NCTS Workshop on

Probability and its Applications

National Center for Theoretical Sciences

Date	VENUE
2026/06/23	**SA223, Science Bldg. 1, NYCU**

Aim & Scope

This workshop aims to bring together both international and domestic experts to exchange recent advances in probability theory. A particular focus will be on the theoretical foundations and applications of random processes. In addition to the theoretical aspects of stochastic processes, the workshop will also cover related areas, including statistics, statistical physics, and signal processing.

Invited Speakers

Guan-Yu Chen
National Yang Ming Chiao Tung University

Wei-Kuo Chen
University of Minnesota

Yu-Ting Chen
University of Victoria*

Gi-Ren Liu
National Cheng Kung University

Te-Chun Wang
EPFL SB MATH STOAN

Hau-Tieng Wu
New York University

* Online Talk

Organizer

Lung-Chi Chen
National Chengchi University

Gi-Ren Liu
National Cheng Kung University

Event QR-Code

Contact	Peggy Lee peggylee@ncts.tw

Program for the NCTS Workshop on Probability and its Applications

時間	活動內容/講題	講者	演講者單位
10:10-10:40	開幕式	貴賓致詞 主持人: 黃信元	
10:40-11:20	Diffusions in continuum disordered systems (online)	陳與庭 (Yu-Ting Chen) 主持人: 陳冠宇	Department of Mathematics and Statistics, University of Victoria, Canada
11:30-12:10	Higher moments for the SHE in high dimensions and their phase transitions	王德鈞 (Te-Chun Wang) 主持人: 須上苑	École Polytechnique Fédérale de Lausanne, School of Basic Sciences, Institute of Mathematics, Stochastic Analysis, Switzerland
12:10-13:20	午餐		
13:20-14:00	Joint parameter estimations in spin glasses	陳偉國 (Wei-Kuo Chen) 主持人: 陳隆奇	School of Mathematics, University of Minnesota, USA
14:00-14:40	Markov chain mixing between past and future	陳冠宇 (Guan-Yu Chen) 主持人: 陳美如	Department of Applied Mathematics, National Yang Ming Chiao Tung University
14:40-15:00	Tea Time		
15:00-15:40	Scalogram ridges of adaptive harmonic signals under Gaussian noise	劉聚仁 (Gi-Ren Liu) 主持人: 林偉傑	Department of Mathematics, National Cheng Kung University
15:40-16:20	When signal processing meets probability in medicine	吳浩榳 (Hau-Tieng Wu) 主持人:千野由喜	Department of Mathematics, NYU, USA
16:20-17:00	會後交流討論		
17:30	晚宴		

Diffusions in Continuum Disordered Systems

Yu-Ting Chen

Department of Mathematics and Statistics
University of Victoria, Canada

Abstract

Originating from a model of domain walls in disordered Ising magnets, the continuum directed random polymer (CDRP) raises several fundamental questions in stochastic analysis. This talk will outline recent progress on the question of constructing Feynman-Kac-type semigroups for the moments of the $(2+1)$-dimensional CDRP, highlighting the principal ideas behind their non-standard formulations.

Moments of a Long-range Correlated $2d$ Stochastic Heat Equation at Criticality

Te-Chun Wang

École Polytechnique Fédérale de Lausanne (EPFL)
School of Basic Sciences
Institute of Mathematics, Stochastic Analysis, Switzerland

Abstract

We study regularized versions of a long-range correlated stochastic heat equation (SHE) in two dimensions and analyze their scaling limit as the regularization vanishes. The spatial correlation kernel of the driving noise approximates, at large scales, a Riesz-type kernel of the form $|x|^{-2}$ with a logarithmic perturbation. In this work, we establish a universal limit. Under critical scaling, the higher moments converge to non-Gaussian limits, which coincide, up to a reparameterization and a multiplicative constant, with the higher moments of the critical two-dimensional stochastic heat flow (SHF). The SHF arises both as a normalized limit of the two-dimensional (short-range) SHE and as a scaling limit of the two-dimensional directed polymer model, both under critical scaling.

