



TIME

10.11

10.16

JOINT FUDAN-SEOUL NATIONAL WORKSHOP ON APPLIED AND COMPUTATIONAL MATHEMATICS

**School of Mathematical Sciences
Fudan University
Shanghai, China**

PARTICIPANT GUIDE

Welcome

Joint Fudan–Seoul National Workshop on Applied and Computational Mathematics 2026

Welcome to the Joint Fudan–Seoul National Workshop on Applied and Computational Mathematics, held at Fudan University, Shanghai, from October 11 to 16, 2026. The workshop brings together faculty and graduate students from the School of Mathematical Sciences at Fudan University and the Department of Mathematical Sciences at Seoul National University for a week of invited talks, student presentations, and collaborative discussion on recent advances in applied and computational mathematics.

The programme opens with two days of invited faculty talks on October 12 and 13, and continues with graduate student sessions on October 14 and 15, giving students from both institutions the opportunity to present their research and build lasting academic connections. Extended discussion sessions on the afternoons of October 13 and 15 leave time to explore shared interests and potential collaborations in depth.

We hope this event fosters meaningful collaboration between our two institutions and look forward to a productive and enjoyable week together.

HOSTED BY

School of Mathematical Sciences, Fudan University
Shanghai Center for Mathematical Sciences
Mathematical Research Center, Fudan University

ORGANIZED BY

School of Mathematical Sciences, Fudan University

ORGANIZING COMMITTEE

Youngjoon Hong Seoul National University	Shuai Lu Fudan University
Quanshui Wu Fudan University	Lun Zhang Fudan University

Programme at a Glance

Joint Fudan–Seoul National Workshop on Applied and Computational Mathematics 2026

OCTOBER 11 – 16 • FUDAN UNIVERSITY • SHANGHAI

DATE	PROGRAMME	VENUE
Sun, Oct 11 ARRIVAL	Arrival & airport pick-up KE887 arr. 12:25 • KE891 arr. 20:10	Shanghai Pudong International Airport (PVG), Terminal 1
	Hotel check-in	Pagoda Hotel Shanghai Wujiaochang
	Dinner	Off-campus restaurants
Mon, Oct 12 DAY 1	Check-in, opening remarks & invited talks 08:30 – 16:55	Room 2201, East Main Building, Guanghua Towers
	Workshop dinner 18:00	Zhengda Restaurant, Fudan University
Tue, Oct 13 DAY 2	Invited talks & discussion 09:00 – 11:30	Room 2201, East Main Building, Guanghua Towers
	Free discussion from 13:00	
	Dinner	Off-campus restaurants
Wed, Oct 14 DAY 3	SNU faculty departure KE882 dep. 11:10	Shanghai Pudong International Airport (PVG), Terminal 1
	Opening remarks & student talks 09:00 – 11:30 • 15:10 – 16:50	Room 1801, East Main Building, Guanghua Towers
	Campus tour 14:00 – 15:00	Handan Campus • finish at Guanghua Towers
	Dinner	Off-campus restaurants
Thu, Oct 15 DAY 4	Student talks 09:00 – 11:30 • 12:40 – 14:50	Room 1801, East Main Building, Guanghua Towers
	Free discussion from 15:00	
	Dinner	Off-campus restaurants
Fri, Oct 16 DEPARTURE	SNU student departure KE882 dep. 11:10	Shanghai Pudong International Airport (PVG), Terminal 1

All times are Shanghai local time (UTC+8). Boxed lunches from Zhengda Restaurant are provided on October 12–15. The workshop is held in the East Main Building of Guanghua Towers, on Fudan University's Handan Campus, 220 Handan Road, Yangpu District, Shanghai.

Workshop Schedule

Joint Fudan–Seoul National Workshop on Applied and Computational Mathematics

Monday, October 12

Day 1 · Invited talks · 50 minutes each, including Q&A

VENUE Room 2201, East Main Building, Guanghua Towers

TIME	SPEAKER	TITLE	MODERATOR
08:00	Depart from Pagoda Hotel		
08:30 – 09:00	Registration & Check-in		
09:00 – 09:15	Opening Remarks & Group Photo		
09:15 – 10:05	Myungjoo Kang SEOUL NATIONAL UNIVERSITY	Deep Learning Based Surface Reconstruction from Point Clouds and Integer Transfer Scheme	Shuai Lu FUDAN
10:05 – 10:55	Rujun Jiang FUDAN UNIVERSITY	Loss Landscape and Error Bound Analysis of Regularized Deep Matrix Factorization	
10:55 – 11:25	Tea Break & Free Discussion		
11:25 – 12:15	Shuai Lu FUDAN UNIVERSITY	Math4AI: Novel Function Spaces with Neural Networks	Youngjoon Hong SNU
12:15 – 13:05	Lunch & Rest · Boxed lunch from Zhengda Restaurant		
13:05 – 13:55	Youngjoon Hong SEOUL NATIONAL UNIVERSITY	Numerics-Guided Machine Learning and Its Theory	Jia Yin FUDAN
13:55 – 14:45	Lei Shi FUDAN UNIVERSITY	Approximation and Generalization of Deep Learning	
14:45 – 15:15	Tea Break & Free Discussion		
15:15 – 16:05	Yingzhou Li FUDAN UNIVERSITY	Algorithms for Neutral-Atom Quantum Computer	Lei Shi FUDAN
16:05 – 16:55	Jia Yin FUDAN UNIVERSITY	High-Order Compact Time-Splitting Methods for Solving the Dirac Equation	
18:00	Workshop Dinner · Zhengda Restaurant, Fudan University		

All invited talks are 50 minutes, including Q&A. Please vacate Room 2201 by 17:00.

