Schedule

All talks take place in lecture room **1.801** of the building “Casino” at Campus Westend.

Friday 9 May	
8:30 – 9:10	Registration
9:10 – 9:15	Welcome / Opening Ceremony
9:15 – 10:15	**Francisco Santos** “Recent results on unimodular triangulations of lattice polytopes”
10:15 – 10:45	Coffee Break
10:45 – 11:15	**Christian Ikenmeyer** “16051 formulas for Ottaviani’s invariant of cubic threefolds”
11:15 – 11:45	**Max Klimm** “Optimal Impartial Selection”
11:45 – 14:00	Lunch Break
14:00 – 15:00	**Karen Aardal** “GMI/Split cuts based on lattice information”
15:00 – 15:30	**Yury Person** “Blow-up lemmas”
15:30 – 16:00	Coffee Break
16:00 – 17:00	**Jacob Fox** “Combinatorics of permutations”
17:00 – 17:30	**Gennadiy Averkov** “Geometry of integral polytopes with a fixed number of interior integral points”
19:00 –	Conference dinner
Saturday 10 May	
9:00 – 10:00	**Jiří Matoušek** “Algorithmic aspects of embedding simplicial complexes in $\mathbb{R}^d$”
10:00 – 10:30	Coffee Break
10:30 – 10:45	Award of the Richard-Rado-Prize
10:45 – 11:15	Talk of the **Rado-Prize Winner**
11:15 – 11:45	**Marika Karbstein** “Combinatorial Aspects of the Steiner Connectivity Problem”
11:45 – 12:15	**Lutz Warnke** “Phase transitions in random graphs with dependencies”
12:15 – 13:30	Lunch Break
13:30 – 14:15	Meeting of the “Fachgruppe Diskrete Mathematik”
14:15 – 15:15	**Michael Drmota** “Combinatorics and shape characteristics of planar (and related) graph classes”
15:15 – 15:45	Coffee Break
15:45 – 16:15	**Karim Adiprasito** “The Upper Bound Theorem for Minkowski sums, and other results in combinatorial isoperimetry”
16:15 – 16:45	**Kanstantsin Pashkovich** “Cut polyhedron and forbidden minors ”

Abstracts

Recent results on unimodular triangulations of lattice polytopes

Francisco Santos
Universidad de Cantabria, Santander, Spain
Friday, May 9th, 9:15 – 10:15

A lattice polytope is a polytope with integer vertices (or with vertices lying in a point lattice). A triangulation (decomposition into simplices that intersect properly) of a lattice polytope is unimodular if all simplices are unimodular with respect to the lattice, that is, if their vertex sets are affine lattice bases.
Unimodularly triangulating a lattice polytope has applications ranging from Enumerative Combinatorics, to Integer Programming, to Algebraic Geometry. Sometimes the triangulations are required or seeked with additional properties, such as being regular and/or flag.
In this talk I will present several recent results on this topic, among them:

- What lattice polytopes with facet normals belonging to a root system possess unimodular triangulations? Those of type A (which include transportation polytopes) have regular, unimodular, and flag triangulations. Less trivial is the fact that type-B also have unimodular triangulations. For the other classical types C and D we do not know the answer, but in some of the exceptional types (e.g. F_4 and E_8) we know explicit examples of polytopes without unimodular triangulations.

- It is known that dilations and products of polytopes that have unimodular triangulations also have unimodular triangulations. We extend this to other operations, such as fiber products and semidirect products, which we introduce.

- A classical result of Knudsen, Mumford and Waterman (1973), motivated by the study of toric resolution of singularities, states that for every lattice polytope P there is a positive integer $k = k(P)$ such that the dilation kP has a unimodular triangulation. We present two results related with this: on the one hand we show that in dimension 3 every natural number greater than 3 except perhaps $k = 5$ is a valid dilation factor for every P. On the other hand we present an effective version of the KMW theorem, in which $k(P)$ is bounded by a double exponential in the dimension and volume of P. With the original proof (or the one from Bruns and Gubeladze 2009) it is on the one hand not easy to even write down an explicit bound, and the bound obtained would on the other hand certainly result in a tower of exponentials of length related to the volume of P.

Joint work with: Christian Haase, Goethe-Universität Frankfurt am Main, Germany;
Andreas Paffenholz, Technische Universität Darmstadt, Germany;
Lindsay Piechnik, High Point University, NC, USA;
Günter Ziegler, Freie Universität Berlin, Germany (results about 3-dimensional dilations).

16051 formulas for Ottaviani's invariant of cubic threefolds

Christian Ikenmeyer
Texas A&M University, College Station, TX, USA
Friday, May 9th, 10:45 – 11:15

We provide explicit combinatorial formulas for Ottaviani's degree 15 invariant which detects cubics in 5 variables that are sums of 7 cubes. Our approach is based on the chromatic properties of certain graphs and relies on computer searches and calculations.

