2025

东亚数学博士生论坛

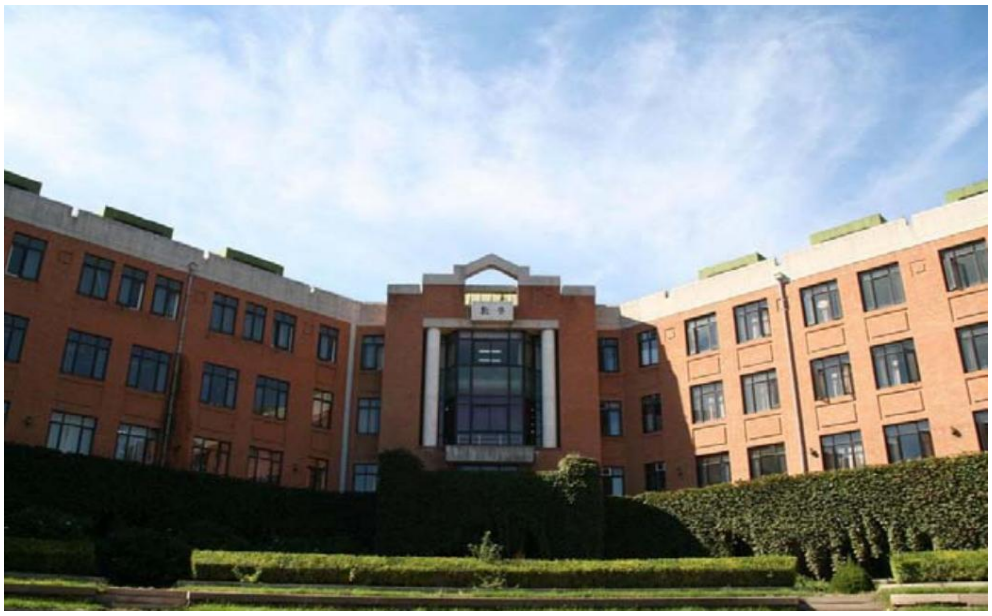
East Asia Core Doctoral Forum On Mathematics 2025

主办单位：清华大学数学科学系

中国 · 北京

2025.1.8-1.10

Forum Venue(论坛地点):



Department of Mathematical Sciences, Sciences Building(理科楼数学系)

Place of accommodation and banquet(住宿用餐地点):

Jiasuo Canteen (甲所餐厅)

Schedule: Day 1

January 8th(Wednesday) Location： Cheng Yu-tung Lecture Hall		
Time	Reporter	Chair
9:00-9:20	Conference check-in	
9:20-9:30	Opening Ceremony	Jian Zhou (Tsinghua University)
9:30-10:20	Prof. Kai Du (Fudan University)	Prof. Jinxin Xue (Tsinghua University)
10:20-10:40	Tea Break	
10:40-11:30	Prof. Jinxin Xue (Tsinghua University)	Prof. Kai Du (Fudan University)
Lunch and Break		
13:30-14:00	Linghu Fan (Tokyo University)	Tianqing Zhu (Tsinghua University)
14:05-14:35	Jiahao Liang (Fudan University)	Linghu Fan (The University of Tokyo)
14:40-15:10	Tianqing Zhu (Tsinghua University)	Jiahao Liang (Fudan University)
15:15-15:35	Tea Break	
15:35-16:05	Shuxun Shi (Fudan University)	Yunfan Chang (Tsinghua University)
16:10-16:40	Jingxuan Sun (Tsinghua University)	Shuxun Shi (Fudan University)
16:45-17:15	Feinuo Zhang (Fudan University)	Jingxuan Sun (Tsinghua University)
17:20-17:50	Yunfan Chang (Tsinghua University)	Feinuo Zhang (Fudan University)
Dinner		