Tuesday, October 13

Day 2 · Invited talks · 50 minutes each, including Q&A

VENUE Room 2201, East Main Building, Guanghua Towers

TIME	SPEAKER	TITLE	MODERATOR
09:00 – 09:50	Dabeen Lee SEOUL NATIONAL UNIVERSITY	Algorithms for Constrained Online Learning with Optimal Regret Guarantees	Myungjoo Kang SNU
09:50 – 10:20	Tea Break & Free Discussion		
10:20 – 11:10	Tiandong Wang FUDAN UNIVERSITY	Emergence of Multivariate Extremes in Multilayer Inhomogeneous Random Graphs	
11:10 – 11:30	Free Discussion		
11:30 – 13:00	Lunch & Rest · Boxed lunch from Zhengda Restaurant · outside Room 2201		
From 13:00	Free Discussion		
Evening	Dinner · Off-campus restaurants		

Please vacate Room 2201 by 12:00.

WEDNESDAY, OCTOBER 14 · FACULTY DEPARTURE

The 3 SNU faculty members depart from Shanghai Pudong International Airport (PVG), Terminal 1, on KE882 at 11:10, arriving at Incheon International Airport (ICN), Terminal 2, at 14:20 (Korea time). Please complete hotel checkout before the airport transfer.

Wednesday, October 14

Day 3 · Student talks · 30 minutes each, including Q&A

VENUE Room 1801, East Main Building, Guanghua Towers

TIME	SPEAKER	TITLE	MODERATOR
09:00 – 09:10	Opening Remarks		
09:10 – 09:40	Juhoon Kang SEOUL NATIONAL UNIVERSITY	Müntz Coefficient Learning for Parametric and Inverse PDE Problems	Ming Li FUDAN
09:40 – 10:10	Hyojun An SEOUL NATIONAL UNIVERSITY	FreeGSNO: Physics-Informed Neural Operator for Free-Boundary Grad–Shafranov Equation	
10:10 – 10:30	Tea Break & Free Discussion		
10:30 – 11:00	Linyue Fan FUDAN UNIVERSITY	A Second-Order Fully Decoupled Scheme for a Non-Isothermal Cahn–Hilliard–Navier–Stokes–Darcy System	Jae Suk Kim SNU
11:00 – 11:30	Mengjia Bai FUDAN UNIVERSITY	A Mixed Residual Method for Biharmonic Equations in Spectral Barron Spaces	
11:30 – 12:00	Lunch · Boxed lunch from Zhengda Restaurant		
12:00 – 14:00	Rest		
14:00 – 15:00	Campus Tour · Handan Campus · finish at Guanghua Towers		
15:00 – 15:10	Return & Presentation Setup		
15:10 – 15:40	Ming Li FUDAN UNIVERSITY	Terminally Constrained Flow-Based Generative Models from an Optimal Control Perspective	Jingkai Kou FUDAN
15:45 – 16:15	Dohyun Park SEOUL NATIONAL UNIVERSITY	Diffusion-Based Refinement for Kilometer-Scale Probabilistic Precipitation Nowcasting	
16:20 – 16:50	Hyeonseok Seo SEOUL NATIONAL UNIVERSITY	When FEM Meets Machine Learning	
Evening	Dinner · Off-campus restaurants		

Please vacate Room 1801 by 12:00; it is unavailable from 12:00 to 15:00. Afternoon talks start at 15:10; the 5-minute gaps allow for speaker changes.

Thursday, October 15

Day 4 · Student talks · 30 minutes each, including Q&A

VENUE Room 1801, East Main Building, Guanghua Towers

TIME	SPEAKER	TITLE	MODERATOR
09:00 – 09:30	Seoungbin Bae SEOUL NATIONAL UNIVERSITY	Improving Dimension Dependence in Logistic Bandits via Sample Splitting	Baiwen Jiang FUDAN
09:30 – 10:00	Juhyeok Choi SEOUL NATIONAL UNIVERSITY	Safe Learning from Audits That Repair: Renewal Policies and Information Limits	
10:00 – 10:30	Tea Break & Free Discussion		
10:30 – 11:00	Baiwen Jiang FUDAN UNIVERSITY	A Distributional Characterization of Bootstrap Stochastic Gradient Descent in Mean-Field Regimes	Seoungbin Bae SNU
11:00 – 11:30	Junehee Lee SEOUL NATIONAL UNIVERSITY	Online Resource Allocation with Budget- and Margin-Independent Bounds	
11:30 – 12:40	Lunch & Rest · Boxed lunch from Zhengda Restaurant		
12:40 – 13:10	Jae Suk Kim SEOUL NATIONAL UNIVERSITY	In-Context Learning in State Space Models: Capabilities and Mechanisms	Bowen Gao FUDAN
13:10 – 13:40	Zhuang’ao He FUDAN UNIVERSITY	On Two-Stage Householder Orthogonalization	
13:40 – 13:50	Tea Break & Free Discussion		
13:50 – 14:20	Seungcheol Shin SEOUL NATIONAL UNIVERSITY	Elastic-Net Regularization for Bilevel Mean-Field Langevin Dynamics	Junehee Lee SNU
14:20 – 14:50	Bowen Gao FUDAN UNIVERSITY	A Mixed Precision Algorithm for the Matrix Square Root	
From 15:00	Free Discussion		
Evening	Dinner · Off-campus restaurants		

Presentations finish at 14:50. Please vacate Room 1801 by 15:00.

FRIDAY, OCTOBER 16 · DEPARTURE

The 9 SNU students depart from Shanghai Pudong International Airport (PVG), Terminal 1, on KE882 at 11:10, arriving at Incheon International Airport (ICN), Terminal 2, at 14:20 (Korea time). Please complete hotel checkout before the airport transfer.

Abstracts

Talks are listed in programme order.

