SIAM Student Chapter @NUS

11th Symposium on Applied and Computational Mathematics, 2022

SIAM Student Chapter @NUS

- Homepage: https://siamnus.github.io/website/

Committee Members

- Prof. Weizhu Bao (matbaowz@nus.edu.sg, Faculty Advisor)
- Mr. Yifei Li (e0444158@u.nus.edu, President)
- Mr. Zichen Zhao (e0444180@u.nus.edu, Vice President)
- Mr. Yurui Chen (e0189580@u.nus.edu, Secretary)

siam Society for Industrial and Applied Mathematics

Date & Zoom Info

- 06 June 2022 Mon
- Part 1 09:30-11:50 Keynote speech
  https://nus-sg.zoom.us/j/84133146776?pwd=SzJpd3gvdG8vbUVxTV-BkN1ZhOCs0QT09
  Meeting ID: 841 3314 6776 / Password: keynote
- Part 2 14:00-17:00
  https://nus-sg.zoom.us/j/6332565609?pwd=SkVnYUR6TWdVY1JuN-VltMlJvRm9QUT09
  Meeting ID: 633 256 5609 / Password: siam2022

Sponsors

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

Guest Speakers

- Prof. Zuowei Shen, Department of Mathematics
- Prof. Xin Tong, Department of Mathematics
- Mengge Li, Department of Mathematics
- Tianyun Tang, Department of Mathematics
- Chushan Wang, Department of Mathematics
- Geshuo Wang, Department of Mathematics
- Zichen Zhao, Department of Mathematics

All are welcome!

NUS National University of Singapore | Department of Mathematics Faculty of Science   NUS National University of Singapore | IMS Institute for Mathematical Sciences

Programme

Time	Guest Speaker	Talk Title/Topic Series
09:25-09:30		Opening Remarks
09:30-10:30	Prof. Zuowei Shen	(Keynote) Mathematics in Data Science • Data science
10:30-10:40		Q & A, Break
10:40-11:40	Prof. Xin Tong	(Keynote) Bayesian Sampling Algorithms • Data science
11:40-11:50		Q & A
11:50-14:00		Lunch & Noon Break
14:00-14:30	Mengge Li	Robust Equilibrium Strategy for Mean-Variance Portfolio Selection • Mathematical finance
14:40-15:10	Tianyun Tang	Solving Graph Equipartition SDPs on an Algebraic Variety • Optimization
15:20-15:50	Chushan Wang	Computing the Least Action Ground State of the Nonlinear Schrödinger Equation by a Normalized Gradient Flow • Numerical PDEs
16:00-16:30	Geshuo Wang	The Bold-Thin-Bold Diagrammatic Monte Carlo Method for Open Quantum Systems • Computational physics
16:40-17:00	Zichen Zhao	Adaptive Sampling for Learning Dynamics • Machine learning

Mathematics in Data Science

Keynote speaker: Prof. Zuowei Shen

Abstract

We are living in the era of big data. The discovery, interpretation and usage of the information, knowledge and resources hidden in all sorts of data to benefit human beings and to improve everyone's day to day life is a challenge to all of us. The huge amount of data we collect nowadays is so complicated, and yet what we expect from it is so much. This provides many challenges and opportunities to many fields, especially, the field of mathematical science. In this talk, we will show by examples how mathematics has been playing important roles in the era of big data. We will further discuss how mathematics can move the frontier of data science and what kind of challenges mathematicians face in this era of big data.

About the speaker

Professor Zuowei Shen is Vice Provost (Graduate Education & Special Duties) at the National University of Singapore (NUS).

Professor Shen received his PhD in 1991 from the University of Alberta, Canada and completed his postdoctoral training at University of Wisconsin-Madison.

Professor Shen is well-known for his fundamental contributions in mathematical foundations of data science, especially in the areas of approximation and wavelet theory, image processing and compressed sensing, computer vision and machine learning. He sits on several editorial boards of top journals and has been invited to speak at many international conferences and congresses, including the International Congress of Mathematicians (ICM) in 2010 and the International Congress of Industrial and Applied Mathematics (ICIAM) in 2015.

Bayesian Sampling Algorithms

Keynote speaker: Prof. Xin Tong

Abstract

Bayesian approach is one general way to handle many problems in data science. Computationally its solution requires generating samples from a target distribution. How to design efficient sampling algorithm is an important question. This becomes particularly critical if the underlying model is high dimensional. In this talk, we will discuss the classical approach of MCMC and some new variational methods.