Schedule: Day 2

January 9th(Thursday) Location： Science Building A404		
Time	Reporter	Chair
9:20-9:50	Yihua Liu (Tsinghua University)	Nian Wang (Tsinghua University)
9:55-10:25	Xinyi Du (Fudan University)	Yihua Liu (Tsinghua University)
10:30-10:50	Tea Break	
10:50-11:20	Tomohiro Karube (The University of Tokyo)	Xinyi Du (Fudan University)
11:25-11:55	Nian Wang (Tsinghua University)	Tomohiro Karube (The University of Tokyo)
Lunch and Committee meeting(Online)		
13:30-14:00	Huali Zhao (Tsinghua University)	Takaaki Shiotani (The University of Tokyo)
14:05-14:35	Puyang Yu (Fudan University)	Huali Zhao (Tsinghua University)
14:40-15:10	Takaaki Shiotani (The University of Tokyo)	Puyang Yu (Fudan University)
15:15-15:45	**Group photo and Tea Break**	
15:45-16:15	Shuanghe Fan (Tsinghua University)	Pingxin Gu (Tsinghua University)
16:20-16:50	Mei Xu (Fudan University)	Shuanghe Fan (Tsinghua University)
16:55-17:25	Pingxin Gu (Tsinghua University)	Mei Xu (Fudan University)
Banquet(Jia Suo Canteen)		

Schedule: Day 3

January 10th(Friday) Location： Cheng Yu-tung Lecture Hall		
Time	Reporter	Chair
9:30-10:20	Prof. Yasuyuki Kawahigashi (The University of Tokyo)	Prof. Peng Shan (Tsinghua University)
10:20-10:40	Tea Break	
10:40-11:30	Prof. Peng Shan (Tsinghua University)	Prof. Yasuyuki Kawahigashi (The University of Tokyo)
Lunch and Break		
13:30-14:00	Xiangdi Fu (Fudan University)	Hongyu Yu (Tsinghua University)
14:05-14:35	Yu Feng (Tsinghua University)	Xiangdi Fu (Fudan University)
14:40-15:10	Hongyu Yu (Tsinghua University)	Yu Feng (Tsinghua University)
15:15-15:35	Tea Break	
15:35-16:05	Qianqian Liu (Fudan University)	Aobo Chen (Tsinghua University)
16:10-16:40	Jiaxu Ma (Tsinghua University)	Qianqian Liu (Fudan University)
16:45-17:15	Jiaxuan Zhang (Fudan University)	Jiaxu Ma (Tsinghua University)
17:20-17:50	Aobo Chen (Tsinghua University)	Jiaxuan Zhang (Fudan University)
	Closing Ceremony	Prof. Yasuyuki Kawahigashi (The University of Tokyo) Prof. Kai Du (Fudan University)
Dinner		

Talk Information

January 8th

- Speaker: Prof. Kai Du (Fudan University)
- Title: A structure-preserving collisional particle method for the Landau kinetic equation
- Abstract: We present a structure-preserving stochastic particle method for the Landau equation, where pairwise grazing collisions are modeled as diffusion processes. The method conserves mass, momentum, energy, and entropy dissipation, with a computational complexity of O(N) per time step. Under regularity assumptions, the convergence of the system to Landau-type equations is established using relative entropy analysis, supported by gradient estimates of logarithmic densities. By utilizing spherical Brownian motion, we develop an exact temporal discretization scheme that aligns the discrete-time particle distributions with the continuous-time system without introducing extra numerical errors. Numerical experiments confirm the method's accuracy, stability, and energy conservation. This talk is based on joint works with Lei Li, Yongle Xie, and Yang Yu.

- Speaker: Prof. Jinxin Xue (Tsinghua University)
- Title: Dynamics of the mean curvature flows
- Abstract: Mean curvature flow is to evolve an embedded hypersurface in Euclidean space according to the vector field given by the mean curvature at each point. We show how to extract geometric information from the asymptotics of a mean curvature flow approaching a singularity. We show that when the flow approaches a cylinder in a nondegenerate manner, i.e. with the slowest asymptotic rate, the flow can be extended through the singularity and the topology change can be described explicitly. When the flow approaches a cylinder in a degenerate manner, i.e. with exponential asymptotic rate, the singularity set can be proved to be at least C^2 modulo a lower dimensional set. This talk is based on a series of works jointly with Ao Sun and Zhihan Wang.

- Speaker: Linghu Fan (Tokyo University)
- Title: McKay correspondence in positive characteristic
- Abstract: McKay correspondence, as a branch of algebraic geometry, studies relations between properties of groups and the associated quotient singularities. In this talk, after a short introduction of McKay correspondence over complex numbers, we will explain its difficulty in positive characteristic by several counterexamples. As the main result, a recent work on Euler numbers of crepant resolutions of specific modular quotient singularities in positive characteristic will be introduced.