INVITED TALKS · OCTOBER 12 – 13

MON 12 OCT · 09:15 – 10:05 · ROOM 2201

Deep Learning Based Surface Reconstruction from Point Clouds and Integer Transfer Scheme

● **Myungjoo Kang** · Professor, Department of Mathematical Sciences, Seoul National University

In this presentation, we introduce an advanced deep learning approach for reconstructing surfaces from unorganized point clouds and Integer Transfer Scheme (ITS). By leveraging an implicit surface representation through a level set function, our method ensures watertight results and seamlessly adapts to various topologies. We employ the p-Poisson equation to precisely learn the signed distance function (SDF), improving accuracy through a variable splitting strategy that incorporates the SDF gradient as an auxiliary variable. Additionally, we enforce a curl-free condition on the auxiliary variable to exploit the irrotational nature of conservative vector fields. Our numerical results illustrate that this strategic integration of partial differential equations and key vector field characteristics efficiently reconstructs high-quality surfaces without the need for prior surface knowledge. Also, we present the ITS to solve scalar conservation laws as antisymmetric integer transfers between cells. ITS guarantees exact mass conservation in integer arithmetic, while maintaining monotonicity and the TVD property.

ABOUT THE SPEAKER

Myungjoo Kang is a Professor in the Department of Mathematical Sciences at Seoul National University and a faculty member of the university's Interdisciplinary Program in Artificial Intelligence. He received his bachelor's degree in Mathematics from Seoul National University in 1986, his M.S. in Applied Mathematics from KAIST in 1988, and his Ph.D. in Applied Mathematics from the University of California, Los Angeles in 1996. His research interests span numerical analysis, scientific computing, computational fluid dynamics, image processing, computer vision, and deep learning, with a particular focus on the mathematical understanding and applications of deep learning.

MON 12 OCT · 10:05 – 10:55 · ROOM 2201

Loss Landscape and Error Bound Analysis of Regularized Deep Matrix Factorization

● **Rujun Jiang** · Professor, School of Data Science, Fudan University

Deep matrix factorization (DMF) is a fundamental model underlying many applications, including deep linear neural networks. Despite its simplicity, the regularized DMF problem exhibits a highly nonconvex optimization landscape that is not yet fully understood. In this talk, we analyze the loss landscape and local geometry of regularized deep matrix factorization. We characterize all critical points and identify conditions under which a critical point is a local minimizer, a global minimizer, a strict saddle point, or a non-strict saddle point. We further establish an error bound around the critical point set, which leads to linear convergence guarantees for gradient-based methods. Our results provide theoretical insights into why first-order methods perform well for regularized DMF and offer a unified perspective on the optimization behavior of deep linear networks as an important application.

ABOUT THE SPEAKER

Rujun Jiang is currently a professor at School of Data Science, Fudan University. He received his Bachelor degree in Mathematics in 2012 from the University of Science and Technology of China. He then obtained his PhD degree in 2016 from The Chinese University of Hong Kong. Before joining Fudan in 2017, he spent one year at CUHK as a postdoctoral fellow. His research interests include optimization and its applications in machine learning and financial engineering. He has served as an area chair at NeurIPS. He has received an ICML Outstanding Paper Award (2022).

MON 12 OCT · 11:25 – 12:15 · ROOM 2201

Math4AI: Novel Function Spaces with Neural Networks

● **Shuai Lu** · Distinguished Professor, Fudan University

This talk presents a tour through the mathematical foundations of Math4AI, with a focus on novel function spaces induced by neural networks, such as extended Barron spaces, variation spaces, Radon-BV spaces, and spectral Barron spaces. We systematically investigate the relations between these spaces, establish new analytical tools that unify different viewpoints, and showcase their utility in partial differential equations, inverse problems, and regularization theory.

ABOUT THE SPEAKER

Shuai Lu is currently a Distinguished Professor at Fudan University. His research mainly focuses on inverse problems and interpretability in deep learning. He has published more than 70 research papers and currently serves as editorial board members for several internationally renowned journals, including *Inverse Problems*, and as a member of the Executive Committee of Inverse Problems International Association.

MON 12 OCT · 13:05 – 13:55 · ROOM 2201

Numerics-Guided Machine Learning and Its Theory

● **Youngjoon Hong** · Associate Professor, Department of Mathematical Sciences, Seoul National University

Scientific machine learning provides new tools for solving partial differential equations, but reliable performance often requires incorporating mathematical and numerical structures into the learning process. In this talk, I will first discuss numerics-guided scientific machine learning methods for challenging PDEs, which combine neural network-based coefficient learning with classical numerical trial spaces, drawing on finite element, discontinuous Galerkin, spectral element, and Müntz-type element methods. By exploiting problem-adapted approximation spaces and stability mechanisms, these methods are effective for PDEs with fluid flow, multiscale behavior, discontinuities, or singular perturbations. I will then turn to the theory behind such methods, presenting results on the approximation power of deep neural networks, including dimension-independent rates for Barron-type and logarithmic Barron classes. Finally, I will discuss how these theoretical tools extend to modern foundation models, providing error bounds that help explain their accuracy and generalization. Throughout, I will emphasize how approximation theory and numerical analysis offer a unifying lens for understanding learning-based methods.

ABOUT THE SPEAKER

Youngjoon Hong is an Associate Professor in the Department of Mathematical Sciences at Seoul National University, where he leads the Machine Learning and Scientific Computing Lab. He received his Ph.D. in Mathematics, with a minor in Scientific Computing, from Indiana University in 2015. He was a postdoctoral researcher at the University of Illinois Chicago and held faculty positions at San Diego State University, Sungkyunkwan University, and KAIST before joining Seoul National University in 2025. His research lies at the intersection of machine learning and scientific computing, spanning the mathematical theory of machine learning and learning-based methods for applications such as fluid dynamics, electromagnetic wave equations, and weather prediction.

MON 12 OCT · 13:55 – 14:45 · ROOM 2201

Approximation and Generalization of Deep Learning

● **Lei Shi** · Professor, School of Mathematical Sciences, Fudan University

Deep learning has become a core method in artificial intelligence. How can neural networks learn to make accurate predictions from limited samples of complex, high-dimensional data? This talk aims to answer this question from a theoretical perspective. Starting with binary classification, we introduce the efficient approximation capabilities of neural networks and use the oracle inequality to show how approximation results lead to generalization bounds. We then show how this framework extends to other machine learning problems. A main focus is overcoming the curse of dimensionality. Beyond the classical assumption of compositional structure, we explore a new approach: studying the distribution of conditional class probabilities and showing how their concentration can support fast learning. In the final part of this talk, we discuss what is needed to extend the theoretical framework presented earlier to address further questions in machine learning, such as understanding optimization and transfer from pretraining to downstream tasks.

