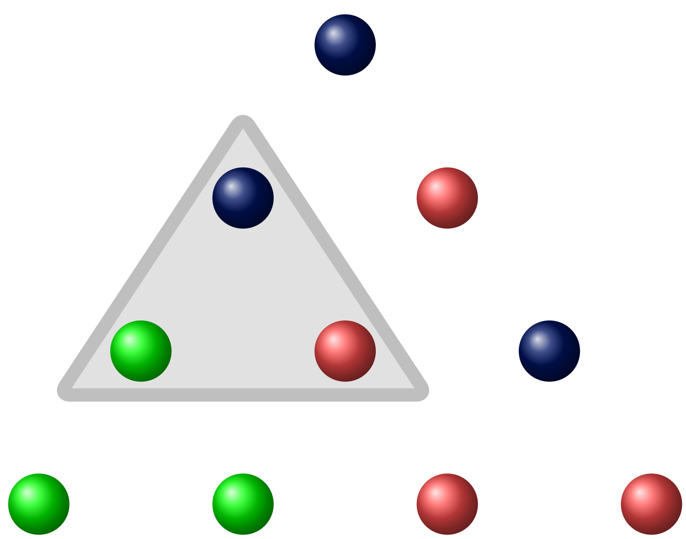
Colloquium on Combinatorics

November 12 - 13, 2010, Saarbrücken, Germany



Program and Abstract Booklet

Friday 12.11.2010

9:15	Welcome
09:30-10:30	**Dominique Foata** (University of Strasbourg) ***Descents and Decreases, Rises and Increases***
10:30-11:00	Coffee Break
11:00-12:25	Contributed Talks
12:30-14:00	Lunch
14:00-15:25	Contributed Talks
15:30-16:00	Coffee Break
16:00-16:55	Contributed Talks
17:00-17:30	Coffee Break
17:30-18:30	**Gabriele Nebe** (RWTH Aachen) ***An Extremal Even Unimodular Lattice of Dimension 72***
18:30	Conference Dinner

Saturday 13.11.2010

09:30-10:30	**Daniela Kühn** (Birmingham University) ***Hamilton Cycles in Graphs and Digraphs***
10:30-11:00	Coffee Break
11:00-12:25	Contributed Talks
12:30-13:30	Lunch
13:30-14:25	Contributed Talks
14:30-14:50	Coffee Break
14:50-15:50	**Marc Noy** (UPC Barcelona) ***Asymptotic Enumeration of Maps and Graphs***

All the invited talks will take place in the room HS 02, and the contributed talks (in three parallel sessions) in SR 014, 015 and 016. All rooms are in the building E1.3 . Food and coffee will be served in MPII (building E1.4).

Friday 12.11.2010

Time	Session 1	Session 2	Session 3
9:15	**Welcome**		
9:30	Invited Talk**: Dominique Foata** - Descents and Decreases, Rises and Increases		
10:30	**Coffee Break**		
11:00	**Jan-Christoph Schlage-Puchta** Additive combinatorics and convex geometry	**Karolina Sołtys** Scrabble is PSPACE-complete	**Oliver Schaudt** The Structure of Total Dominating Subgraphs
11:30	**Leif Jørgensen** Quotient Graphs from Subplane Partitions of Projective Planes	**Arash Rafiey** On the Combinatorial Structure of Tractable Cases in Digraph Homomorphism Problem	**Deryk Osthus** A Proof of Sumner's Universal Tournament Conjecture for Large Tournaments
12:00	**Madhusudan Manjunath** Riemann-Roch for the Sublattices of the Root Lattice and its Applications	**Regina Hildenbrandt** Partitions-Requirements-Matrices and Perturbed Partitions	**Nicolas Lichiardopol** Vertex-Disjoint Directed Cycles in Regular Tournaments
12:30	**Lunch**		
14:00	**Andreas Paffenholz** Cyclic Permutation Polytopes	**Jane Gao** Probabilities of Large Induced Subgraphs in Sparse Random Regular Graphs	**David Pritchard** Edge-Colouring Hypergraphs Properly (Covering with Matchings) or Polychromatically (Packing Covers)
14:30	**Timo de Wolff** Polytopes with Special Simplices	**Nikolaos Fountoulakis** Finding Maximum Matchings in Sparse Random Graphs	**Vera Weil** In Search of Counterexamples to Reed's Conjecture that are Minimal or Regular
15:00	**Carol Zamfirescu** Hamiltonian Properties of Generalized Pyramids	**Bernhard Gittenberger** On the Complexity of Boolean Functions Represented by Trees in Implicational Logic	**Jan Foniok** On Cutting Points in the Homomorphism Order
15:30	**Coffee Break**		
16:00	**Georg Seitz** The Number of Inversions in Simply Generated Trees	**Nico Van Cleemput** Generation of Generalized Classes of Cubic Graphs	**Susanna Reiss** Optimizing the Maximum Eigenvalue of the Weighted Laplacian of a Graph
16:30	**Veronika Kraus** On Vertices of Given Degree in Pólya Ttrees	**Jan Goedgebeur** Fast Generation of Snarks	**Tony Nixon** The Rigidity of Graphs on Surfaces
17:00	**Coffee Break**		
17:30	Invited Talk : **Gabriele Nebe -** An Extremal Even Unimodular Lattice of Dimension 72		
18:30	**Conference Dinner**		

