tuesday (Recess Week)
- S17-04-06 (Seminar Room 1), Department of Mathematics

Sponsors

- Society of Industrial and Applied Mathematics (SIAM)
- National University of Singapore (NUS)

Committee Members

- Prof. Weizhu Bao (matbaowz@nus.edu.sg, Faculty Advisor)
- Ms. Jia Yin (yinjia15@u.nus.edu, President)
- Mr. Yancheng Yuan (yuanyancheng@u.nus.edu, Vice President)
- Mr. Lilong Qian (qian.lilong@u.nus.edu, Secretary)

Guest Speakers

- Prof. Jonathan Scarlett, Department of Mathematics & Department of Computer Science
- Dr. Ruofei Ouyang, Wecash
- Dr. Jinyu Chen, Department of Mathematics
- Dr. Lizhen Chen, Department of Mathematics
- Dr. Fanhai Zeng, Department of Mathematics
- Dr. Jiejie Zhang, Department of Statistics and Applied Probability
- Dr. Luchan Zhang, Department of Mathematics
- Dr. Wei Zhang, Center of Excellence in Modelling and Simulation for Next Generation Ports

All are welcome!

Programme

Time	Guest Speaker	Talk Title/Topic Series
08:50-09:00		Opening Remarks
09:00-10:00	Prof. Jonathan Scarlett	Information-Theoretic Limits for Statistical Inference, Learning, and Optimization • Machine Learning, Data Science
10:00-10:20		Tea Break & Group Photo
10:20-10:55	Dr. Jiejie Zhang	Modelling Seasonality and Serial Dependence of Electricity Price Curves with Warping Functional Autoregressive • Electricity Prices Forecasting
10:55-11:30	Dr. Jinyu Chen	Integrative Analysis of Genomic Data for Modular Patterns Discovery via Matrix Factorization • Bioinformatics
11:30-12:05	Dr. Fanhai Zeng	Fast Time-stepping Method for Fractional Integral and Derivative Operators • Convolution Quadrature
12:05-13:30		Buffet Lunch & Noon Break
13:30-14:05	Dr. Lizhen Chen	Stokes Eigenspace: From 2-d Regular Polygons toward the Disc • Numerical Methods for PDEs
14:10-15:10	Dr. Ruofei Ouyang	Data Analytical Models in Wecash • Data Science
15:10-15:40		Tea Break & Group Photo
15:40-16:15	Dr. Luchan Zhang	The Effect of Randomness on the Strength of High-entropy Alloys • Material Science
16:15-16:50	Dr. Wei Zhang	Using Nemirovski's Mirror-Prox Method as Basic Procedure in Chubanov's Method for Solving Homogeneous Feasibility Problems • Linear Programming
16:50-18:30		Pizza Dinner

Information-Theoretic Limits for Statistical Inference, Learning, and Optimization

Jonathan Scarlett

Abstract

The field of information theory was introduced as a means for understanding the fundamental limits of data compression and transmission, and has shaped the design of practical communication systems for decades. In this talk, I will discuss the emerging viewpoint that information theory is not only a theory of communication, but a far-reaching theory of data that is applicable to seemingly unrelated problems such as estimation, prediction, and optimization. This perspective leads to principled approaches for certifying the near-optimality of practical algorithms, as well as understanding where further improvements are possible. I will provide an introduction to some of the main ideas and insights offered by this perspective, and present examples in the problems of group testing, graphical model selection, sparse regression, and black-box function optimization.

Modelling Seasonality and Serial Dependence of Electricity Price Curves with Warping Functional Autoregressive Dynamics

Jiejie <u>Zhang</u>

Abstract

Electricity prices are high dimensional, serially dependent and have seasonal variations. We propose a Warping Functional AutoRegressive (WFAR) model that simultaneously accounts for the cross time-dependence and seasonal variations of the large dimensional data. In particular, electricity price curves are obtained by smoothing over the 24 discrete hourly prices on each day. In the functional domain, seasonal phase variations are separated from level amplitude changes in a warping process with the Fisher-Rao distance metric, and the aligned (season-adjusted) electricity price curves are modeled in the functional autoregression framework. In real application, the WFAR model provides superior out-of-sample forecast accuracy in both a normal functioning market, Nord Pool, and an extreme situation, the California market. The forecast performance as well as the relative accuracy improvement are stable for different markets and different time periods.

