Submittee: Marni Mishna
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Title: FPSAC 2016 (Formal power series and algebraic combinatorics)
Event Type: Conference-Workshop

Location:
SFU Downtown Vancouver, BC

Dates:
July 4 - 8, 2016

Topic:
Topics include all aspects of combinatorics and their relations with other parts of mathematics, physics, computer science, and biology.

Methodology:
9 invited lectures, 27 contributed (refereed) lectures, 75 contributed (refereed) posters.

Objectives Achieved:
Over 230 participants came from a wide international audience, including over 100 Americans. There were over 60 students that received funding.

Scientific Highlights:
The quality of the talks was extremely high. The conference received 161 submissions for the 27+75 slots. This is the second highest submission and participation rate in the 28 year history of the conference.

Organizers:
Mishna, Marni, Math, SFU (Main organizer)
Chauve, Cedric, Math, SFU
Courtiel, Julien, Math, UBC/ PIMS
Elizalde, Sergi, Math, Dartmouth College
Fusy, Eric, CS, CNRS; Polytechnique
Melczer, Stephen, CS, University of Waterloo / Ecole normale superieure de Lyon
Pilaud, Vincent, CS, CNRS/ Ecole Polytechnique
Rechnitzer, Andrew, math, UBC
Yen, Lily, Math, SFU/ Capilano

Speakers:
Federico Ardila (San Francisco State University)
Jason Bell (University of Waterloo)
Ben Brubaker (University of Minnesota)
Guillaume Chapuy (CNRS/ UniversitÃ© Paris-Diderot)
Jennifer Morse (Drexel University)
Masato Okado (Osaka City University)
Margaret Readdy (University of Kentucky)
Jozsef Solymosi (University of British Columbia)
Mike Steel (University of Canterbury)

TITLES & ABSTRACTS:

Federico Ardila (San Francisco State University): The algebraic and combinatorial structure of generalized permutahedra.

Generalized permutahedra are a beautiful family of polytopes which are known to have a rich combinatorial structure. We explore the Hopf algebraic structure of this family, and use it to unify old results, prove new results, and answer open questions about families of interest such as graphs, matroids, posets, trees, set partitions, building sets, hypergraphs, and simplicial complexes.

The talk will be based on joint work with Marcelo Aguiar, and will assume no previous knowledge of Hopf algebras or generalized permutahedra. //

Jason Bell (University of Waterloo): Diagonals of rational power series and their uses in combinatorics, number theory, and computer science

Given a power series $F(x_1,...x_d) = \sum f_{i_1,\,i_d} x_1^{i_1}...x_d^{i_d}$, one can form a one-variable power series $\Delta(F)(t) = \sum f_{n,n,...,n} t^n$, called the diagonal of F. When F is the power series expansion of a rational function, the diagonal enjoys of F enjoys many nice properties, including satisfying a linear homogeneous differential equation with polynomial coefficients. Many natural generating functions arising in combinatorial enumeration can be expressed as diagonals and this fact often gives one a wealth of information about congruences of coefficients mod primes and asymptotic information. We give a survey of the theory of diagonals and discuss some more recent results and some of their applications to other areas of mathematics.//

Ben Brubaker (University of Minnesota): Explicit formulas for special functions: crystal bases, ice models, and Iwahori-Hecke algebras

We discuss various ways of obtaining explicit expressions for symmetric functions and their deformations, which are often realized as matrix coefficients for p-adic groups. The three methods featured are statistical mechanics (two-dimensional lattice models), crystal bases for highest weight representations, and symmetrizers in Iwahori-Hecke algebras.//

Guillaume Chapuy (CNRS / Universite Paris-Diderot): Counting Maps on Surfaces

I will talk about maps, which are graphs embedded on surfaces. The enumeration of maps was initiated in the 1950's by Tutte, who discovered that planar maps (when the surface is the sphere) are counted by beautiful formulas. This was just the beginning of a story that is still developing today and has connections to almost every part of combinatorics.

The question of understanding how the enumerative properties of maps depend on the genus g >= 0 of the underlying surface is especially interesting. Very strong results can be proved, coming from a variety of techniques, from representation theory of the symmetric group, to generatingfunctionology, integrable systems and tau-functions, or bijective combinatorics. However we still lack a general theory encapsulating all these results together. The look for a unification raises many questions and challenges for each of the tools involved.

