THE GEORGE WASHINGTON UNIVERSITY STUDENT CHAPTER OF SIAM

Spring 2019 Conference on Applied Mathematics

Washington DC

May 4, 2019

Timetable

9:30-10:00
Welcoming Refreshment
Phillips 730

10:00-10:30
Xin Dong, University of Maryland, College Park
Dynamics of the Reduced Hartree-Fock Model with an External Magnetic Field

10:40-11:10
Asia Wyatt, University of Maryland, College Park
A Mathematical Model of Adaptive Memory in Primary and Secondary Immune Response

11:20-11:40
Break

11:40-12:10
Nikhil Mande, Georgetown University
A Short List of Equalities Induces Large Sign Rank

12:20-12:30
Picture Time

12:30-1:30
Lunch
Phillips 730

1:30-2:00
Ming Zhong, Johns Hopkins University
Data-driven Approaches for Scientific Discoveries

2:10-2:40
Yuxiao Huang, The George Washington University
On the Discovery of Feature Importance Distributions: An Overlooked Area

2:50-3:00
Break

3:00-3:30
Debdeep Bhattacharya, The George Washington University
Global Well-posedness of 2d Modified Zakharov-Kuznetsov Equation for Low-regularity Data

*All talks will be held in Rome 351

Xin Dong
University of Maryland, College Park

Title

Dynamics of the Reduced Hartree-Fock Model with an External Magnetic Field

Abstract

In the talk, I will introduce the reduced Hartree-Fock model with an external magnetic field, where the interaction potential is the singular delta instead of the coulomb one. We consider infinitely many Fermions. Under this setting, we establish the global well-posedness and the long Strichartz estimate of the Schrödinger equation associated to the reduced Hartree-Fock functional.

Asia Wyatt
University of Maryland, College Park

Title

A Mathematical Model of Adaptive Memory in Primary and Secondary Immune Response

Abstract

During an immune response, it is understood that there are key differences between the cells and cytokines that are present in a primary response and those present in subsequent responses. Specifically, after a primary response memory cells are present and drive the clearance of antigen in these later immune responses. In this paper, we develop a mathematical model to explore these differences between a primary and secondary immune response through the creation, activation, and regulation of memory T cells. We mimic this biological behavior with a delay differential equation (DDE) model of both primary and secondary immune response to the same antigen. It is shown that while we observe similar amounts of antigen stimulation from both immune responses, with the incorporation of memory T cells, we see an increase in both amount of effector T cells present and speed of activation of the immune system in the secondary response. We conclude that memory T cells play a major role in the effectiveness of the immune system once encountering the same antigen a second time.

Nikhil Mande
Georgetown University

Title

A Short List of Equalities Induces Large Sign Rank

Abstract

The sign rank of a s x t {-1, 1}-valued matrix M (also viewed as the "communication matrix" corresponding to a Boolean function on st inputs) is the minimum rank of a real matrix, all of whose entries agree in sign with the corresponding entries in M. Sign rank is a widely studied notion and has connections in various areas in applied mathematics and theoretical computer science, such as Boolean circuit complexity, communication complexity, learning theory and algebraic geometry. We exhibit a natural function F_n : {-1, 1}^n x {-1, 1}^n to {-1, 1}, computable by a linear sized "decision list of Equalities", but whose sign rank is exp(Omega(n^{1/4})).

The simplicity of F_n yields, among other things, a separation between certain depth-2 threshold circuit classes, answering a question that was open since the work of Goldmann, Hastad and Razborov [Computational Complexity'92] and explicitly posed by Amano and Maruoka [MFCS'05] and Hansen and Podolskii [CCC'10].
In order to prove our main result, we view F_n as an XOR function, and develop a technique to lower bound the sign rank of such functions. This requires novel approximation theoretic arguments that allow us to conclude that polynomials of low Fourier weight cannot approximate certain functions, even if they are allowed unrestricted degree.

Based on joint work with Arkadev Chattopadhyay (TIFR, Mumbai), appeared in FOCS 2018.

Ming Zhong
Johns Hopkins University

Title

Data-driven Approaches for Scientific Discoveries

Abstract

As observation data has become abundant and observing technique has matrued over the years, we ponder upon the possibility of making scientific discoveries from a plethora of observations.

We propose various efficient and effective algorithms along with their analysis for learning and recovery from observations. For learning from observing agent baed dynamics, we develop a non-parametric inference of interaction laws and discuss its convergence and accuracy in applications to various kind of prototypical self-organized dynamics. For recovery from ill-conditioned observations, we develop two multi-scale regularization methods for approximating the original unkonwns with better accuracy and higher efficiency. We also demonstrate several numerical examples to accompany our theoretical claims.

Yuxiao Huang
The George Washington University

Title

On the Discovery of Feature Importance Distributions: An Overlooked Area

Abstract

Detecting feature importance (predictive power) is a key problem in Machine Learning. Previous methods have been focusing on providing a single value as the estimation of the importance. However, the meaning of such value is not always obvious. Moreover, in reality a feature's importance may vary dramatically across the feature's values. A point estimation of the importance cannot capture such variations. We propose a new definition of feature importance, which directly measures a feature's predictive power. We also propose an approach to detect a high-resolution distribution of a feature's importance across the feature's values. The key novelty is a feature importance model that allows identifying significant change of importance between adjacent feature values, and a cost function that permits separating the importance of different features. Empirical results on real-world medical datasets (Breast Cancer, Parkinson's, and Drug Consumption) show that, the proposed work could help discover better knowledge, build better models, and make better decisions.

Debdeep Bhattacharya
The George Washington University

Title

Global Well-posedness of 2d Modified Zakharov-Kuznetsov Equation for Low-regularity Data

Abstract

In this talk, we revisit the history of the celebrated Korteweg-de Vries equation, and its higher dimensional generalization, the Zakharov-Kuznetsov (ZK) equation to describe ion-accoustic waves in magnetized plasma. Using the I-method, we prove the global well-posedness of the 2D modified ZK equation in H^s spaces for $s > 3/4$ under the assumption that the mass of the initial data is less than the mass of the ground state solution of $\Delta\varphi - \varphi + \varphi^3 = 0$. We obtain the same result for the defocusing equation without any such assumption.