Integrative Analysis of Genomic Data for Modular Patterns Discovery via Matrix Factorization

Jinyu Chen

Abstract

With the rapid development of biotechnology, multi-dimensional genomic data are available for us to study the regulatory associations among multiple levels. Thus, it is essential to develop a tool to identify not only the modular patterns from multiple levels, but also the relationships among these modules. In this study, we adopt a novel non-negative matrix factorization framework (NetNMF) to integrate pairwise genomic data in a network manner. NetNMF could reveal the modules of each dimension and the connections within and between both types of modules. This tool provides us comprehensive insights into the mechanisms of how the two levels of molecules cooperate with each other.

Fast Time-stepping Method for Fractional Integral and Derivative Operators

Fanhai Zeng

Abstract

We develop fast time-stepping method with linear complexity to calculate the discrete convolution for the approximation of the fractional integral and derivative operators. The memory requirement and computational cost of Fast Method II are $O(Q)$ and $O(QM)$, respectively, where M is the number of the final time steps and Q is the number of quadrature points used in the trapezoidal rule. The effectiveness of the fast methods is verified through a series of numerical examples for long-time integration, including a numerical study of a fractional reaction-diffusion model.

Stokes Eigenspace:
From 2-d Regular Polygons toward the Disc

Lizhen <u>Chen</u>

Abstract

The Stokes eigen-modes in two-dimensions on regular polygons are computed numerically by spectral element solvers and their convergence toward the eigen-modes on the disc is analyzed.

Data Analytical Models in Wecash

Ruofei Ouyang

Abstract

Emerging economies have seen an explosive growth of the Internet population, which enables sophisticated credit scoring system to predict creditworthiness of individuals. Wecash APAC provides efficient microfinance services for millions of people by analyzing those non-traditional internet data. In this session, we will discuss the progress of Wecash data science team in analyzing these data on two major topics: 1) financial service related natural language processing models and 2) credit risk evaluation using incomplete social graph information.

The first topic covers the NLP models of a modified short text topic model focusing, the text classification to automatically identify financial sensitive information and our customer service chatbot.

The second topic covers the social graph models we developed internally. One major challenge of graph related model is computational complexity. It is teamwork that combines the modeling skills and engineering skills to provide accurate social graph features to our customers in seconds.

The Effect of Randomness on the Strength of High-entropy Alloys

Luchan <u>Zhang</u>

Abstract

High-entropy alloys (HEAs), i.e., single-phase, (nearly) equiatomic multi-component, metallic materials, are associated with novel mechanical properties, such as high strength, fracture resistance etc. We propose a stochastic Peierls-Nabarro (PN) model to understand how random site occupancy affects intrinsic strength. The stochastic PN model accounts for the randomness in the composition, characterized by both the standard deviation of the perturbation in the interplanar potential and the correlation length within the spatial compositional distribution. The model presented includes the effects of non-uniform compositional distribution both in the direction of dislocation glide and along a dislocation line to predict overall dislocation glide resistance. The model predicts the intrinsic strength of HEAs as a function of the standard deviation and the correlation length of the randomness. We find that, in most of the parameter space, the compositional randomness in an HEA gives rise to an intrinsic strength that far exceeds that of any of the pure metals from which the HEA is composed. This approach provides a fundamental explanation to the origin of the high strength of HEAs.

Using Nemirovski's Mirror-Prox Method as Basic Procedure in Chubanov's Method for Solving Homogeneous Feasibility Problems

Wei Zhang

Abstract

We introduce a new variant of Chubanov's method for solving linear homogeneous systems with positive variables. We propose a new Basic Procedure based on Nemirovski's Mirror-Prox method. Our Modified Main Algorithm is in essence the same as Chubanov's Main Algorithm, except that it uses the new Basic Procedure as a subroutine. The new method has $O(n^{4.5}L)$ time complexity. Some computational results are presented in comparison with Gurobi.