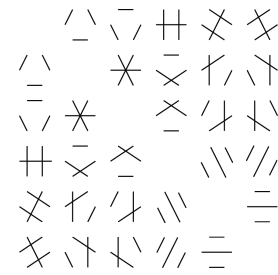# Mathematics Seminar

## Rocky Mountain Algebraic Combinatorics Seminar

### On classes of permutations avoiding 231 or 321

Nik Ruskuc
University of St Andrews, UK

Let $S$ denote the set of all finite permutations, considered as rearrangements of $\{1, ..., n\}$, $n = 1, 2, 3, ...$ Pattern involvement is a partial order on $S$. Of particular interest are downward closed sets under this ordering, usually called pattern classes. Such classes can be defined by specifying minimal forbidden permutations; we write $Av(\pi_1, \pi_2, ...)$ to denote the pattern class consisting of all permutations avoiding $\pi_1, \pi_2, ...$ Thus, for instance:

- $Av(21)$ consists of all increasing permutations $12...n$, $n \in N$;
- $Av(321)$ consists of all permutations with no descending subsequences of length 3;
- $Av(231)$ consists of all permutations that can be sorted by a stack.

In this talk I will discuss the subclasses contained in $Av(321)$ and $Av(231)$. I will set the scene by outlining some superficial similarities: e.g. they are both enumerated by the Catalan numbers. Then I will point out some radical differences: e.g. $Av(231)$ is well quasi ordered (it has no infinite antichains), while $Av(321)$ is not. Most of the talk will be devoted to an explication of some less obvious, but deeper, similarities between the subclasses, to do with their enumeration sequences. The new results concerning the subclasses of $Av(321)$ are a joint work with M. Albert, R. Brignall and V. Vatter.

### Combinatorial Polytopes in Algebraic and Geometric Complexity Theory

Joshua Grochow
University of Colorado, Boulder

Beginning in the 1960s with the rise of efficient algorithms for Linear Programming, polytopes have played an important role in computational complexity. The past 5 years have witnessed a surge of lower bound methods for and based on polytopes. In addition to discussing some of this history and the more general role of polytopes in complexity, we'll discuss two recent results: (1) (joint with K. Mulmuley and Y. Qiao) a use of polytopes in helping understand the geometric complexity theory approach to VP vs VNP (an algebraic analogue of P vs NP) and (2) how lower bounds on the extension complexity of polytopes imply monotone algebraic circuit lower bounds.

Weber 223
4–6 pm
Friday, March 2, 2018
(Refreshments in Weber 117, 3:30–4 pm)
Colorado State University

This is a joint Denver U / UC Boulder / UC Denver / U of Wyoming / CSU seminar that meets biweekly.
Anyone interested is welcome to join us at a local restaurant for dinner after the talks.

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