- Speaker: Jiahao Liang (Fudan University)
- Title: Multidimensional BSDEs with rough drifts
- Abstract: In this talk, we are concerned with a multidimensional backward stochastic differential equation with an additional rough drift (rough BSDE). With a flow transformation, we give the existence and uniqueness of the adapted solution, either when the terminal value and the geometric rough path are sufficiently small, or when each component of the rough drift only depends on the corresponding component of the first unknown variable. In particular, when the rough drift is linear but allowed to be random and time-varying, we first introduce the p-rough stochastic integration for $p \in [2, 3)$, and then give via a fixed-point argument a general existence and uniqueness result for the multidimensional rough BSDE with a general square integrable terminal value. Furthermore, we connect it to a system of rough partial differential equations. This talk is based on a joint work (Tran. AMS 2025) with Prof. Shanjian Tang.

- Speaker: Tianqing Zhu (Tsinghua University)
- Title: Baxter Q-operators from quantum K-theory of quiver varieties
- Abstract: In the theory of quantum integrable models for the quantum affine algebras. There are two realisations of the quantum integrable models which are both important, one is the Bethe-Ansatz method and another is the Baxter Q-operator methods. There are many conjectures and relations between the two realisations in the theory, and one of the most important application is to distinguish the eigenvalues of the quantum integrable models. In this talk we will show how to realise the Baxter Q-operators in terms of the class in the quantum K-theory of quiver varieties, which can be thought of as a geometric realisation of the quantum affine algebras. As an applications, we will give a geometric proof for the Baxter's relation between the Baxter Q-operators and transfer matrices. This is a work in progress.

- Speaker: Shuxun Shi (Fudan University)
- Title: A BDF-spectral method for a class of nonlocal partial differential equations with long time delay
- Abstract: A numerical method for a class of nonlocal partial differential equations with long time delay is designed. The system involves a variable on $\Omega \times \mathbb{R} \times \mathbb{R}^+$, in which case for $\Omega \subset \mathbb{R}^d$, a $(d+2)$-dimensional problem is to be solved numerically, which is challenging, especially for $d = 2$ or $d = 3$. An effective numerical method is proposed: BDF schemes and Fourier spectral method are applied for time and space discretization respectively, and the long time delay term is treated by Laguerre spectral method. The unique solvability of the numerical schemes is proved, and the energy upper bound of the numerical solution for the long time is given by energy estimation. By applying the generalized Laguerre orthogonal projection, the error estimate is obtained within finite final time for the fully discretization. Numerical experiments are applied to verify the energy bound and convergence order. Also, examples are given to show how the solutions evolve and approach the global attractor.

- Speaker: Jingxuan Sun (Tsinghua University)
- Title: A sharp Moser-Trudinger type inequality involving L^p norm in $\mathbb{R}^n$ with degenerate potential
- Abstract: In this paper, we establish a Moser-Trudinger type inequality with a special degenerate potential V. Specifically, we demonstrate that for any potentials $V(x)$ satisfying the conditions (V_1) and (V_2), the following inequality

$$\mathcal{MT}(V,\alpha,p) := \sup_{u\in E, \|u\|\le 1} \int_{\mathbb{R}^n} \Phi\left(\alpha_n \left(1+\alpha\|u\|_p^n\right)^{\frac{1}{n-1}} u^{\frac{n}{n-1}}\right) dx < \infty$$

holds if $\alpha < \lambda_1(V)$; where E is the usual weighted Sobolev space associated to the potential V, the norm $\|u\|^n := \int_{\mathbb{R}^n} |\nabla u|^n + V(x)|u|^n dx$, and $\lambda_1(V)$ is the first Dirichlet eigenvalue of the corresponding operator $-\Delta + V$. The potential conditions are as follows.
$(V_1)\, 0 \le m = \inf_{x\in\mathbb{R}^n} V(x) < \sup_{x\in\mathbb{R}^n} V(x) = \lim_{|x|\to\infty} V(x) = M \le \infty$.
(V_2) V is radially symmetric, non-decreasing.

