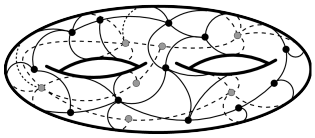
ICMAT Workshop
Recent Trends in Algebraic and Geometric Combinatorics



Nov. 27-29, 2013

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Contents

Over the past four decades, algebraic combinatorics has evolved into an important branch of modern mathematics. Nowadays, it plays an essential role in a wide variety of subjects, such as, for instance, Representation Theory, Number Theory, Free Probability, Quantum Field Theory, Statistical Mechanics, Control Theory, Geometric Integration Methods, Lyons' Rough Paths Theory, Percolation Theory, Discrete Geometry, Algebraic Geometry.

This 3-days workshop aims at bringing together leading researchers working in algebraic and geometric combinatorics. The three principal topics are: applications of modern combinatorics in algebra, enumerative combinatorics and combinatorial geometry. The workshop shall provide a platform for discussions around recent progress.

www.icmat.es

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1 Speakers and Schedule

1.1 Speakers

1) Christos A. Athanasiadis, *University of Athens*, Greece

2) Frédéric Chapoton, *Institut Camille Jordan*, France

3) Vladimir Dotsenko, *Trinity College Dublin*, Ireland

4) Valentin Féray, *Universität Zürich*, Switzerland

5) Christophe Hohlweg, *Université du Quebec á Montreal*, Canada

6) Joachim Kock, *Universitat Autónoma de Barcelona*, Spain

7) Christian Krattenthaler, *Universität Wien*, Austria

8) Marc Noy, *Universitat Politècnica de Catalunya*, Spain

9) Roland Speicher, *Saarland University*, Germany

10) Andrea Sportiello, *Laboratoire d'Informatique de Paris Nord*, France

11) Xavier Viennot, *Lab. Bordelais de Recherche en Informatique*, France

12) Volkmar Welker, *Philipps-Universität Marburg*, Germany

1.2 Schedule

Opening on Wednesday, 09:30 – Closing on Friday, 17:30

Wednesday, 27/11/2013

10:00 – 11:00	Talk 1 **Speicher**
– coffee break –	
11:30 – 12:30	Talk 2 **Athanasiadis**
– lunch –	
15:00 – 16:00	Talk 3 **Sportiello**
– coffee break –	
16:30 – 17:30	Talk 4 **Kock**

Thursday, 28/11/2013

10:00 – 11:00	Talk 1 **Noy**
– coffee break –	
11:30 – 12:30	Talk 2 **Féray**
– lunch –	
15:00 – 16:00	Talk 3 **Viennot**
– coffee break –	
16:30 – 17:30	Talk 4 **Hohlweg**

Friday, 29/11/2013

09:00 – 10:00	Talk 1 **Krattenhaler**
10:00 – 11:00	Talk 2 **Chapoton**
– coffee break –	
11:30 – 12:30 Special Event **Aula AZUL**	UAM-ICMAT Colloquium * *R. Speicher*
– lunch –	
15:00 – 16:00	Talk 3 **Dotsenko**
– coffee break –	
16:30 – 17:30	Talk 4 **Welker**

*Note: The Colloquium will take place in **Aula AZUL**, ICMAT.

Talks will take place in Aula NARANJA, which is equipped with blackboards and beamer.

2 Titles + Abstracts

Some recent results on subdivisions and local h-vectors

Christos A. Athanasiadis

Abstract: The enumerative theory of subdivisions of simplicial complexes was developed by Stanley in order to understand the effect of simplicial (and more general type of) subdivision on the h-vector of a simplicial complex. A key role in the theory is played by the concept of a local h-vector. This talk will focus on

(a) applications of this theory to subdivisions of flag simplicial homology spheres and their γ-vectors, and
(b) examples of simplicial subdivisons for which the computation of the local h-vector leads to interesting enumerative problems on colored permutations and noncrossing partitions.

Several related open problems will also be discussed.

On a tree-indexed series with two parameters

Frédéric Chapoton

Abstract: After recalling the rich algebraic setting involving free PreLie algebras and the combinatorics of rooted trees, I will describe an interesting tree-indexed series called Ω and its one-parameter and two-parameters generalizations that have appeared more recently. I will present a description of their coefficients using Ehrhart polynomials of lattice polytopes.

Patterns in shuffle trees

Vladimir Dotsenko

Abstract: Combinatorics of patterns (subwords) in words algebraically is motivated by Groebner bases for associative algebras. I shall discuss a far reaching generalisation of that analogy motivated by algebraic operads, and introduce a range of naturally arising questions on the borderline of algebra and combinatorics: some of them fully understood by now, some partly resolved, some only supported by computer experiments.

Dual combinatorics of Jack polynomials

Valentin Féray

Abstract: Jack polynomials are some one-parameter deformation of Schur functions, a well-known basis of the symmetric function ring. They have been introduced in 1970 and have been widely studied since.
Here, we follow a more recent approach, due to Michel Lassalle. This approach extends some work of Kerov and Olshanski on representation theory of symmetric groups. We will present this approach, state some conjecture also due to Michel Lassalle, explained some solved cases and finally present some lead to tackle the general case.
This involves the combinatorics of graphs embedded in (oriented and non-oriented) surfaces.

Words and Roots in Infinite Coxeter groups

Christophe Hohlweg

Abstract: The relations between roots and reduced words play a fundamental role in the study of Coxeter groups and related structures; for instance, they are at the heart of the proof of Brink and Howlett that the infinite Coxeter groups are automatic.