Optimal Impartial Selection

Max Klimm
Technische Universität Berlin, Germany
Friday, May 9th, 11:15 – 11:45

We study the problem of selecting a member of a set of agents based on nominations by agents from that set. A selection mechanism is called impartial if the nominations of an agent do not influence the probability of selecting it. Designing impartial mechanisms is an important problem with applications in situations where representatives are selected from within a group or where publishing or funding decisions are made based on a process of peer review. Alon et al. (2011) conjecture that it is possible to impartially select a member with in expectation at least half the maximum number of nominations. We give a randomized mechanism that achieves this ratio thus proving their conjecture. Subject to impartiality, the factor of $1/2$ is best possible.

Joint work with: Felix Fischer, University of Cambridge, UK.

GMI/Split cuts based on lattice information

Karen Aardal
Delft University of Technology, The Netherlands and
Centrum Wiskunde & Informatica, Amsterdam, The Netherlands.
Friday, May 9th, 14:00 – 15:00

Cutting planes incorporated in a branch-and-bound framework is the most dominant solution approach for (mixed)-integer optimization problems.
One important family of cutting planes is the family of split cuts. A computational study by Balas and Saxena indicates that the first closure associated with the family of split inequalities is a very good approximation of the convex hull of feasible solution. It is, however, NP-hard to optimize a linear function over the split closure, so achieving these results is computationally expensive.
A special case of the split cuts, which can trivially be generated, is the family of GMI-inequalities that can be obtained from optimal basic feasible solutions. The computational effectiveness of these inequalities is however much more modest (Bixby, Gu, Rothberg, and Wunderling).
The discrepancy between the potential effectiveness of GMI/split inequalities indicated by the study of Balas and Saxena, and the results that so far can be realized by generating such inequalities from optimal basic solutions, led Cornuejols to suggest that one should look for deep split cuts that can be separated efficiently.
In our work we suggest a heuristic way of generating GMI/split inequalities that is based on information from the structure of the underlying lattice. We present examples and some initial computational indications.

Joint work with: Frederik von Heymann, Universität zu Köln, Germany;
Andrea Lodi, Università di Bologna, Italy;
Andrea Tramontani, Università di Bologna, Italy;
Laurence Wolsey, Université catholique de Louvain, Louvain-la-Neuve, Belgium.

Blow-up lemmas

Yury Person
Goethe-Universität Frankfurt am Main, Germany
Friday, May 9th, 15:00 – 15:30

The blow-up lemma of Komlós, Sárközy and Szemerédi is a powerful tool which, combined with the regularity lemma, allows one to embed large bounded degree graphs into dense graphs of sufficiently high minimum degree. In my talk I will present its recent generalizations to sparse graphs and discuss several applications.

Joint work with: Peter Allen, The London School of Economics and Political Science, UK;
Julia Böttcher, The London School of Economics and Political Science, UK;
Hiệp Hàn, Universidade de São Paolo, Brasil;
Yoshiharu Kohayakawa, Universidade de São Paolo, Brasil.

Combinatorics of permutations

Jacob Fox
Massachusetts Institute of Technology, Cambridge, MA, USA
Friday, May 9th, 16:00 – 17:00

For a permutation p, let $S_n(p)$ be the number of permutations on n letters avoiding p. A decade ago, Marcus and Tardos proved the celebrated Stanley-Wilf conjecture that, for each permutation p, $S_n(p)^{1/n}$ tends to a finite limit $L(p)$. Backed by numerical evidence, it has been conjectured by various researchers over the years that $L(p)$ is on the order of k^2 for every permutation p on k letters. We disprove this conjecture, showing that $L(p)$ is exponential in a power of k for almost all permutations p on k letters. The proof uses ideas from extremal and probabilistic combinatorics.

Geometry of integral polytopes with a fixed number of interior integral points

Gennadiy Averkov
Otto von Guericke Universität Magdeburg, Germany.
Friday, May 9th, 17:00 – 17:30

I will report on the recent progress in the study of d-dimensional polytopes with $k > 0$ interior integral points, paying special attention to the case $k = 1$. The special case $k = 1$ is important with a view towards applications in algebraic geometry and mixed-integer optimization. For fixed d and k, the family of such polytopes is finite up to affine transformation that preserve the integer lattice. On the other hand, the maximum volume of polytopes in this family is extremely large for large d.

Algorithmic aspects of embedding simplicial complexes in $\mathbb{R}^d$

Jiří Matoušek
Charles University, Prague, Czech Republic and Eidgenössische Technische Hochschule Zürich, Switzerland

Saturday, May 10th, 09:00 – 10:00

It is well known that one can test in linear time whether a given graph is planar. We consider the higher-dimensional generalization of this problem: given a k-dimensional simplicial complex K and a target dimension d, does K embed (piecewise linearly) into $\mathbb{R}^d$? The algorithmic complexity of this problem turns out to depend strongly on k and d. In some cases ($k = d - 1$ and $d > 4$) the problem is algorithmically undecidable, in others it is polynomial-time solvable, and in some cases we have results such as decidability or NP-hardness. We will survey the main results, which in some cases involve methods of classical homotopy theory combined with more recent algorithmic methods, and in others (embedding in $\mathbb{R}^3$) methods of 3-dimensional topology.

