2020 Spring Young Mathematician Forum

Organized by the School of Mathematical Sciences, Shanghai Jiao Tong University

Conference Program

Shanghai Jiao Tong University, Shanghai, China

April 18-19, 2020

Table of Contents

Organizing Committee

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Schedule by Day

April 18

ZOOM Conference ID: 972 958 36579   Password: 764698

Chair: Li, Congming	
08:30-09:20	**Talk A1** **Yang, Zhiguo** *A roadmap for devising energy stable schemes for general dissipative system*
09:30-10:20	**Talk A2** **Wang, Fei** *The inviscid limit for the Navier-Stokes equations and the boundary Layers*
10:30-11:20	**Talk A3** **Zhang, Ruobing** *The Ricci curvature in metric geometry and complex geometry*
11:30-13:30	**Lunch Break**
Chair: Wang, Fang	
13:30-14:20	**Talk A4** **Xu, Peirong** *Automatic detection of significant areas for functional data with directional error control*
14:30-15:20	**Talk A5** **Zheng, Cheng** *Sparse equidistribution of unipotent orbits*
Chair: Lai, Mijia	
15:30-16:20	**Talk A6** **Wei, Wei** *A σ_2 Penrose inequality for conformal asymptotically hyperbolic 4-discs*
16:30-17:20	**Talk A7** **Zhang, Kewei** *A Bishop type theorem for Kahler manifolds*

April 19

ZOOM Conference ID: 988 548 60661   Password: 998585

Chair: Xie, Feng	
08:30-09:20	**Talk B1** **Ren, Haojie** *Threshold selection in feature screening via error rate control*
09:30-10:20	**Talk B2** **Luo, Peng** *Characterization of fully coupled FBSDE in terms of portfolio optimization*
10:30-11:20	**Talk B3** **Luo, Tao** *Generalization and optimization theory of deep learning and its application to PDE*

Abstracts

Characterization of fully coupled FBSDE in terms of portfolio optimization

Luo, Peng

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We provide a verification and characterization result of optimal maximal sub-solutions of BSDEs in terms of fully coupled forward backward stochastic differential equations. We illustrate the application thereof in utility optimization with random endowment under probability and discounting uncertainty. We show with explicit examples how to quantify the costs of incompleteness when using utility indifference pricing, as well as a way to find optimal solutions for recursive utilities.

Generalization and optimization theory of deep learning and its application to PDE

Luo, Tao

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Except many successful applications, more and more empirical studies of deep neural networks (DNNs) emerge in order to understand success of DNNs. In this talk, I will first present some state-of-the-art results on two central issues of DNNs: estimates of the generalization error and convergence rate of optimization methods. Then I will show some extensions of the generalization and optimization theory to DNN-based PDE solvers.

Threshold selection in feature screening via error rate control

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Hard thresholding rule is commonly adopted in feature screening procedures to screen out unimportant predictors for ultrahigh-dimensional data. However, different thresholding terms are required to adapt to different contexts of screening problems and an appropriate thresholding magnitude usually varies from the model and error distribution. With an ad-hoc choice, it is unclear whether all of the important predictors are selected or not, and it is very likely that the procedures would include many unimportant features. We introduce a data-adaptive threshold selection procedure via error rate control, which is applicable to most kinds of popular screening methods. The key idea is to apply the sample-splitting strategy to construct a series of statistics with marginal symmetry property and then to utilize the symmetry for obtaining an approximation to the number of false discoveries. We show that the proposed method is able to asymptotically control the false discovery rate and per family error rate under certain conditions and still retains all of the important predictors. Three important examples are presented to illustrate the merits of our procedure. Numerical experiments indicate that the proposed methodology works well for many existing screening methods.

The inviscid limit for the Navier-Stokes equations and the boundary layers

Wang, Fei

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I will talk about the inviscid limit for the Navier-Stokes equations in a half space (in both 2D and 3D case), with initial datum that is analytic only close to the

boundary of the domain, and has finite Sobolev regularity in the complement. I will also address the blow up of the Prandtl equations in finite time in this talk.

A σ_2 Penrose inequality for conformal asymptotically hyperbolic 4-discs

Wei, Wei

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In this paper, we consider conformal metrics on a unit 4-disc with an asymptotically hyperbolic end and possible isolated conic singularities. Under a positive σ_2 curvature lower bound condition, we define a corresponding mass term and establish a Penrose-type inequality. When no singularity occurs, our mass is non-negative. Sharp cases are also discussed. We point out that our curvature condition is different from the scalar curvature condition required in earlier literature. This work is joint with Hao Fang.

Automatic detection of significant areas for functional data with directional error control

Xu, Peirong

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In this paper we propose a large-scale multiple testing procedure to find the significant sub-areas between two samples of curves automatically. The procedure is optimal that controls the directional false discovery rate at any specified level on a continuum asymptotically. By introducing a nonparametric Gaussian process regression model for the two-sided multiple test, the procedure is computationally inexpensive. It can cope with problems with multidimensional covariates and accommodate different sampling designs across the samples. We further propose the significant curve/surface, giving an

insight on dynamic significant differences between two curves. Simulation studies demonstrate that the proposed procedure enjoys superior performance with strong power and good directional error control. The procedure is also illustrated with the application to two executive function studies in hemiplegia. (Joint work with Youngjo Lee, Jianqing Shi and Janet Eyre.)

A roadmap for devising energy stable schemes for general dissipative systems

Yang, Zhiguo

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In this presentation, I will present a framework for devising unconditionally energy stable schemes for general dissipative systems based on a generalized auxiliary variable. A unified procedure for treating the dissipative governing equations and the generalized auxiliary variable on the discrete level has been introduced. Applications of this method to multiphase flow problems are also presented.

A Bishop type theorem for Kahler manifolds

Zhang, Kewei

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In this talk I will show that the complex projective space equipped with the Fubini-Study metric attains the maximal volume among all Kahler manifolds with positive Ricci curvature.

The Ricci curvature in metric geometry and complex geometry

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This talk centers around the recent developments of the convergence theory of the Ricci curvature in both metric Riemannian geometry and Kaehler geometry, with a specific focus on the degeneration theory of Calabi-Yau (Ricci-flat Kaehler) manifolds. The goal of this talk is to present some recent progress and first-step evidence towards the metric-geometric formulation of the Strominger-Yau-Zaslow Conjecture in mirror symmetry theory.

Sparse equidistribution of unipotent orbits

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We consider the standard unipotent flow $u(t)$ on the homogeneous space G/H, where G is the special linear group $SL(2,R)$ and H is a non-uniform lattice. We show that if a point p in G/H satisfies certain Diophantine condition, then the sparse orbit $\{u(n^{1+r})p: n=1,2,...\}$ ($r>0$ sufficiently small) equidistributes in G/H. This extends a result of Venkatesh.