Dynamics and Information

Science Building No. 6, Shanghai Jiao Tong University
April 11 - 13, 2019

Schedule

Thursday, April 11, Room 703

09:10 – 10:10 Johannes Siemons *Singular graphs from finite simple groups*
10:20 – 11:20 Yinfeng Zhu *Homogeneity of transformation semigroups*
13:45 – 14:45 Chihao Zhang *The location of complex zero and approximate counting*
15:00 – 16:00 Moumanti Podder *First order logic on Galton-Watson trees*
16:15 – 17:15 Mikhail Volkov *Completely reachable automata: an interplay between transformation semigroups, finite automata, and binary trees*

Friday, April 12, Room 703

09:20 – 10:20 Ivan Todorov *Zero-error quantum information*
10:40 – 11:40 Mikio Nakahara *Majorana representation of complex vectors and its applications*

Saturday, April 13, Room 639

09:30 – 10:30 Enhui Shi *The alternative for groups of circle homeomorphisms*
10:40 – 11:40 Hui Xu *The simultaneous linearization of commuting circle diffeomorphisms*

Abstracts

Singular graphs from finite simple groups

11 Apr
09:10 AM
Room 703

Johannes Siemons
University of East Anglia

Let Γ be a finite undirected graph without loops or multiple edges. Then Γ is singular if its adjacency matrix is singular. Alternatively, Γ is singular if and only if its spectrum contains the eigenvalue 0. Singular graphs play a significant role in physics and chemistry (e.g. Hückel Theory), but have also ramifications for problems in algebra, combinatorics and incidence geometries. We start with an introductory exposition of graph singularity, explaining its significance and basic asymptotic behaviour, including the work of T. Tao, Van Vu, K. Costello and E. Szemerédi. While a great deal is known about graph spectra – so that singularity could be decided just by looking up a data base – it is not likely that a general theory of graph singularity per se will emerge. Some progress however can be made for graphs which have a group G of automorphisms that acts transitively on the vertices of the graph. Here the singularity question can be discussed, in some cases, via the linear representation theory of G. It turn out that singularity is closely related to the vanishing of certain characters of G. In the second part of the lecture I will discuss connections between graph spectra and automorphism groups. The details can be found in a recent paper [1] with A. Zalesski.

References:

[1] J. Siemons and A. Zaleskii, Remarks on singular Cayley graphs and vanishing elements of simple groups, J Algebraic Combinatorics 2018.

Homogeneity of transformation semigroups

11 Apr
10:20 AM
Room 703

Yinfeng Zhu
Shanghai Jiao Tong University

Let S be a transformation semigroup acting on a set Ω . The action of S on Γ can be naturally extended to be an action on all subsets of Γ . We say that S is ℓ -homogeneous provided it can send A to B for any two (not necessarily distinct) ℓ -subsets A and B of Γ . On the condition that $k \leq \ell \leq k + \ell \leq |\Omega|$, we show that every ℓ -homogeneous transformation semigroup acting on Ω must be k -homogeneous. We report other variants of this result and suggest a matroid framework for further research along the same direction. Joint work with Yaokun Wu.

The location of complex zero and approximate counting

11 Apr
13:45 PM
Room 703

Chihao Zhang
Shanghai Jiao Tong University

Barvinok developed a powerful method that uses Taylor expansion to approximately evaluate the generating function of combinatorial objects. The accuracy of the approximation is closely related to the location of the complex zeros of the generating function. In this talk, I will survey some recent progress in this direction, and explain our recent work on a dichotomy result for the approximability of Holant problems.
Part of the talk is based on joint work with Heng Guo, Chao Liao and Pinyan Lu.

First order logic on Galton-Watson trees

11 Apr
15:00 PM
Room 703

Moumanti Podder
University of Washington

This talk will focus my joint work with Joel Spencer on the rooted Galton-Watson (GW) branching process with Poisson (λ) offspring distribution. The first order (FO) language on rooted trees comprises sentences or properties that are expressible in terms of the relations of vertex equality ($x = y$) and parent-child ($\pi(y) = x$ implies that x is the parent of y), and the root is treated as a constant symbol. We analyze the probabilities of FO sentences on the GW tree, and obtain these probabilities as the unique fixed points of contracting distributional maps, thus establishing their analyticity in λ . We show that, conditioned on survival of the GW tree, the FO properties of quantifier depth at most k that hold for the tree are almost surely determined by the neighbourhood of the root of radius $\approx 3^{k+2}$. Time permitting, I shall briefly touch on some of my recently concluded work on first order logic, the probabilities of its sentences and zero-one laws, on the Erdős–Rényi random graphs $G(n, p(n))$ for various values of the edge probability function $p(n)$.

