14th SIAM Student Chapter Symposium at NUS

Date: April 24, 2025

Venue: S17-04-04, Department of Mathematics, NUS

Organizer: SIAM Student Chapter at NUS

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

Organizing Committee:

- Prof. Bao Weizhu (matbaowz@nus.edu.sg, Faculty Advisor)
- Mr. Liu Shuigen (shuigen@u.nus.edu, President)
- Ms. Liu Shuya (e0675581@u.nus.edu, Vice President)
- Mr. Hou Di (dihou@u.nus.edu, Secretary)

Scan for Full Schedule

Plenary Speaker:

- Prof. Ren Weiqing, *Department of Mathematics*
- Prof. Cai Zhenning, *Department of Mathematics*

Student Speaker:

- Mr. Cheng Jingpu, *Department of Mathematics*
- Dr. Lin Xiaotong, *Department of Statistics and Data Science*
- Mr. Chen Junyu, *Department of Mathematics*
- Dr. Wang Shiwei, *Institute of Operational Research and Analytics*
- Ms. Sun Yixiao, *Department of Mathematics*
- Mr. Zhang Yulin, *Department of Mathematics (SJTU)*
- Mr. Zhou Tao, *Department of Mathematics*
- Mr. Lyu Runcao, *Department of Mathematics*

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Program:

14th SIAM Student Chapter Symposium at NUS		
April 24, 2025 (S17-04-04)		
Time	Title	Name
8:55–9:00 AM	Opening Remarks	
Chair: Liu Shuigen		
9:00–9:45 AM	**Plenary Talk:** On the Holway-Weiss debate on smooth shock profiles in Grad's moment method	Cai Zhenning
9:45–10:15 AM	TBD	Cheng Jingpu
10:15–10:45 AM	Hypothesis Testing in Gaussian Graphical Models: Novel Goodness-of-Fit Tests and Conditional Randomization Tests	Lin Xiaotong
10:45–11:00 AM	Coffee Break	
Chair: Hou Di		
11:00–11:30 AM	Semidefinite Relaxations of the Gromov-Wasserstein Distance	Chen Junyu
11:30–12:00 PM	TBD	Wang Shiwei
12:00–2:00 PM	Lunch Break	
Chair: Liu Shuya		
2:00–2:45 PM	**Plenary Talk:** Modelling rare events in complex systems	Ren Weiqing
2:45–3:15 PM	TBD	Sun Yixiao

3:15–3:45 PM	A generalized structure-preserving parametric finite element method for anisotropic curvature flows on closed curves	Zhang Yulin
3:45–4:00 PM	Coffee Break	
Chair: Chen Jingpu		
4:00–4:30 PM	TBD	Zhou Tao
4:30–5:00 PM	TBD	Lyu Runcao

Abstracts

On the Holway-Weiss debate on smooth shock profiles in Grad's moment method

Prof. Cai Zhenning

Department of Mathematics, NUS

Grad's moment method is a classical modeling technique to approximate the Boltzmann equation in the gas kinetic theory. Despite its simplicity and flexibility, the method is known to suffer from several shortcomings, including the loss of hyperbolicity and the prediction of unphysical subshocks in shock profiles. These issues are well known and broadly acknowledged. However, there is another possible issue that spurred some arguments in the history of moment methods. In a seminal 1965 paper, Holway argued that there is an upper bound on the Mach number beyond which smooth shock profiles do not exist for all Grad's moment equations. However, more than three decades later, Weiss challenged this claim, arguing that this restriction does not exist. In this talk, we will revisit the debate, discuss their findings, and explain that both arguments have a correct and an incorrect part. Inspired by the debate, we will present a new strategy to improve Grad's moment method.

Modelling rare events in complex systems

Prof. Ren Weiqing

Department of Mathematics, NUS

Many problems in applied sciences can be abstractly formulated as systems navigating over complex energy landscapes. Well-known examples include conformational changes of biomolecules, chemical reactions, nucleation events during phase transitions, and extreme events in some cases that lead to material or system failure, etc. These events happen infrequently relative to the relaxation timescale of the system, but when they do happen, they usually happen rather

quickly and have important consequences. In this talk, I will discuss numerical methods for the study of such rare events, including the string method and the recently developed machine learning techniques.

TBD

Mr. Cheng Jingpu

Department of Mathematics, NUS

TBD.

Hypothesis Testing in Gaussian Graphical Models: Novel Goodness-of-Fit Tests and Conditional Randomization Tests

Dr. Lin Xiaotong

Department of Statistics and Data Science, NUS

We introduce novel hypothesis testing methods for Gaussian graphical models, whose foundation is an innovative algorithm that generates exchangeable copies from these models. We utilize the exchangeable copies to formulate a goodness-of-fit test, which is valid in both low and high-dimensional settings and flexible in choosing the test statistic. This test exhibits superior power performance, especially in scenarios where the true precision matrix violates the null hypothesis with many small entries. Furthermore, we adapt the sampling algorithm for constructing a new conditional randomization test for the conditional independence between a response Y and a vector of covariates X given some other variables Z. Thanks to the model-X framework, this test does not require any modeling assumption about Y and can utilize test statistics from advanced models. It also relaxes the assumptions of conditional randomization tests by allowing the number of unknown parameters of the distribution of X to be much larger than the sample size. For both of our testing procedures, we propose several test statistics and conduct comprehensive simulation studies to demonstrate their superior performance in controlling the Type-I error and achieving high power. The usefulness of our methods is further demonstrated through real-world applications.

Semidefinite Relaxations of the Gromov-Wasserstein Distance

Mr. Chen Junyu

Department of Mathematics, NUS

The Gromov-Wasserstein (GW) distance is an extension of the optimal transport problem that allows one to match objects between incomparable spaces. At its core, the GW distance is specified as the solution of a non-convex quadratic program and is not known to be tractable to solve. In particular, existing solvers for the GW distance are only able to find locally optimal solutions. In this work, we propose a semi-definite programming (SDP) relaxation of the GW distance. The relaxation can be viewed as the Lagrangian dual of the GW distance augmented with constraints that relate to the linear and quadratic terms of transportation plans. In particular, our relaxation provides a tractable (polynomial-time) algorithm to compute globally optimal transportation plans (in some instances) together with an accompanying proof of global optimality. Our numerical experiments suggest that the proposed relaxation is strong in that it frequently computes the globally optimal solution. Our Python implementation is available at https://github.com/tbng/gwsdp.

TBD

Dr. WANG Shiwei

Institute of Operational Research and Analytics, NUS

TBD.

TBD

Ms. Sun Yixiao

Department of Mathematics, NUS

TBD.

A generalized structure-preserving parametric finite element method for anisotropic curvature flows on closed curves

Mr. Zhang Yulin

Department of Mathematics, SJTU

TBD.

TBD

Mr. Zhou Tao

Department of Mathematics, NUS

TBD.

TBD

Mr. Lyu Runcao

Department of Mathematics, NUS

TBD.