Joint work with: Martin Čadek, Masaryk University, Brno, Czech Republic;
Marek Krčál, Charles University, Prague, Czech Republic;
Eric Sedgwick, DePaul University, Chicago, IL, USA;
Francis Sergeraert, Université Joseph Fourier, Grenoble, France;
Martin Tancer, Institute of Science and Technology Austria, Klosterneuburg, Austria;
Lukáš Vokřínek, Masaryk University, Brno, Czech Republic;
Uli Wagner, Institute of Science and Technology Austria, Klosterneuburg, Austria.

Combinatorial Aspects of the Steiner Connectivity Problem

Marika Karbstein
Zuse-Institut Berlin, Germany

Saturday, May 10th, 11:15 – 11:45

The Steiner connectivity problem is to connect nodes in a graph by a cost minimal set of paths. More precisely, let G be a finite undirected graph and P a set of paths in G. Two nodes are connected by a subset P' of P if they are connected in the P'-induced subgraph. This problem can be interpreted in hypergraphs, and it has relations to the set covering problem and the Steiner tree problem. Connecting two specific nodes by a cost minimal set of paths yields a combinatorial companion theorem to Menger's theorem for hypergraphs. Connecting all nodes by a cost minimal set of paths can be defined as a submodular set covering problem which is known to be approximable within a factor of $\log k$. Connecting a subset of nodes (terminal nodes) by a cost minimal set of paths can be seen as a generalization of the Steiner tree problem to hypergraphs. We show that this problem is approximable within a factor of $k + 1$ if all paths contain at most k edges or if all paths contain at most k terminal nodes.

Phase transitions in random graphs with dependencies

Lutz Warnke
University of Cambridge, UK
Saturday, May 9th, 11:45 – 12:15

In the *Erdős–Rényi random graph process*, starting from an empty graph, in each step a new random edge is added to the evolving graph. One of its most interesting features is the 'percolation phase transition': as the ratio of the number of edges to vertices increases past a certain critical density, the global structure changes radically, from only small components to a single giant component plus small ones.
In this talk we consider *Achlioptas processes*, which have become a key example for random graph processes with dependencies between the edges. Starting from an empty graph these proceed as follows: in each step *two* potential edges are chosen uniformly at random, and using some rule *one* of them is selected and added to the evolving graph. We shall survey recent results concerning the percolation phase transition in Achlioptas processes, and discuss some of the key techniques used.

Combinatorics and shape characteristics of planar (and related) graph classes

Michael Drmota
Technische Universität Wien, Austria
Friday, May 9th, 14:45 – 15:45

Planar graphs and related graph classes like planar maps, series-parallel graphs etc. have been re-discussed quite intensively during the last 10 or 15 years, in particular many asymptotic shape characteristics could be characterized. The underlying random model is the uniform one, where all graphs of size n (in a particular graph class) are considered to be equally likely. The aim of this talk is give a survey on these results and to present the main proof techniques that range from "pure" combinatorics with generating functions to complex asymptotic and probabilistic methods.

The Upper Bound Theorem for Minkowski sums, and other results in combinatorial isoperimetry

Karim Alexander Adiprasito
Institut des Hautes Études Scientifiques, Bures-sur-Yvette, France
Saturday, May 10th, 14:15 – 14:45

In my talk, I will discuss the resolution the following classical Upper Bound Problem for Minkowski sums:
"Given a family (P_i) of m polytopes on (n_i) vertices, how many k-dimensional faces can the Minkowski sum of the polytopes P_i have? How many totally mixed faces can the Minkowski sum have?"
This has a wide range of applications, from enumerative algebraic geometry to robot motion planning. The resolution of this problem requires us to extend Stanley-Reisner Theory to relative simplicial complexes, which allows us to treat even more interesting combinatorial problems.

Joint work with: Raman Sanyal, Freie Universität Berlin, Germany.

Cut polyhedron and forbidden minors

Kanstantsin Pashkovich
Université libre de Bruxelles, Brussels, Belgium
Saturday, May 9th, 16:15 – 16:45

We study the cut polyhedron which comes from the minimum cut problem in the case of nonnegative weights; the cut polyhedron is defined as the convex hull of the characteristic vectors for all cuts in the graph plus the nonnengative orthant. The smallest (with respect to the number of inequalities and the size of coefficients) linear system with integer coefficients $Ax \geq b$ may involve inequalities with arbitrary large right-hand side. Here, we provide a characterization of the graphs for which the right-hand side is at most two, these are all the graphs without two fixed graphs as a minor.