Besides, we also prove that for any potentials $V(x)$ satisfying the condition (V_1) merely and for $p = n$, the previous inequality is still valid. In addition, this inequality is sharp in the sense that if $p > n$ and $\alpha \ge \lambda_1(V)$, there holds $\mathcal{MT}(V,\alpha,p) = \infty$. Meanwhile, if $\alpha > \lambda_1(V)$, then $\mathcal{MT}(V,\alpha,n) = \infty$. Furthermore, via a subtle blow-up analysis, we also prove the existence of an extremal function for the inequality above when α is sufficiently small.

- Speaker: Feinuo Zhang (Fudan University)
- Title: The geometry of moduli spaces of one-dimensional sheaves on surfaces
- Abstract: Moduli spaces of one-dimensional sheaves on surfaces have formed a rich subject to explore. Many geometric properties of them are unknown, in contrast to moduli spaces of torsion free sheaves. On the other hand, the support morphism endows the cohomology of the moduli space of one-dimensional sheaves a so called perverse filtration, which is expected to refine enumerative invariants for local Calabi-Yau threefolds. I will report recent progress on the cohomological stabilization and the "P=C" conjecture (a compact and Fano analogue of the famous "P=W" conjecture) for the moduli of one-dimensional sheaves on del Pezzo surfaces, as well as partial results on the asymptotic behavior of the moduli on arbitrary surfaces. This talk is based on joint work with Weite Pi, Junliang Shen, and Fei Si.

- Speaker: Yunfan Chang (Tsinghua University)
- Title: A robust numerical method based on a deep-learning operator for solving the 2D acoustic wave equation
- Abstract: The numerical solution of a wave equation plays a crucial role in computational geophysics problems, which forms the foundation of inverse problems and directly impacts the high-precision imaging results of earth models. However, common numerical methods often lead to significant computational and storage requirements. Due to the heavy reliance on forward-modeling methods in inversion techniques, particularly full-waveform inversion, enhancing the computational efficiency and reducing the storage demands of traditional numerical methods have become key issues in computational geophysics. We develop the deep Lax-Wendroff correction (DeepLWC) method, a deep-learning-based numerical format for solving 2D hyperbolic wave equations. DeepLWC combines the advantages of traditional numerical schemes with a deep neural network. We provide a detailed comparison of this method with the representative traditional Lax-Wendroff correction method. Our numerical results indicate that the DeepLWC significantly improves the calculation speed (by more than 10 times) and reduces the space needed for storage by more than 10,000 times compared with traditional numerical methods. In contrast to the more popular physics-informed neural network method, DeepLWC maximizes the advantages of traditional mathematical methods in solving partial differential equations and uses a new sampling approach, leading to improved accuracy and faster computations. It is particularly worth pointing out that DeepLWC introduces a novel research paradigm for numerical equation solving, which can be combined with various traditional numerical methods, enabling acceleration and reduction in the storage requirements of conventional approaches.

January 9th

- Speaker: Yihua Liu (Tsinghua University)
- Title: Irregular representation of Kac-Moody algebra and irregular KZ equation
- Abstract: We consider Liouville conformal blocks with degenerate field insertions and one operator in an irregular representation of the Virasoro algebra. Such blocks satisfy modified BPZ equations and admit integral representations with integration over non-compact Lefschetz cycles.

We show how they satisfy an irregular version of KZ equations from which the modified BPZ equations follow. Finally, we argue that our irregular KZ equations follow from irregular Kac-Moody representations. I will show how such irregular representations correspond to irregular Gaiotto-Teschner representations of the Virasoro algebra.

- Speaker: Xinyi Du (Fudan University)
- Title: A fully decoupled, positivity-preserving, unconditionally energy stable numerical scheme of the Abels–Garcke–Grün model for incompressible two-phase flows with unmatched densities
- Abstract: We propose and analyze a fully decoupled finite difference scheme for the Abels–Garcke–Grün model for a mixture of two viscous incompressible fluids with unmatched densities and viscosities. The coupled system consists of the Navier–Stokes equations for the volume-averaged fluid velocity and a convective Cahn–Hilliard equation with Flory–Huggins potential for the phase-field variable. The unique solvability and unconditional energy stability of the numerical scheme are established. In particular, we verify the positivity-preserving property, which means that the discrete solution of the phase-field always stays in $(-1, 1)$ at a point-wise level. This crucial fact ensures the feasibility of our scheme for the Cahn–Hilliard equation with a singular (logarithmic) potential. Furthermore, we perform a detailed optimal rate convergence analysis and derive error estimates that are first-order accurate in time and second-order accurate in space. Numerical results are presented to validate the convergence rate and energy stability.