ABOUT THE SPEAKER

Lei Shi is a professor at the School of Mathematical Sciences, Fudan University. His research interests lie in learning theory and approximation theory, with a focus on the approximation, generalization, and optimization theories of machine learning algorithms.

MON 12 OCT · 15:15 – 16:05 · ROOM 2201

Algorithms for Neutral-Atom Quantum Computer

● **Yingzhou Li** · Professor, Fudan University

Neutral-atom quantum computers offer flexible connectivity and native entangling operations, but their performance is strongly affected by hardware constraints. In this talk, I will present two algorithmic approaches that exploit mathematical structure to reduce practical costs.

First, we study the compilation of structured quantum gates on two-dimensional neutral-atom arrays. Algebraic decompositions reduce addressing layers for single-qubit gates, while graph-theoretic methods provide efficient transport scheduling for controlled-Z gates, substantially reducing addressing and atom-transport overhead.

Second, we introduce an adaptive entanglement-assisted Hadamard test for high-precision phase estimation. By iteratively refining the reference phase, the method enables stronger phase amplification, suppresses bias from imperfect eigenstate preparation, and reduces device-restart cost.

These results demonstrate how hardware constraints can be transformed into useful mathematical structures for efficient quantum algorithm design.

ABOUT THE SPEAKER

Yingzhou Li is a Professor at Fudan University. Li obtained his Ph.D. from Stanford University in 2017 and was a Phillip Griffiths Research Assistant Professor at Duke University from 2017 to 2020. His research focuses on designing and analyzing efficient algorithms to address problems from various fields, including quantum computing, differential and integral equations, computational chemistry.

MON 12 OCT · 16:05 – 16:55 · ROOM 2201

High-Order Compact Time-Splitting Methods for Solving the Dirac Equation

● **Jia Yin** · Young Researcher, School of Mathematical Sciences, Fudan University

To efficiently solve the Dirac equation, we propose fourth-order and sixth-order compact time-splitting methods. By incorporating time-ordering techniques, we derive the corresponding methods, verify key commutator properties through lemmas, and extend the approach to the case of time-dependent potentials. In numerical experiments, we validate the Klein paradox and compare the accuracy and efficiency of different methods on one- and two-dimensional examples. The results show that the proposed fourth- and sixth-order compact time-splitting methods exhibit high-order convergence, are computationally efficient, and preserve mass conservation. In the non-relativistic limit, the methods still exhibit superconvergence. This study provides a highly accurate and efficient new approach for the numerical solution of the Dirac equation.

ABOUT THE SPEAKER

Jia Yin is a Young Researcher at the School of Mathematical Sciences, Fudan University. Her main research interests include the design and analysis of numerical methods for highly oscillatory partial differential equations arising in quantum mechanics, as well as data-driven model order reduction methods for the dynamics of non-equilibrium quantum many-body systems.

TUE 13 OCT · 09:00 – 09:50 · ROOM 2201

Algorithms for Constrained Online Learning with Optimal Regret Guarantees

● **Dabeen Lee** · Assistant Professor, Department of Mathematical Sciences, Seoul National University

Constrained online learning is about decision-making under uncertainty, aiming to optimize performance while satisfying constraints on resources, safety, fairness, and other requirements. In this talk, we discuss our recent progress on several classes of constrained online learning problems. In particular, we introduce new algorithms for online optimization, constrained contextual bandits, and constrained reinforcement learning that guarantee near-optimal regret bounds.

ABOUT THE SPEAKER

Dabeen Lee is an Assistant Professor in the Department of Mathematical Sciences at Seoul National University, with affiliate appointments in the university's Interdisciplinary Program in Artificial Intelligence and the Center for AI and Natural Sciences at the Korea Institute for Advanced Study. He received his Ph.D. in Algorithms, Combinatorics, and Optimization from Carnegie Mellon University and his B.S. in Industrial and Management Engineering from POSTECH. Before joining Seoul National University, he was a postdoctoral researcher in the Discrete Mathematics Group at the Institute for Basic Science and an Assistant Professor of Industrial and Systems Engineering at KAIST. His research develops algorithms with provable guarantees for optimization and sequential decision-making, including online learning and bandits, reinforcement learning theory, and stochastic programming.

TUE 13 OCT · 10:20 – 11:10 · ROOM 2201

Emergence of Multivariate Extremes in Multilayer Inhomogeneous Random Graphs

● **Tiandong Wang** · Tenure-Track Associate Professor, Fudan University

In this talk, we introduce a multilayer inhomogeneous random graph model (MIRG). Layers of the MIRG may consist of both single-edge and multi-edge graphs. In the single layer case, it has been shown that the regular variation of the weight distribution underlying the inhomogeneous random graph implies the regular variation of the typical degree distribution. We extend this correspondence to the multilayer case by showing that multivariate regular variation of the weight distribution implies multivariate regular variation of the asymptotic degree distribution. Furthermore, under suitable assumptions, the extremal dependence structure present in the weight distribution will be adopted by the asymptotic degree distribution. By considering the asymptotic degree distribution, a wider class of Chung–Lu and Norros–Reittu graphs may be incorporated into the MIRG layers. Additionally, we prove consistency of the Hill estimator when applied to degrees of the MIRG that have a tail index greater than 1. Simulation results indicate that, in practice, hidden regular variation may be consistently detected from an observed MIRG. Finally, we analyze user interactions on Reddit and observe that they exhibit properties of the MIRG.

ABOUT THE SPEAKER

Tiandong Wang is currently a Tenure-Track Associate Professor at Fudan University. Her research interest is on the interface of applied probability and statistics, especially the modeling of heavy-tailed phenomena in complex networks. Before joining Fudan, she was an Assistant Professor in the Department of Statistics at Texas A&M University.