In this talk, we will discuss the case of infinite Coxeter groups in which the combinatorics of words and roots is mostly uncharted territory. In particular we will discuss a generalization of the notion of words, and of the weak order, through the notion of biclosed sets of roots. Along the way, we will explain the interplay between infinite root systems, imaginary cones and limits of roots that gives new tools to study infinite roots systems and words. This last part is based on joint works with M. Dyer, J.-P. Labbé and V. Ripoll.

Decompositions spaces, incidence algebras, and Möbius inversion
Joachim Kock

Abstract: I'll explain how the classical Leroux theory of incidence algebras of Möbius categories (which covers both locally finite posets (Rota) and finite decomposition monoids (Cartier–Foata)) admits a far-reaching generalisation in terms of what we call decomposition spaces (introduced independently by Dyckerhoff–Kapranov). They are simplicial (infinity) groupoids satisfying an exactness condition weaker than the Segal condition. Just as the Segal condition expresses up-to-homotopy composition, the new condition expresses decomposition.
Specific new examples covered by the theory include the Faà di Bruno and Connes–Kreimer bialgebras, and the Lawvere–Menni Hopf algebra of Möbius intervals which contains the universal Möbius function (but does not itself come from a Möbius category). Generic classes of examples include Schmitt incidence algebras of restriction species, and Hall algebras: the Waldhausen S-construction of abelian (or stable infinity) categories are decomposition spaces, and their incidence algebras are Hall algebras.
While explaining the basic theory and the key examples mentioned above, I will also spend some time explaining the bigger programme of upgrading some aspects of enumerative and algebraic combinatorics from finite sets to homotopy-finite groupoids and (infinity-groupoids), and how recent progress in higher category theory allows for this upgrade at a very reasonable price.
This is joint work with Imma Gálvez and Andy Tonks.

Non-crossing partitions for reflection groups and their cyclic sieving
Christian Krattenthaler

Abstract: Kreweras defined non-crossing partitions in 1972. Thirty years later, Bessis, and independently Brady and Watt discovered that there is a natural generalisation of Kreweras' non-crossing partitions for all finite reflection groups. Kreweras' original objects arise as the special case where the reflection group is the symmetric group. This definition has been further extended to "m-divisible" non-crossing partitions by Armstrong.
I shall recall the corresponding definitions, and then show that the "m-divisible" non-crossing partitions satisfy two instances of the so-called cyclic sieving phenomenon, a phenomenon originally formulated by Reiner, Stanton, and White, which since then has been observed in numerous contexts.

Logical limit laws for minor-closed classes of graphs

Marc Noy

Abstract: Let G be an addable minor-closed class of graphs. We prove that a zero-one law holds in monadic second-order logic (MSO) for connected graphs in G, and a convergence law in MSO for all graphs in G. For each surface S, we prove the existence of a zero-one law in first order logic (FO)

for connected graphs embeddable in S, and a convergence law in FO for all graphs embeddable in S. Moreover, the limiting probability that a given FO sentence is satisfied is independent of the surface S.
If G is an addable minor-closed class, we prove that the closure of the set of limiting probabilities is a finite union of intervals, and it is the same for FO and MSO. For the class of planar graphs it consists of exactly 108 intervals. We give examples of non-addable classes where the results are quite different: for instance, the zero-one law does not hold for caterpillars, even in FO.
This is joint work with Peter Heinig, Tobias Müller and Anusch Taraz.

Algebraic Combinatorics and Free Probability
Roland Speicher

Abstract: Free Probability has quite a few aspects which relate with algebraic and enumerative combinatorics; in particular, the appearance of non-crossing partitions and the Hopf-like structures behind subordination in free convolutions. I will address in my talk some of these connections.

Patterns in the deterministic Abelian Sandpile Model, and square-triangle tilings
Andrea Sportiello

Abstract: The Abelian Sandpile Model (ASM) is an automaton describing an idealised dynamics of 'avalanches' into an unstable pile of sand. In its "stochastic" implementation, it is known to be related to the Potts Model / Tutte Polynomial (specialised to connected subgraphs). The investigation of its behaviour under "deterministic" dynamics is similarly old, but precise quantitative results are mostly recent.
I present the results of common work with G. Paoletti and S. Caracciolo, aiming at the classification of periodic patterns emerging in the deterministic sandpile in $D = 2$, the determination of the emergence of remarkable exact fractal Sierpinski-like structures in various lattice realisations, and the illustration of how the different realisations fall "under one roof", through a projection procedure applied to an (universal?) Sierpinski-like configuration in the square-triangle tiling (that lives in $D = 4$).

Canopy of binary trees, intervals in associahedra and exclusion model in physics
Xavier Viennot

Abstract: In recent years many works have been done on associahedra, in particular intervals in the underlying Tamari lattice. We introduce the notion of canopy of a binary tree, which is the analog for binary trees of the classical notion of up-down sequence for permutations. We show the relation between this notion of canopy and some intervals in the associahedron. The determination of the size of such intervals is related to the computation of some stationary probabilities in a model of moving particles with exclusion (called TASEP) in the physics of dynamical systems.

Enumerative and Geometric Combinatorics of Initial Ideals for Classical Rings
Volkmar Welker

Abstract: In this talk we survey on connections between the certain extremal Groebner bases of classical ideals, such as determinantal ideals, symmetric determinantal ideals, Pfaffian ideals etc. and triangulated spheres, including multiassociahedra.