About the speaker

Professor Xin Tong is the assistant Professor at the National University of Singapore (NUS). He received his PhD in 2013 from Princeton University and completed his postdoctoral training at the Courant Institute of New York University. He joined the NUS in 2016.

Professor Tong's research interests lie broadly inside probability theory and its applications in statistics, machine learning, and nonlinear systems.

Robust Equilibrium Strategy for Mean-Variance Portfolio Selection

Mengge Li

Abstract

In this talk, we will consider a general dynamic mean-variance framework and propose a novel definition of the robust equilibrium strategy. Under our definition, a classical solution to the corresponding PDE system implies a robust equilibrium strategy. We then explicitly solve the PDE system for some special stochastic dynamics arising from portfolio selection problems.

Solving Graph Equipartition SDPs on an Algebraic Variety

Tianyun Tang

Abstract

Semidefinite programs are generally challenging to solve due to its high dimensionality. Burer and Monteiro developed a non-convex approach to solve linear SDP problems by applying its low rank property. Their approach is fast because they used factorization to reduce the problem size. In this paper, we focus on solving the SDP relaxation of a graph equipartition problem, which involves an additional semidefinite upper bound constraint over the traditional linear SDP. By applying the factorization approach, we get a non-convex problem with a non-smooth spectral inequality constraint. We discuss when the non-convex problem is equivalent to the original SDP, and when a local minimum of the non-convex problem is also a global minimum. Our results generalize previous works for linear SDP. Moreover, the constraints of the non-convex problem involve an algebraic variety with some conducive properties that allow us to use Riemannian optimization and non-convex augmented Lagrangian method to solve the SDP problem very efficiently with certified global optimality.

Computing the Least Action Ground State of the Nonlinear Schrödinger Equation by a Normalized Gradient Flow

Chushan Wang

Abstract

In this talk, we consider the computation of the least action ground state of the nonlinear Schrödinger equation. The least action ground state can be characterized as a minimizer of the action functional on the Nehari manifold. Based on it, we generalize the normalized gradient flow method which is first applied to computing the least energy ground state to compute the least action ground state. A continuous normalized gradient flow (CNGF) will be presented and the action decreasing property will be proved to provide a mathematical justification of the gradient flow with discrete normalization (GFDN). To further discretize the CNGF, we use backward-forward Euler method, which leads to the GFDN-BF scheme. It can be shown that the GFDN-BF scheme diminishes the action unconditionally. We also compare the GFDN-BF with other schemes modified from corresponding ones designed for the computation of the least energy ground states. It turns out that the GFDN-BF scheme performs much better than the others in accuracy, efficiency and robustness for large time steps. Extensive numerical results of least action ground states for several types of (singular) potentials are provided. We also use our numerical results to verify some existing results and lead to some conjectures.

The Bold-Thin-Bold Diagrammatic Monte Carlo Method for Open Quantum Systems

Geshuo Wang

Abstract

We present two diagrammatic Monte Carlo methods for quantum systems coupled with harmonic baths, whose dynamics are described by integro-differential equations. The first approach can be considered as a reformulation of Dyson series, and the second one, called ``bold-thin-bold diagrammatic Monte Carlo'', is based on resummation of the diagrams in the Dyson series to accelerate its convergence. The underlying mechanism of the governing equations associated with the two methods lies in the recurrence relation of the path integrals, which is the most costly part in the numerical methods. The proposed algorithms give an extension to the work [``Fast algorithms of bath calculations in simulations of quantum system-bath dynamics", Computer Physics Communications, to appear], where the algorithms are designed based on reusing the previous calculations of bath influence functionals. Compared with the algorithms therein, our methods further include the reuse of system associated functionals and show better performance in terms of computational efficiency and memory cost. We demonstrate the two methods in the framework of spin-boson model, and numerical experiments are carried out to verify the validity of the methods.

Adaptive Sampling for Learning Dynamics

Zichen Zhao

Abstract

Learning dynamic systems from observed trajectories is a fundamental problem in data-driven science and engineering. While many existing works focus on improving model architectures or training methods, with less focus on how to efficiently sample the training data to give rise to accurate models. In particular, one of the most fundamental issues is choosing the length of sampled trajectory balances computational overhead due to sampling and the quality of learned the models. In this talk, we try to address the task of improving the efficiency of learning dynamic sampling. We first formulate an appropriate target risk to evaluate model performance for dynamic learning settings. This allows us to combine generalization with matching empirical measures to specific target measures. Based on this observation, we propose a class of adaptive algorithms to find efficient sampling strategy to control the length of the sampling trajectory.