- Speaker: Tomohiro Karube (The University of Tokyo)
- Title: Derived categories and stability conditions
- Abstract: I will discuss derived categories and related topics from the perspective of algebraic geometry. The derived categories of the coherent sheaves are viewed as invariants of algebraic varieties. In this talk, I will particularly focus on equivalences of derived categories. Spherical objects, as defined by Seidel and Thomas, are known to induce autoequivalences; they are considered to correspond to Dehn twists under the mirror symmetry. Finally, I will introduce Bridgeland stability conditions and demonstrate that the spaces of stability conditions provide a geometric approach to understanding autoequivalence groups.

- Speaker: Nian Wang (Tsinghua University)
- Title: A 3D waveform-based location method and a 3D anelastic full waveform inversion method
- Abstract: Accurate and robust source location is fundamental in seismology. The location accuracy is limited by several factors, including velocity models, which are often poorly known. In contrast, surface topography, the largest velocity contrast in the Earth, is often precisely mapped at the seismic wavelength (>100 m). We propose a waveform based location method using waves scattered by surface topography, which is a grid search method combined with the 3D strain Green's tensor database. We validate this method with observed seismic data from the 1993 Non-Proliferation Experiment, a chemical explosion with a precisely known location in a region with moderate topography at the Nevada Test Site. Results show that the incorporation of P coda significantly improves solution accuracy and reduces solution uncertainty.

In addition, we will talk about the 3D anelastic full waveform modelling and inversion. Accurate and efficient forward modelling methods are important for simulation of seismic wave propagation in 3D realistic Earth models and crucial for high-resolution full waveform inversion. In the presence of attenuation, wavefield simulation could be inaccurate or unstable over time if not well treated, indicating the importance of the implementation of a strong stability preserving time discretization scheme. We choose the optimal strong stability preserving Runge-Kutta (SSPRK) method for the temporal discretization and apply the fourth-order MacCormack scheme for the spatial discretization. Theoretical and numerical analyses show that, compared with the traditional fourth-order Runge-Kutta method, the SSPRK has a larger stability condition number and can better suppress numerical dispersion. As a result, our method can largely improve the computational efficiency in numerical modelling. Finally, in the frame of scattering-integral method, we discuss a new method for computing the 3D waveform sensitivity kernels that account for full physical-dispersion and dissipation attenuation, and we verify the accuracy of the computed 3D sensitivity kernels through comparing the waveform measurements with predictions from the kernels by choosing the Northwestern United States region as a realistic example.

- Speaker: Huali Zhao (Tsinghua University)
- Title: Debiased high-dimensional regression calibration for errors-in-variables log-contrast models
- Abstract: Motivated by the challenges in analyzing gut microbiome and metagenomic data, this work aims to tackle the issue of measurement errors in high-dimensional regression models that involve compositional covariates. This paper marks a pioneering effort in conducting statistical inference on high-dimensional compositional data affected by mismeasured or contaminated data. We introduce a calibration approach tailored for the linear log-contrast model. Under relatively lenient conditions regarding the sparsity level of the parameter, we have established the asymptotic normality of the estimator for inference. Numerical experiments and an application in microbiome study have demonstrated the efficacy of our high-dimensional calibration strategy in minimizing bias and achieving the expected coverage rates for confidence intervals. Moreover, the potential application of our proposed methodology extends well beyond compositional data, suggesting its adaptability for a wide range of research contexts.

- Speaker: Puyang Yu (Fudan University)
- Title: Effective non-vanishing for weighted complete intersections
- Abstract: In this talk, I will introduce the Kawamata's effective non-vanishing conjecture for weighted complete intersections in weighted projective spaces and the work of Pizzato, Sano and Tasin for this conjecture. I will also enlighten some interesting connections between the Kawamata's conjecture and the Frobenius coin problem since this conjecture would give new bounds for the Frobenius number. Finally, I will introduce some recent results. This is a joint work with Prof. Chen Jiang.