STUDENT TALKS · OCTOBER 14 – 15

WED 14 OCT · 09:10 – 09:40 · ROOM 1801

Müntz Coefficient Learning for Parametric and Inverse PDE Problems

● **Juhoon Kang** · Seoul National University

Parametric PDEs with nonsmooth solutions pose challenges for numerical analysis and machine learning methods, calling for learning frameworks that incorporate singularity-adapted approximation spaces. For Poisson equations and generalized eigenvalue problems with mixed Dirichlet–Neumann boundary conditions, neural networks learn coefficients in singularity-adapted Müntz spaces, with the Galerkin formulation providing label-free training objectives. For a time-fractional diffusion inverse problem, the Müntz discretization supplies the forward observation operator in an empirical-Bayes formulation, while a neural network amortizes the resulting evidence optimization without requiring parameter labels. We establish convergence rates of the proposed learning framework by combining Müntz–Galerkin discretization estimates with neural-network approximation and generalization bounds. Numerical experiments validate the predicted convergence behavior and demonstrate favorable performance against operator-learning and inverse-learning baselines, illustrating the potential of incorporating problem-specific numerical structure into scientific machine learning.

WED 14 OCT · 09:40 – 10:10 · ROOM 1801

FreeGSNO: Physics-Informed Neural Operator for Free-Boundary Grad-Shafranov Equation

● Hyojun An · Seoul National University

This study introduces a physics-informed neural operator framework for solving the free-boundary Grad-Shafranov equation. First, we decompose the Grad-Shafranov equation into two sub-problems and train two neural operators independently, using physics-informed loss functions without solution labels. Next, we combine their outputs to obtain the full solution of the one-step Grad-Shafranov equation. This model is then integrated into an existing iterative Grad-Shafranov solver, and the solver-in-the-loop surrogate converges to an accurate equilibrium. Validation on the Solov'ev equilibrium shows that the proposed method provides accurate poloidal flux with mean RMSE error of 1.329×10^{-3} . Also, validation on MAST-U tokamak equilibria shows that the proposed method converges to the similar poloidal flux as the conventional solver with similar iteration steps, for both diverted and limited plasma configurations, and reproduces physically relevant equilibrium quantities, with some out-of-distribution cases.

WED 14 OCT · 10:30 – 11:00 · ROOM 1801

A Second-Order Fully Decoupled Scheme for a Non-Isothermal Cahn-Hilliard-Navier-Stokes-Darcy System

● Linyue Fan · Fudan University

We consider a non-isothermal Cahn-Hilliard-Navier-Stokes-Darcy system for two-phase flow in coupled free-flow and porous-medium regions. The model involves the interaction of phase evolution, fluid dynamics, heat transport, thermal buoyancy, and complex interface conditions. The coupling of these physical fields introduces intrinsic numerical challenges. To address these challenges, we develop a second-order linear and fully decoupled scheme using BDF2 time discretization and auxiliary-variable techniques. This formulation avoids solving a fully coupled nonlinear system at each time step while retaining the structure required for stability analysis. We establish the unique solvability and unconditional energy stability of the proposed scheme. Numerical experiments demonstrate the observed second-order convergence and long-time stability of the proposed scheme in representative simulations.

WED 14 OCT · 11:00 – 11:30 · ROOM 1801

A Mixed Residual Method for Biharmonic Equations in Spectral Barron Spaces

● Mengjia Bai · Postdoctoral Researcher, Fudan University

We propose a mixed residual method (MIM) for numerically solving the biharmonic equation with nonhomogeneous clamped boundary conditions. By establishing the well-posedness of the biharmonic equation in spectral Barron spaces, we derive an error bound for MIM that relates shallow neural network approximations to the exact solution and overcomes the curse of dimensionality. This error bound consists of two components: the first corresponds to the approximation error of the neural network, while the second represents the generalization error arising from randomly sampled training data. Several numerical experiments are presented to demonstrate the effectiveness of the proposed method.

WED 14 OCT · 15:10 – 15:40 · ROOM 1801

Terminally Constrained Flow-Based Generative Models from an Optimal Control Perspective

● Ming Li · Fudan University

We address the problem of sampling from terminally constrained distributions with pre-trained flow-based generative models through an optimal control formulation. Theoretically, we characterize the value function through a Hamilton–Jacobi–Bellman equation and show that the optimal control takes the form of a gradient correction to the reference velocity field. We show that the terminal distribution converges to the reference distribution as the control penalty increases, and to a generalized Wasserstein projection onto the constraint manifold as the penalty vanishes. Algorithmically, we introduce Terminal Optimal Control with Flow-based models (TOCFlow), a geometry-aware sampling-time guidance method for pre-trained flows. Solving the control problem in a terminal co-moving frame that tracks reference trajectories yields a closed-form scalar damping factor along the Riemannian gradient, capturing second-order curvature effects without matrix inversions. TOCFlow therefore matches the geometric consistency of Gauss–Newton updates at the computational cost of standard gradient guidance. We evaluate TOCFlow on three high-dimensional scientific tasks spanning inequality, equality, and global statistical constraints, namely geometry-constrained trajectory planning, PDE-constrained generation for Darcy flow, and turbulence snapshot generation under spectral constraints. Across all settings, TOCFlow improves constraint satisfaction over Euclidean guidance and projection baselines while preserving the reference model's generative quality. This is joint work with Professor Weiguo Gao and Professor Qianxiao Li.