In this talk I will show some of these results and some of these connections. //

Jennifer Morse (Drexel University): Discrete affairs with Macdonald and Gromov-Witten

After discussing the nature of problems in Schubert calculus, we will see how our lasting relationship with Macdonald symmetric functions has led us to find that Lascoux-SchÃ¼tzenberger charge on tableaux can be used as a tool in quantum, affine and equivariant Schubert calculus. We will also give a new formula for the monomial expansion of Macdonald polynomials using the charge statistic.//

Masato Okado (Osaka City University): Crystal bases and rigged configurations

In my talk I will report on the present status of our project to understand a certain identity, called X=M, that has arisen in the end of the 20th century from the studies of combinatorial aspects of quantum integrable systems. Both sides of X=M are as simple as

$$\sum_{b\in\mathcal{P}(B,\lambda)}q^{E(b)} = \sum_{\nu\in C(L(B),\lambda)}q^{c(\nu)}\prod_{a,i}{m^{(a)}_i+p^{(a)}_i\choose m^{(a)}_i}_q$$

but what it implies is surprisingly deep. For instance, it is related to the following topics:

Generalizing Lascoux-Schutzenberger's charge and Schutzenberger's involution to other root systems
Mysterious combinatorial bijection due to Kerov-Kirillov-Reshetikhin.
Calculating the number of irreducible modules in a tensor product of gl_n-modules of rectangular shapes.
Closed formula for a branching function corresponding to a pair of affine Lie algebras and its underlying finite-dimensional simple Lie algebra.
Linearizing a certain ultra-discrete nonlinear integrable system called box-ball system
Geometric crystals introduced by Berenstein-Kazhdan and a solution to the Yang-Baxter equation by positive birational maps.

For affine type A most (but not all!) topics are fairly well understood. However, apart from type A many conjectures are still waiting to be settled. For instance, item 2 of the above list was just worked out for type D only in this March. Taking this wonderful opportunity to talk at FPSAC meeting, I would like to persuade (especially young) people to join in this project.//

Margaret Readdy (University of Kentucky): Polytopes and Beyond

Grunbaum and Shephard remarked that there were three developments which foreshadowed the modern theory of convex polytopes:

The publication of Euclid's Elements and the five Platonic solids in 300 BC.

Euler's formula in a 1750 letter to Goldbach which states that $f_0 - f_1 + f_2 = 2$ holds for any 3-dimensional polytope, where f_i is the number of i-dimensional faces.

The discovery of polytopes in dimensions greater or equal to four by Schlafli in the 1850's.

We will use these as a springboard to describe the theory of convex polytopes leading into the 21st century and beyond. Our survey will include recent results for flag enumeration of polytopes, Bruhat graphs, balanced digraphs, Whitney stratified spaces and quasi-graded posets.//

Jozsef Solymosi (University of British Columbia): Geometric Incidences in Combinatorics

What is the maximum number of incidences determined by n points and m lines? The answer to this question is often hard to find depending on the underlining field and other possible constraints. On the other hand such questions arise naturally from various fields of mathematics and computer science, so it is important to understand incidence structures with high incidence numbers. I will mention some recent breakthrough results and many open problems. //

Mike Steel (University of Canterbury): Formal power series and combinatorial methods in phylogenetics

Phylogenetics is the reconstruction and analysis of evolutionary trees in systematic biology and other areas of classification (e.g. historical linguistics, epidemiology). The mathematics that underlies this field is based on combinatorics and discrete random processes. In this talk, I will highlight both established and recent phylogenetic applications of familiar combinatorial techniques that have proved useful for deriving new results on phylogenetic trees. In particular, I will describe how:
exponential generating functions for trees and forests can be used (together with Menger's theorem and multivariate Lagrange inversion) to enumerate phylogenies under a `minimal evolution' score;
every binary phylogenetic tree can be realized as a unique `perfect phylogeny' with just four functions (`characters') from the leaf set of the tree into an infinite discrete state space;
the probabilistic method provides an O(n^alpha) (for any 0 extended Polya urn models are relevant to speciation-extinction models that `evolve' phylogenetic trees.//

Links:
https://sites.google.com/site/fpsac2016/home

Comments / Miscellaneous:
PIMS funding was essential to us securing this event. The PIMS CRG-27 money paid for 33 students and postdocs to travel and participate. (American students were covered by NSA/ NSF)