- Speaker: Takaaki Shiotani (The University of Tokyo)
- Title: Statistical Inference for Point Process Models and Noisy Bivariate Neyman-Scott Point Processes
- Abstract: In this talk, we will discuss statistical inference problems for point process models. Point process models provide a probabilistic framework for analyzing the occurrence times of random events, such as financial transactions or earthquakes. We will begin by formulating the problem of estimating model parameters from observed data. Then, we will introduce our proposed noisy bivariate Neyman-Scott process and discuss its application to the analysis of financial transaction data. This is a joint work with Prof. Nakahiro Yoshida (The University of Tokyo).

- Speaker: Shuanghe Fan (Tsinghua University)
- Title: Higher Order Hessian Matrix Theory and Its Applications in Calabi-Yau Manifolds
- Abstract: One of the fundamental problems in algebraic geometry and singularity theory is to investigate whether two given smooth projective manifolds X and Y are projectively equivalent. In hypersurface case, when their defining equations have degree 2, this can be resolved using quadratic form theory and classical Hessian matrix theory. For cases with degrees greater than 2, in this talk, we shall develop the novel "higher order Hessian matrix theory" as a generalization of classical Hessian matrix theory. Many new invariants for projective manifolds (especially Calabi-Yau manifolds) are obtained beyond the classical theory. With this sequence of invariants, we solve a several decades old problem about the classification of complex structures of K_3 surfaces in $\mathbb{CP}^3$.

- Speaker: Mei Xu (Fudan University)
- Title: Gaussian limit for Pfaffian point processes
- Abstract: In this talk, we introduce the central limit theorem for linear statistics over Pfaffian point processes. As an application, we obtain the Gaussian limit for the number of points over Sine_4-process under a scaling. This is a joint work with Prof. Kai Wang.

- Speaker: Pingxin Gu (Tsinghua University)
- Title: Weinstock inequality in hyperbolic space
- Abstract: In this talk, we establish the Weinstock inequality for the first non-zero Steklov eigenvalue on star-shaped mean convex domains in hyperbolic space Hn for n 4. In particular, when the domain is convex, our result gives an affirmative answer to Open Question 4.27 in [7] for the hyperbolic space Hn when n 4.

January 10th

- Speaker: Prof. Yasuyuki Kawahigashi (The University of Tokyo)
- Title: Topological physics and operator algebras
- Abstract: Two-dimensional topological order in condensed matter physics has much attention recently. A quasi-particle called an anyon is expected to play a major role in topological quantum computation if it is realized experimentally. I will present a mathematical approach based on theory of operator algebras to this area of such topics.

- Speaker: Prof. Peng Shan (Tsinghua University)
- Title: Skein algebras and quantized Coulomb branches
- Abstract: We will explain how to attach a quantized Coulomb branch in the sense of Braverman-Finkelberg-Nakajima to a compact oriented surface of genus at most one, and compare it to the Kauffman bracket Skein algebra in some special cases. This is based on joint work with Dylan Allegretti.

- Speaker: Xiangdi Fu (Fudan University)
- Title: Extension of Norm One Projections
- Abstract: Through the establishment of several extension theorems, we provide explicit expressions for norm one projections and 1-complemented subspaces in the Hardy space $H^p(\mathbb{T})$ for $1 \leq p < \infty$, $p \neq 2$. Our characterization leads to two significant corollaries: first, all 1-complemented subspaces of $H^p(\mathbb{T})$ with dimension greater than one are isometric to $H^p(\mathbb{T})$; second, all norm one projections on $H^p(\mathbb{T})$ are restrictions of norm one projections on $L^p(\mathbb{T})$ that leave $H^p(\mathbb{T})$ invariant. The second corollary answers an open problem posed by P. Wojtaszczyk in 2003.