WED 14 OCT · 15:45 – 16:15 · ROOM 1801

Diffusion-Based Refinement for Kilometer-Scale Probabilistic Precipitation Nowcasting

● Dohyun Park · Seoul National University

Localized extreme precipitation is a major trigger of urban flash floods, landslides and infrastructure failures, yet producing nowcasts that combine fine spatial detail with probabilistic uncertainty remains challenging. Here we introduce exPreCast-ENS, a conditional residual diffusion framework that transforms the deterministic 4 km radar nowcaster exPreCast into a 1 km probabilistic ensemble while correcting systematic forecast errors. Conditioning on both the exPreCast forecast and preceding radar observations allows the ensemble-mean to correct the deterministic baseline, rather than merely perturb it, in addition to allowing individual members to represent unresolved fine-scale variability. In tests using radar observations over the Korean Peninsula, increasing ensemble size improves both the deterministic skill of the ensemble-mean and probabilistic forecast skill. In two high-impact events in 2023, a 30-member ensemble recovers 38–47% of heavy-rain pixels missed by exPreCast while retaining approximately 95% of its correct detections and alarming on under 1% of the pixels it correctly left clear. The method generates a 1-h forecast in 3.4 s on a single GPU and yields consistent improvements on the French regional MeteoNet radar dataset. On the 2026 monsoon season, held out entirely from training, the ensemble attains a higher critical success index and a lower false-alarm ratio than the Korea Meteorological Administration's operational nowcasting system at every threshold and lead time examined. These results establish a computationally efficient approach to high-resolution probabilistic precipitation nowcasting that can complement deterministic forecasts within operational warning systems.

WED 14 OCT · 16:20 – 16:50 · ROOM 1801

When FEM Meets Machine Learning

● Hyeonseok Seo · Seoul National University

Solving partial differential equations (PDEs) numerically has long been one of the most important research topics. And quite literally, numerous methods have been developed. The finite element method (FEM) is a traditional example, while recently machine learning is highly involved in this field. In this talk, I would like to share a method that combines these two, along with its error estimates. Of course, the PDE of our interest can be nonlinear!

THU 15 OCT · 09:00 – 09:30 · ROOM 1801

Improving Dimension Dependence in Logistic Bandits via Sample Splitting

● Seoungbin Bae · Seoul National University

We study the K -armed logistic bandit problem, where at each round, the agent observes K feature vectors associated with K actions. Existing approaches that achieve a rate-optimal $\tilde{O}(\sqrt{dT})$ regret bound rely heavily on context diversity assumptions, such as strict positivity of the minimum eigenvalue of a context covariance matrix. These assumptions, however, impose strong restrictions on the context process, as they rule out the situation where the context vectors are concentrated in a low-dimensional subspace. In this talk, we introduce SupSplitLog, which, to the best of our knowledge, is the first algorithm for logistic bandits that achieves $\tilde{O}(\sqrt{dT})$ regret without any context diversity assumption. The key idea is to split the collected samples into two disjoint subsets when constructing estimators; one is used to compute an initial-point estimator, while the other is used to apply a Newton-type one-step correction procedure. The splitting rule is carefully designed to balance the accuracy requirements of the initial-point estimator and the one-step correction procedure. Moreover, SupSplitLog strictly improves on the existing algorithms in terms of the dependence on dimension d in the regret upper bound. Furthermore, SupSplitLog can be adapted simply to deduce a regret bound that grows with a data-dependent complexity measure, avoiding a direct dependence on d , which is favorable when the context vectors are concentrated in a low-dimensional subspace.

THU 15 OCT · 09:30 – 10:00 · ROOM 1801

Safe Learning from Audits That Repair: Renewal Policies and Information Limits

● Juhyeok Choi · Seoul National University

An audit can do more than reveal a system's condition: it can also trigger a repair. This dual role couples information acquisition with control, because the timing of an audit determines both the deterioration it prevents and the information it provides. We study this interaction in constrained restless bandits with unknown geometric deterioration rates, feedback available only at audits, and budgets on cumulative exposure to deterioration. I will present a renewal-based learning framework that combines optimistic planning with pessimistic safety checks. With bounded audit intervals and a certified strictly safe reference policy, the framework achieves $O(\sqrt{T \log T})$ regret for fixed instance parameters against a renewal occupancy benchmark, while meeting expected cumulative exposure budgets at a prescribed horizon. A central ingredient is completing adaptively launched renewal cycles, which makes finite-horizon safety accounting valid despite history-dependent policy updates.

I will then discuss a complementary information-theoretic limitation. In a separate setting without exposure constraints, allowing indefinite passivity creates a difficult decision: whether auditing is worthwhile at all. Even for one arm, this uncertainty yields a worst-case regret lower bound of $\Omega(T^{2/3}/(\log T)^{4/3})$ against the unrestricted finite-horizon optimum. The talk will emphasize the intuition behind these results and explain why the allowed audit intervals and the choice of benchmark are essential to understanding the achievable learning guarantees.

THU 15 OCT · 10:30 – 11:00 · ROOM 1801

A Distributional Characterization of Bootstrap Stochastic Gradient Descent in Mean-Field Regimes

● **Baiwen Jiang** · Fudan University

We study the finite-time distributional behavior of bootstrap stochastic gradient descent (BSGD) in a high-dimensional regime where the sample size and parameter dimension grow proportionally. Repeated use of the same data creates dependencies between the iterates and the design matrix, while bootstrap resampling introduces repeated observations. Using a leave-one-out decomposition, we analyze the resulting coordinate trajectories, with particular emphasis on the random coordinate projection structure of stochastic gradient updates. We present finite-time perturbation estimates and discuss their role in a state evolution approximation to the joint distribution of a fixed coordinate across iterations. The analysis separates the effects of the original random design, bootstrap resampling, and online sample selection. We conclude by discussing the limitations of approximations for unscaled iterates and the additional error control needed to characterize fluctuations after centering and rescaling.

THU 15 OCT · 11:00 – 11:30 · ROOM 1801

Online Resource Allocation with Budget- and Margin-Independent Bounds

● **Junehee Lee** · Seoul National University

We study online resource allocation with general cumulative constraints and hard budgets. For i.i.d. requests from an unknown distribution, both regret and violation are bounded with high probability by $\tilde{O}(\sqrt{T})$ for fixed dimensions, free of inverse budget-density and feasibility-margin factors. Regret is measured against the expected dynamic offline optimum. Hard-resource consumption satisfies proportional budgets at every prefix. We assume almost-sure offline feasibility without requiring positive Slater slack. A common void action consumes no hard resources but need not satisfy general constraints. Reciprocal prices exploit bounded price-weighted consumption to avoid inverse-budget factors. With general constraints, scaling the resource penalty preserves this control, while a corrected dual signal cancels the additional resource term and adaptive regularization stabilizes prices. The same algorithm has an adversarial guarantee with a consumption-normalized repair fraction that reduces to the budget-only competitive fraction when general constraints are absent; its additive errors remain free of inverse budget-density and margin factors.