Completely reachable automata: an interplay between transformation semigroups, finite automata, and binary trees

11 Apr
16:15 PM
Room 703

Mikhail Volkov
Ural Federal University

We present recent results by the speaker et al. related to finite deterministic automata in which every non-empty subset of the state set is reachable. Motivations for studying automata of this sort come from Cerny's celebrated conjecture about synchronizing finite automata as well as from certain questions in the theory of transformation semigroups.

Zero-error quantum information

12 Apr
09:20 AM
Room 703

Ivan Todorov
Queen's University Belfast

The problem of information transmission with zero error was first studied by Shannon, who defined the zero-error capacity of a classical information channel in terms of the independence number of a graph, canonically associated with the channel. This gave rise to fruitful interactions between Graph Theory and Information Theory and led to the introduction of informationally inspired graph parameters such as the Lovasz number. Analogous developments have been taking place in Quantum Information Theory in the past few years. The current fruitful approach in the quantum case involves methods from Functional Analysis and objects called operator systems, studied in Operator Algebra Theory since the 1960's. In this talk, I will discuss these developments and some open questions faced by the area at present.

Majorana representation of complex vectors and its applications

12 Apr
10:40 AM
Room 703

Mikio Nakahara
Shanghai University

It is well-known that a unit vector in $\mathbb{C}^2$ can be visualized as a unit vector in $\mathbb{R}^3$, which is known as the Bloch vector in physics community. The Majorana representation is a generalization of this idea to higher-dimensional complex vector space [1]. Here we take advantage of the fact that the higher-dimensional irreducible representation of $SU(2)$ is composed of the symmetric combination of the fundamental representations to visualize high-dimensional complex vectors. Each vector in the fundamental representation is represented by a vector on a unit sphere S^2 and there correspond $d-1$ such Bloch vectors for a vector in $\mathbb{C}^d$. These Bloch vectors are called the Majorana vectors of the complex vector. In this talk, we will explain how to obtain the Majorana vectors for a given complex vector and introduce some applications of Majorana representation to quantum information theory, such as Symmetric, Informationally Complete, Positive Operator-Valued Measure (SIC-POVM) [2]. Finally we introduce our recent application of Majorana representation to describe homotopically nontrivial structures in a cold atom system, whose state is described by a unit vector in $\mathbb{C}^5$ (i.e., Spin-2) [3]. Joint work with Yan Zhu.

References:

[1] E. Majorana, Atomi Orientati in Campo Magnetico Variabile. Nuovo Cimento 9, 43-50 (1932).
[2] P.K. Aravind, MUBs and SIC-POVMs of a spin-1 system from the Majorana approach, arXiv:1707.02601 (2017).
[3] K. Tiurev, T. Ollikainen, P. Kuopanportti, M. Nakahara, D.S. Hall and M. Möttönen, Three-dimensional skyrmions in spin-2 Bose–Einstein condensates, New J. Phys. 20, 055011 (2018)

The alternative for groups of circle homeomorphisms

13 Apr
09:30 AM
Room 639

Enhui Shi
Soochow University

In this talk, I will introduce Margulis' proof of the weak version of Tits alternative for groups of circle homeomorphisms (which was conjectured by Ghys): if G is a group generated by circle homeomorphisms, then either G preserves a probability measure on the circle, or G contains a free subgroup on 2 generators.

The simultaneous linearization of commuting circle diffeomorphisms

13 Apr
10:40 AM
Room 639

Hui Xu
Soochow University

In this talk, I will first review the definition of rotation number of a circle homeomorphism and give the detailed proofs of the classical linearization theorems due to Poincare and Denjoy. Then I will talk about some works and open questions on the simultaneonus linearization of commuting circle diffeomorphisms.
