NUS National University of Singapore | Department of Mathematics, Faculty of Science

SYMPOSIUM IN MATHEMATICS

Friday 5 August 2022
9.00 am to 5.30 pm (SGT)
Lecture Theatre 34
Block S17
National University of Singapore

~ Organised by DINH Tien-Cuong and Subhro GHOSH ~

PROGRAMME

9.00 AM Opening Remarks by **TOH Kim Chuan**, Head, NUS Department Mathematics

9.05 AM Talk by **YAO Yao**

Title: Symmetry and Uniqueness via a Variational Approach

10.05 AM Talk by **ZHANG Lei**

Title: Wavefront Set and the Local Gan-Gross-Prasad Conjecture

11.00 AM Coffee Break

11.20 PM Talk by **Dilip RAGHAVAN**

Title: Stable Ordered Union versus Selective Ultrafilters

12.15 PM Lunch

2.00 PM Talk by **Jl Hui**

Title: Self-Supervised Deep Learning for Solving Inverse Problems in Imaging

3.00 PM Talk by **HUANG Hao**

Title: Covering Cubes by hyperplanes

3.55 PM Coffee Break

4.15 PM Talk by **Vincent TAN**

Title: Optimal Clustering with Bandit Feedback

5.10 PM IMS & Closing Remarks by **CHONG Chi Tat**, Director, Institute of Mathematical Sciences

To register, visit https://bit.ly/3Owt2Vd

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ABSTRACTS

Speaker: YAO Yao

Title: Symmetry and Uniqueness via a Variational Approach

Abstract: For some nonlocal PDEs, their steady states can be seen as critical points of some associated energy functional. Therefore, if one can construct perturbations around a function such that the energy decreases to first order along the perturbation, this function cannot be a steady state. In this talk, I will discuss how this simple variational approach has led to some recent progress in the following equations, where the key is to carefully construct a suitable perturbation. I will start with the aggregation-diffusion equation, which is a nonlocal PDE driven by two competing effects: nonlinear diffusion and long-range attraction. We show that all steady states are radially symmetric up to a translation (joint with Carrillo, Hittmeir and Volzone), and give some criteria on the uniqueness/non-uniqueness of steady states within the radial class (joint with Delgadino and Yan). I will also briefly discuss applications of this variational approach to the 2D Euler equation (joint with G´omez-Serrano, Park and Shi) and a geometry problem (joint with Li and Yan).

Speaker: ZHANG Lei

Title: Wavefront Set and the Local Gan-Gross-Prasad Conjecture

Abstract: Fourier coefficients of automorphic forms have many applications in number theory such as counting the number of representations of a natural number as the sum of squares. Guided by the local-global principle, a necessary nonvanishing condition of such Fourier coefficients is determined by the wavefront set of the representations over local fields. In this talk, we use the celebrated Gan-Gross-Prasad conjecture and consecutive local descent theory to introduce a new invariant associated with the irreducible representations, so-called arithmetic wavefront sets. In further, we conjecture that the arithmetic wavefront sets coincide with the classical wavefront sets defined by the Harish-Chandra characters, and are associated with the nilpotent orbits extensively studied in the orbit method such as the recent breakthrough progress on the constructions of special unipotent representations by Barbasch-Ma-Sun-Zhu.

Speaker: Dilip RAGHAVAN

Title: Stable Ordered Union versus Selective Ultrafilters.

Abstract: Stable ordered union and selective ultrafilters are two special types of ultrafilters derived from two of the most important results of Ramsey theory: Ramsey's theorem for ${[\mathbb{N}]}^{2}$ and Hindman's theorem for the semigroup $\langle \mathrm{FIN}, \cup \rangle$. Every stable ordered union ultrafilter $\mathcal{H}$ has two selective ultrafilters ${\mathcal{H}}_{\mathrm{min}}$ and ${\mathcal{H}}_{\mathrm{max}}$ which are Rudin-Keisler reducible to it via the projections induced by the max and min maps. Further ${\mathcal{H}}_{\mathrm{min}}$ is not Rudin-Keisler isomorphic to ${\mathcal{H}}_{\mathrm{max}}$. In 1987 Blass asked whether the existence of a stable ordered union ultrafilter could be proved from just the existence of two selective ultrafilters that are not Rudin-Keisler isomorphic. We will present a negative solution to Blass' question. This is joint work with Juris Steprans

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ABSTRACTS

Speaker: JI hui

Title: Self-Supervised Deep Learning for Solving Inverse Problems in Imaging

Abstract: In the past, the prominent approach for solving inverse problem in imaging/sensing systems is based on static image models derived from physics or intuition, e.g. wavelets and sparse representation. Today, deep learning has emerged as a highly successful tool in many domains, including inverse imaging problems. Most existing successful deep learning methods are based on supervised learning, which requires many ground-truth images for training a deep neural network (DNN). Such a prerequisite on training datasets limits their applicability in data-limited domains, e.g., medicine and science. This talk will introduce a series of works on self-supervised learning for solving inverse imaging problems, which teaches a DNN to predict images from their noisy and partial measurements without seeing any related image. The main ingredient in these works is the neutralization of Bayesian inference with DNN-based over-parametrization of images. Coming as a surprise to most, even without given any training data, the proposed self-supervised method can compete well against supervised learning methods in many real-world imaging tasks.

Speaker: HUANG Hao

Title: Covering Cubes by Hyperplanes

Abstract: The vertices of the n-dimensional cube {0, 1}^n can be covered by two affine hyperplanes x_1=1 and x_1=0. However if there is a vertex not allowed to cover, then suddenly at least n affine hyperplanes are needed. This is a classical result of Alon and Furedi, followed from the Combinatorial Nullstellensatz. In this talk, we consider the following natural generalization of the Alon-Furedi theorem: what is the minimum number of affine hyperplanes such that the vertices in {0, 1}^n-{0} are covered at least k times, and 0 is uncovered? We conjecture that for large n, the answer is n+{k \choose 2} and verify it for k>=3, using a punctured version of the Combinatorial Nullstellensatz. We also completely solve the fractional version of this problem, by developing an analogue of the Lubell-Yamamoto-Meshalkin inequality for subset sums. Joint work with Alexander Clifton (Emory University).

Speaker: Vincent TAN

Title: Optimal Clustering with Bandit Feedback

Abstract: This work considers the problem of online clustering with bandit feedback. A set of arms (or items) can be partitioned into various groups that are unknown. Within each group, the observations associated to each of the arms follow the same distribution with the same mean vector. At each time step, the agent queries or pulls an arm and obtains an independent observation from the distribution it is associated with. Subsequent pulls depend on previous ones as well as the previously obtained samples. The agent's task is to uncover the underlying partition of the arms with the least number of arm pulls and with a probability of error not exceeding a prescribed constant δ. The problem proposed finds numerous applications from clustering of variants of viruses to online market segmentation. We present an instance-dependent information-theoretic lower bound on the expected sample complexity for this task and design a computationally efficient and asymptotically optimal algorithm, namely Bandit Online Clustering (BOC). The algorithm includes a novel stopping rule for adaptive sequential testing that circumvents the need to exactly solve any NP-hard weighted clustering problem as its subroutines. We show through extensive simulations on synthetic and real-world datasets that BOC's performance matches the lower bound asymptotically, and significantly outperforms a non-adaptive baseline algorithm. This is joint work with my amazingly talented student Junwen Yang (Institute of Operations Research and Analytics, NUS) and Zixin Zhong (Dept of Mathematics, NUS).

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