THU 15 OCT · 12:40 – 13:10 · ROOM 1801

In-Context Learning in State Space Models: Capabilities and Mechanisms

● **Jae Suk Kim** · Seoul National University

State space models (SSMs), including Mamba, have emerged as alternatives to Transformers for sequence modeling. In-context learning (ICL), widely recognized as an emergent capability of large language models, enables models to perform tasks using examples provided in the context without updating their parameters. Synthetic ICL tasks offer a controlled setting for comparing this capability across architectures and examining how models use contextual information. This talk reviews recent studies of ICL in SSMs, covering both task-level performance comparisons and analyses of the mechanisms underlying their differences. Particular attention is given to how task characteristics and architectural components influence learning and retrieval from context. Building on these studies, I will share some questions and ideas for further exploration, particularly concerning model depth and the design of hybrid architectures.

THU 15 OCT · 13:10 – 13:40 · ROOM 1801

On Two-Stage Householder Orthogonalization

● Zhuang'ao He · Fudan University

Two-stage orthogonalization is essential in numerical algorithms such as Krylov subspace methods. For this task we need to orthogonalize a matrix A against another matrix V with orthonormal columns. A common approach is to employ the block Gram–Schmidt algorithm. However, its stability largely depends on the condition number of $[V, A]$. While performing a Householder orthogonalization on $[V, A]$ is stable, it does not utilize the knowledge that V has orthonormal columns. To address these issues, we propose a two-stage Householder orthogonalization algorithm based on the generalized Householder transformation. Instead of explicitly orthogonalizing the entire V , our algorithm only needs to orthogonalize a square submatrix of V . Theoretical analysis and numerical experiments demonstrate the stability and efficiency of our method.

THU 15 OCT · 13:50 – 14:20 · ROOM 1801

Elastic-Net Regularization for Bilevel Mean-Field Langevin Dynamics

● Seungcheol Shin · Seoul National University

Bilevel mean-field Langevin dynamics learns feature representations by optimizing coefficients at the inner level and evolving a distribution over feature parameters at the outer level. In this talk, we introduce elastic-net regularization to promote sparsity in the particle coefficients. Under suitable assumptions, we characterize the inner optimizer through soft thresholding and derive an explicit first variation of the outer objective, yielding the corresponding noisy particle gradient updates. A numerical experiment illustrates a reduction in the fraction of active particles while maintaining test accuracy comparable to the quadratic baseline.