Joint Parameter Estimations in Spin Glasses

Wei-Kuo Chen

School of Mathematics
University of Minnesota, USA

Abstract

Spin glasses are disordered statistical physics systems with competing ferromagnetic and anti-ferromagnetic spin interactions. The Gibbs measure belongs to the exponential family with parameters, such as inverse temperature $\beta > 0$ and external field h in R. One interesting statistical perspective of this measure is concerned with the estimation problem of the system parametersfrom a given sample. This question was firstly addressed by Chatterjee in 2007, who proved that the maximum pseudo-likelihood estimator for β is $\sqrt{N}$-consistent for a broad class of spin glass models with two-spin interactions in the absence of external field. It was left open if one can achieve joint estimation of (β, h). In this talk, I will present a recent progress, which shows that under some easily verifiable conditions, the bi-variate maximum pseudo-likelihood estimator is indeed jointly $\sqrt{N}$-consistent for a large collection of spin glasses, including the Sherrington-Kirkpatrick model and its diluted variants. Based on a joint work with Arnab Sen and Qiang Wu.

Markov Chain Mixing between Past and Future

Guan-Yu Chen

Department of Applied Mathematics
National Yang Ming Chiao Tung University, Taiwan

Abstract

Mixing Markov chains is a widely considered subject in many disciplines including statistic physics, computer science, quantitative finances and biology, etc. The estimate of how Markov chains are close to their stationarity, called mixing time, has been proved useful in studying the behavior of mixing and the spectrum of the transition matrix is well-known for the role it plays in bounding the mixing time.

In this talk, we first review some well-developed results related to bounds of mixing time and then turn to the discussion of the spectral gap and higher-order eigenvalues of the transition matrix. With restrictions to birth and death chains, a clear profile of the spectrum is available and, on this basis, leads to several criteria on bounding or computing the eigenvalues. Correspondingly, we will display relative future works from the perspective of random walks in random environments.

Scalogram Ridges of Adaptive Harmonic Signals under Gaussian Noise

Gi-Ren Liu

Department of Mathematics
National Cheng Kung University, Taiwan

Abstract

Ridges in the scalogram, defined via the squared modulus of the wavelet transform, are a central tool for analyzing nonstationary time series. Despite their widespread use in practice, their behavior in noisy environments remains poorly understood from a theoretical standpoint.

In this talk, we study ridge analysis by modeling ridges as a (possibly set-valued) random process arising from local maxima of the scalogram random field along the scale axis. Under the adaptive harmonic model with additive stationary Gaussian noise, we establish several fundamental properties of this random ridge process. In particular, we prove a uniqueness property of ridge points at fixed time instances and establish upper hemicontinuity of the ridge process. We further derive probabilistic bounds that quantify the deviation between the ridge of a noisy signal and that of the corresponding clean signal.

Finally, we discuss the connection between the proposed theoretical framework and commonly used ridge extraction algorithms. Numerical experiments illustrate the theoretical findings and suggest potential directions for improving ridge extraction methods in the presence of noise.

When Signal Processing Meets Probability in Medicine

Hau-Tieng Wu

Courant Institute of Mathematical Sciences
New York University, USA

Abstract

Modern biomedical signals contain rich information about underlying physiological processes. These processes are often characterized by complex, nonstationary dynamics with substantial uncertainty, making the extraction of clinically meaningful information a persistent challenge. In this talk, we discuss how ideas from signal processing and probability can be combined to address these challenges. Through clinical examples drawn from cardiovascular monitoring and sleep medicine, we illustrate how modern time-frequency analysis, stochastic modeling, and statistical inference can uncover hidden physiological information and improve data-driven decision-making. More broadly, we argue that continued advances in medicine depend on a fruitful dialogue among mathematics, engineering, and medicine, where signal processing and probability complement one another in the pursuit of a deeper understanding of human health.