- Speaker: Yu Feng (Tsinghua University)
- Title: Logarithmic correlation functions in 2D critical percolation
- Abstract: It is believed that the large-scale geometric properties of 2D critical percolation are described by a logarithmic conformal field theory (CFT), but it has been challenging to exhibit concrete examples of logarithmic singularities and to find an explanation and a physical interpretation, in terms of lattice observables, for their appearance. We show that certain percolation correlation functions receive independent contributions from a large number of similar connectivity events happening at different scales. Combined with scale invariance, this leads to logarithmic divergences. Our results provide support for the validity of a CFT description of critical percolation and a step in the direction of a mathematically rigorous formulation of a logarithmic CFT of 2D critical percolation. This talk is based on joint works with Federico Camia.

- Speaker: Hongyu Yu (Tsinghua University)
- Title: Alignment-Free Sequence Comparison and Its Biological Applications
- Abstract: With the advancement of sequencing technologies, the number of sequenced biological sequences has grown rapidly. In this context, traditional alignment-based sequence comparison face increasing limitations in efficiency. Alignment-free methods have emerged as a solution. This report focuses on two alignment-free methods: Chaos Game Representation and Natural Vector. We will explore their excellent theoretical properties and demonstrate their impressive results in various biological applications, especially in the applications that integrate with deep learning algorithms. We will elaborate on how these models achieve more efficient and accurate biological data analysis.

- Speaker: Qianqian Liu (Fudan University)
- Title: A new flow dynamic approach for Wasserstein gradient flows
- Abstract: We develop a new regularized flow dynamic approach to construct efficient numerical schemes for Wasserstein gradient flows in Lagrangian coordinates. Instead of approximating the Wasserstein distance which needs to solve constrained minimization problems, we reformulate the problem using the Benamou-Brenier's flow dynamic approach, leading to algorithms which only need to solve unconstrained minimization problem in L^2 distance. Our schemes automatically inherit some essential properties of Wasserstein gradient systems such as positivity-preserving, mass conservative and energy dissipation. We present ample numerical simulations of Porous-Medium equations, Keller-Segel equations and Aggregation equations to validate the accuracy and stability of the proposed schemes. Compared to numerical schemes in Eulerian coordinates, our new schemes can capture sharp interfaces for various Wasserstein gradient flows using relatively smaller number of unknowns.

- Speaker: Jiaxu Ma (Tsinghua University)
- Title: Anisotropic capillary hypersurfaces in a wedge
- Abstract: We investigate anisotropic capillary hypersurfaces within a wedge in Euclidean space. In this study, we generalize the Minkowski norm F, traditionally employed to define the anisotropic surface energy, to a gauge on the unit sphere S^n. This generalization helps to illuminate a significant relationship between capillary hypersurfaces and hypersurfaces with free boundary. Our main results include new Minkowski formulae and a Heintze-Karcher type inequality. As an application, we prove an Alexandrov-type theorem, thereby extending the known results to the anisotropic setting.

- Speaker: Jiaxuan Zhang (Fudan University)
- Title: Extended Neural Delay Differential Equations: System Reconstruction and Image Classification
- Abstract: Continuous deep neural networks—Neural Ordinary Differential Equations (NODEs)—have garnered significant attention. To address the limitations of NODEs, Neural Delayed Differential Equations (NDDEs) have been introduced as continuous deep neural networks that incorporate delays, thereby enhancing the capacity for nonlinear representations. Building upon those, we propose an extended version called Extended Neural Delayed Differential Equations (ENDDEs). ENDDEs not only take into account the existing parameters of the neural network but also include the delays, termination times, and initial states of DDEs as supplementary training parameters. ENDDEs employ the adjoint sensitivity method to compute gradients of the loss function, and we analyze the computational complexity of the framework. Furthermore, we conduct a comprehensive series of experiments, including model-based and model-free system reconstructions without prior knowledge of the actual delays, as well as performance on image datasets with fixed or trained termination times. Our findings clearly indicate that ENDDEs possess enhanced representational capabilities and significantly improve neural network performance.

- Speaker: Aobo Chen (Tsinghua University)
- Title: Stability of heat kernel bounds under pointed Gromov-Hausdorff convergence
- Abstract: We construct a conservative and strongly local regular symmetric Dirichlet form on the pointed Gromov-Hausdorff limit space and demonstrate the stability of heat kernel estimates under this convergence. Furthermore, we establish the Mosco convergence of the associated energy forms along a subsequence.

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