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PANEM Title and Abstracts

Speaker: Oleg Zaboronski

Title: Representations of Hecke algebras and Markov dualities for reaction-diffusion systems

Abstract

There exists is a number of Markovian interacting particle systems in one spatial dimension which turn out to be exactly solvable in the sense that their single time law can be calculated for any deterministic initial condition. Among the examples are such classical models as annihilating or coalescing random walks, exclusion processes, voter models on $\mathbb{Z}$. The exact solvability of each of these models can be traced back to the presence of a set of Markov duality functions whose expectations determine the single time law uniquely. The relevant duality functions include the indicators of empty sets, the parity of particle numbers, polynomial and exponential functions of particle occupational numbers. Where do they all come from?

Typically, one searches for duality functions for each model at hand starting from the conservation laws present, such as the conservation of parity or the number of particles. In these lectures I will discuss a link between the duality functions and representations of algebras generated by the operators describing the microscopic interaction rules of the system, the so-called generator algebras.

In the first lecture I will give an elementary introduction to infinitesimal generators for continuous Markov processes, the notion of Markov duality, and the description of Markov processes on $\{0,1\}^{\mathbb{Z}}$ using infinite tensor products. Basic definitions and facts concerning (type-A) Hecke algebras will be also be presented.

The second lecture will be dedicated to the exact solution of annihilating random walks on $\mathbb{Z}$ via the construction of 'small' representations of the corresponding generator algebra. This will lead to duality functions of parity type and the identification of the one-dimensional law of the system with a certain Pfaffian point process. The generator algebra will turns out to be a factor algebra of a specialisation of Hecke algebra. It will be shown that the appearance of duality functions of the parity type can be traced back to the braid and the quadratic relations of the algebra.

In the final lecture I will discuss various generalisations and consequences of the algebraic construction of duality functions: the classification of all continuous Markov

processes on $\{0,1\}^{\mathbb{Z}}$ whose generator is given by the sum of two-site idempotent operators; the emergence of Hecke algebras for the 'typical' models on the list; the irreducibility of representations of Hecke algebras spanned by duality functions; the interpretation of duality functions as intertwiners and a novel coordinate representation of Hecke algebras; Baxterisation and solutions to the Young-Baxter equation corresponding to interaction rules not not conserving the number of particles.

Zhipeng Liu

Title: Some exact formulas of the KPZ fixed point and directed landscape

Abstract:

In the past twenty years, there have been huge developments in the study of the Kardar-Parisi-Zhang (KPZ) universality class, which is a broad class of physical and probabilistic models including one-dimensional interface growth processes, interacting particle systems and polymers in random environments, etc. It is broadly believed and partially proved, that all the models share the universal scaling exponents and have the same asymptotic behaviors. The height functions of models in the KPZ universality class are expected to converge to a limiting space-time fluctuation field, which is called the KPZ fixed point. Moreover, there is a random "directed metric" on the space-time plane that is expected to govern all the models in the KPZ universality class. This "directed metric" is called the directed landscape. Both the KPZ fixed point and the directed landscape are central objects in the study of the KPZ universality class, while they were only characterized/constructed very recently [MQR21, DOV18].

In this talk, we will discuss some exact formulas of distributions in these two random fields. These exact formulas are in terms of an infinite sum of multiple contour integrals, which are analogous to the Fredholm determinant expansions. We will show some surprising probabilistic properties of the KPZ fixed point and the directed landscape using the exact formulas. Some of the results are based on joint work with Yizao Wang and Ray Zhang.

Octavio Arizmendi (CIMAT)

Title: Some limit theorems for polynomials appearing in finite free convolution.

Abstract: In this talk we discuss various limit theorems motivated or explained by finite free probability, obtained recently in joint work with K. Fujie and Y. Ueda. The main tool we will use is a new combinatorial identity and finite free cumulants.

James Mingo (Queen's University)

Title: Infinitesimal Laws in Free Probability

Abstract: Infinitesimal laws for random matrix models go back to Johansson (1998) and Dumitriu and Edelman (2006). These authors showed that in the large N expansion of some random matrix models, there was an interesting distribution at the $1/N$ level, what has now been called the infinitesimal law. Thanks to the work of many authors (Belinschi, Biane, Fevrier, Goodman, Nica, and Shlyakhtenko, and Tseng to name a few), there is now a good set of tools for analysing the distribution of freely independent random variables at the infinitesimal level.

I will present some recent joint works with Cébron, Tseng, and Vázquez on some random matrix models and polynomials in infinitesimally free operators.

Natasha Blitvic (Queen Mary University of London)

There are many notions of positivity in combinatorics, each opening up a window on a different area of current mathematics research. We will focus on the notion of positivity that interprets sequences enumerating combinatorial structures as moments of probability measures on the real line. There are many motivations for exploring this interface, from the proliferation of noncommutative probability theories, each tied to a specific type of combinatorial structure, to the modern takes on the classical moment problems. Some of the questions we will be asking are: When is a specific combinatorial sequence a moment sequence? What is universality (seen through this lens)? How does combinatorial structure translate to probabilistic structure? How can we seek to exploit the probabilistic structure to tackle some hard open problems in enumerative combinatorics?

Konstantin Matetski (Michigan State University)

Title: Exactly solvable interacting particle systems described by determinantal measures

Abstract: We introduce interacting particle systems whose evolutions are described by certain determinantal measures. Examples of such systems are variants of TASEP with different particle speeds, jump distributions, interactions, and memory lengths. An explicit biorthogonalization method allows writing the distribution functions in the form of Fredholm determinant formulas which are suitable for asymptotic analysis. The method of exact solution will be explained in the talk, and several previously unknown examples of particle systems will be demonstrated.

Torin Greenwood (North Dakota State University)

Title: Asymptotics and distributions via generating functions

Abstract: In analytic combinatorics, a primary goal is to automate the process of computing asymptotics or limiting distributions from a combinatorial description of a problem. For example, how many walks start at (0, 0), end at (n, 0), take steps from (1, -1), (1, 0), (1, 1), and never dip below the x-axis? Among these walks, what is the distribution of horizontal steps? To answer these questions, one can use the ”symbolic method” to encode the problem within a generating function, and then use singularity analysis to pull asymptotics out of the generating function. After looking at an array of applications in probability, we will see some areas where the theory of analytic combinatorics has not yet been fully developed.

Ioana Dumitriu (UCSD)

Title: TBD

Abstract: TBD