THU 15 OCT · 14:20 – 14:50 · ROOM 1801

A Mixed Precision Algorithm for the Matrix Square Root

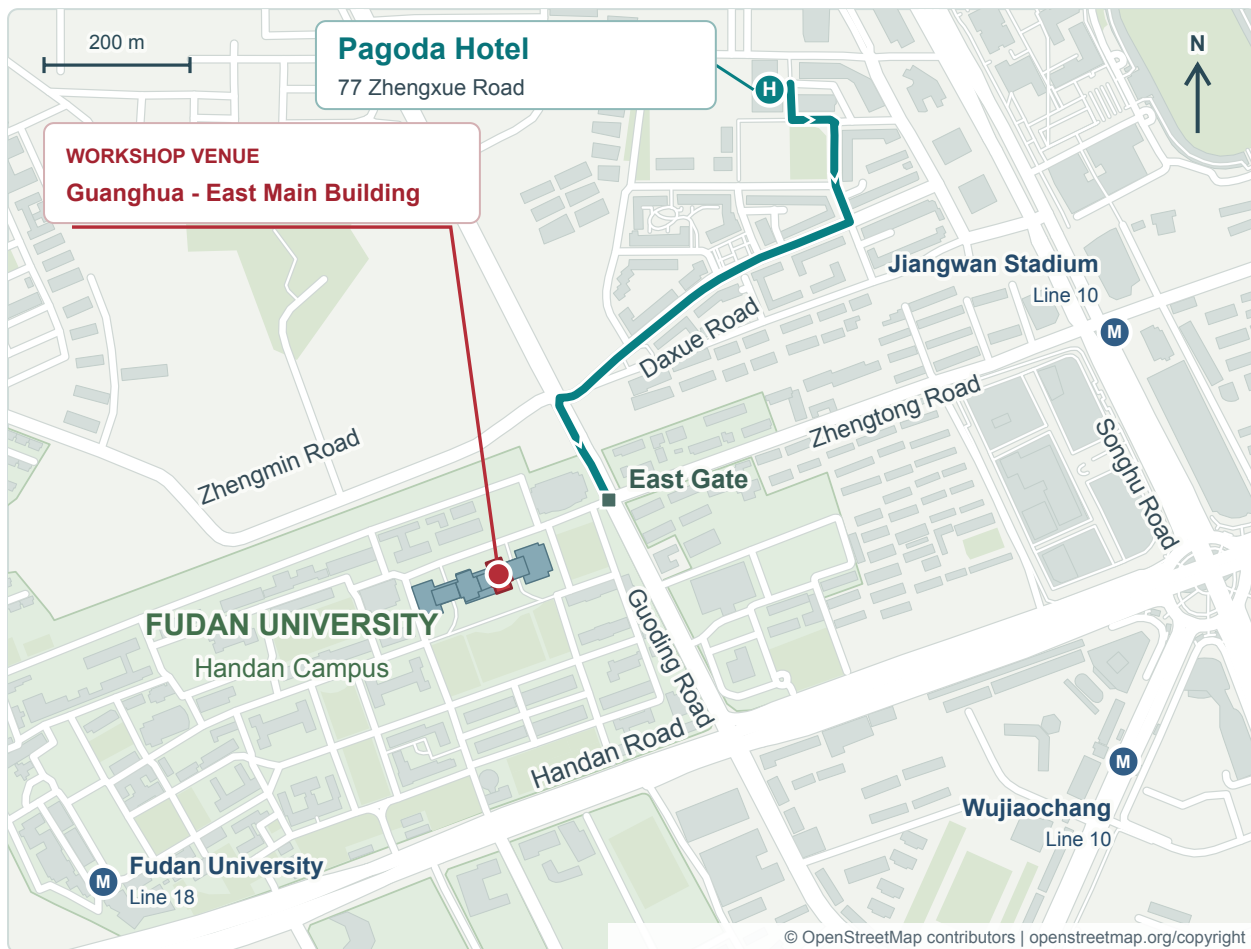
● Bowen Gao · Fudan University

Mixed precision algorithms can significantly enhance the performance of linear algebra solvers by leveraging increasingly powerful low precision hardware while recovering working precision accuracy through, for example, iterative refinement. In this talk, we propose a novel mixed precision algorithm for computing matrix square roots. Our algorithm combines a Schur decomposition approach in low precision with iterative refinement performed through an approximate Newton method. We perform a detailed convergence analysis of the approximate Newton method. For the special case of symmetric positive definite matrices, this analysis implies that one can recover full working precision accuracy under mild conditions. Numerical experiments on x86-64 architectures indicate that our algorithm frequently reduces execution time compared with a fixed working-precision Schur algorithm.

Campus and Surroundings

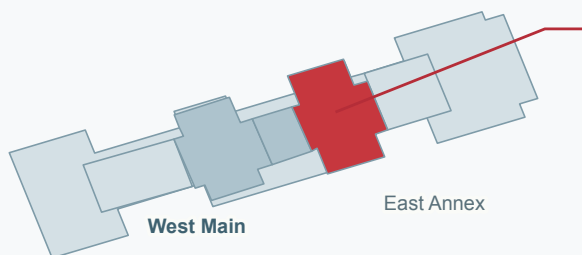
Pagoda Hotel to East Gate · Handan Campus, Fudan University

PAGODA HOTEL TO HANDAN CAMPUS



Walking route to East Gate via Daxue Road and Guoding Road

GUANGHUA TOWERS - BUILDING DETAIL



East Main Building

Room 2201 - October 12 and 13

Room 1801 - October 14 and 15

Use the tall eastern main tower.

The lower East Annex is a separate wing.

Practical Information

Workshop Venue

School of Mathematical Sciences, Fudan University

East Main Building, Guanghua Towers — Room 2201 (October 12–13) and Room 1801 (October 14–15)
Handan Campus, 220 Handan Road, Yangpu District, Shanghai

Lecture-room availability: October 12, 08:00–17:00; October 13, 08:00–12:00; October 14, 08:00–12:00 and from 15:00; October 15, 08:00–15:00. No workshop activities are scheduled in these rooms outside those hours.

Accommodation

Pagoda Hotel Shanghai Wujiaochang

No. 77 Zhengxue Road, Yangpu District, Shanghai
Hotel telephone: +86-21-60139666

The hotel is near **Jiangwan Stadium Station, Metro Line 10**. Fudan's visitor guide recommends **Exit 9** for the hotel. Follow a live walking map to the entrance. Standard hotel check-in is from 14:00 and checkout is by 12:00; departing delegates must check out before their airport transfer.

Airport Transfers

Airport pickup and return transfers will be arranged for the SNU delegation. Jingkai Kou will be responsible for airport pickup. Confirmed flights use Shanghai Pudong International Airport (PVG), Terminal 1, and Incheon International Airport (ICN), Terminal 2.

October 11 • 11 participants (2 faculty and 9 students): KE887, ICN 11:10 → PVG 12:25.

October 11 • Professor Dabeen Lee: KE891, ICN 18:55 → PVG 20:10.

October 14 • 3 faculty members: KE882, PVG 11:10 → ICN 14:20.

October 16 • 9 students: KE882, PVG 11:10 → ICN 14:20.

Flight times are local to each airport: Shanghai UTC+8; Incheon UTC+9. Please complete hotel checkout before your return transfer.

Campus Entry

Arrange visitor registration through the Fudan coordinators before arrival and carry the passport used for registration. Registration and check-in for the workshop are on **October 12, 08:30–09:00**, before the 09:00 opening.

Wireless Internet

Network (SSID): eduroam

Username: jointfdu@guest

Password: Math2026

Open the available Wi-Fi networks, select **eduroam**, enter the username and password above, and click or tap **Connect**. A successful connection is shown as **eduroam — Connected**.

[Setup guide for Android, macOS and Windows 10.](#)

Meals

- **Lunch:** boxed lunches from Zhengda Restaurant on October 12–15.
- **Tea breaks and discussion:** scheduled each session day.
- **Workshop dinner:** October 12, 18:00, Zhengda Restaurant, Fudan University.
- **Other dinners:** October 11, 13, 14 and 15. Off-campus restaurants.
- **Breakfast:** served at the hotel, **07:00–10:00**.

Please send dietary restrictions and allergies to the coordinators.

Campus Tour

Wednesday, October 14, 14:00–15:00. The Handan Campus tour finishes at Guanghua Towers, allowing ten minutes to return and prepare before the 15:10 talks.

Useful Apps and Nearby Dining

- **Alipay:** Link eligible overseas bank cards for supported mobile payments.
- **WeChat Pay:** Link eligible overseas bank cards for supported mobile payments.
- **Metro Daduhui:** Shanghai Metro's QR-code app.
- **Amap:** Maps and navigation.
- **Baidu Maps:** Maps and navigation.
- **DiDi:** Ride-hailing.

Metro tickets can also be purchased at station service centres. Wujiaochang has shopping malls and restaurants; Guoquan Road also offers local dining.

Contacts

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Emergency: Police 110 · Ambulance 120 · Fire 119

Fudan University main line: +86-21-65642222



JOINT FUDAN-SEOUL NATIONAL WORKSHOP 2026

**School of Mathematical Sciences
Fudan University
Department of Mathematical Sciences
Seoul National University**

October 11-16, 2026 · Shanghai, China