Saturday 13.11.2010

Time	Session 1	Session 2	Session 3
9:30	Invited Talk: **Daniela Kühn** - Hamilton Cycles in Graphs and Digraphs		
10:30	**Coffee Break**		
11:00	**Jannik Matuschke** Approximation Algorithms for Capacitated Location Routing	**Martin Trinks** The Merrifield-Simmons Conjecture for a Generalization of Cycles	**Eckhard Steffen** Nowhere-Zero r-Flows
11:30	**Xujin Chen** The Maximum-Weight Stable Matching Problem: Duality and Efficiency	**Heiko Harborth** A Conjecture on Pascal's Triangle	**Alois Panholzer** Permutation Statistics for Generalized Stirling Permutations
12:00	**Carola Winzen** Black-Box Complexities for Randomized Search Heuristics	**Matthias Lenz** Hierarchical Zonotopal Power Ideals	**Carsten Lange** Minkowski Decompositions of Associahedra
12:30	**Lunch**		
13:30	**Raymond Lapus** On the Lower Bound for the Spread Process in a Graph	**Felix Effenberger** simpcomp - A GAP Toolbox for Simplicial Complexes	**Angela Mestre** Riordan Arrays via Umbral Calculus
14:00	**Tobias Friedrich** Quasirandom Load Balancing	**Jonathan Spreer** Simplicial Blowups	**Timo Kötzing** An Application of Graph Theory to Inductive Inference
14:30	**Coffee Break**		
14:50	Invited Talk: **Marc Noy** - Asymptotic Enumeration of Maps and Graphs		
15:50	**Goodbye**		

Traveling to Saarbrücken

You will probably try to reach Saarbrücken by train. If you have a flight to Frankfurt, this is extremely easy. There is a train station right in the terminal building. Trains run frequently. You have to buy a ticket before you board the train, and there you can also ask which trains to take.

From Stuttgart, Cologne or Dortmund you would also take the train, but this might take a good three to four hours. From Paris it is just a two hour train ride.

From Saarbrücken main train station ("Saarbrücken Hauptbahnhof") to your hotel

From the train station to your hotel you can use public transport: Buses and a tramway that is called "Saarbahn".

- The **Hotel B&B Saarbrücken** is located directly at the main train station.
- For **Hotel Madeleine** and the **Hotel Fuchs**, you take the tramway S1 with destination "Sarreguemines", "Brebach", or "Kleinblittersdorf" and get off at the stop "Johanneskirche" (two stops). You can also walk (15 minutes).
- For **Hotel Weller**, you take bus 124 with destination "Universität Busterminal" and get off at the stop "An der Trift" (five stops).
- For the **Youth Hostel**, you take bus 124 with destination "Universität Busterminal" and get off at the stop "Prinzenweiher/DJH" (six stops).
- For **Hotel Kaiserhof**, take the tramway S1 with destination "Sarreguemines", "Brebach", or "Kleinblittersdorf" and get off at the stop "Uhlandstrasse" (five stops).
- For the **Etap-Hotel**, take the tramway S1 with destination "Sarreguemines", "Brebach", or "Kleinblittersdorf" and get off at the stop "Kieselhumes". (six stops).

Getting to the MPII and back

All busses to the MPII will have "Universität" as part of their destination sign. You get off the bus at the stop "Universität Mensa". The MPI building is located on the left side a bit further down the street (Building number E1.4). You can also look at the map below. On the way back you depart from the same bus stop (other side of the road).

- From the main train station and from **Hotel B&B Saarbrücken**, take bus 124 with destination "Universität Busterminal" and get off at the stop "Universität Mensa (12 stops). On the way back, the destination is "Betriebsbahnhof".
- From the city center (**Hotel Madeleine** and **Hotel Fuchs** are located here) several buses to the MPII (stop "Universität Mensa") start at the bus stop "Rathaus": bus 101 with destination "Dudweiler Dudoplatz" (10 stops), bus 102 with destination "Dudweiler Dudoplatz" (13 stops), bus 109 with destination "Universität Busterminal " (13 stops), and bus 150 with destination "Neuweiler Sternplatz" (10 stops). On the way back to the city center you get off the bus at the bus stop "Johanneskirche". The destinations are "Füllengarten Siedlung" for bus 101, "Altenkessel Talstrasse" for bus 102, "Saarcenter/Goldene Bremm" for bus 109, and "Saarcenter" for bus 150.
- From the **Hotel Kaiserhof** (tramway stop "Uhlandstrasse") or the **Etap-Hotel** (tramway stop "Kieselhumes") take the tramway S1 back in direction main station (destinations "Siedlerheim" and "Riegelsberg Süd") and get off at the tramway stop "Johanneskirche" (three/four stops). Walk over to the bus stop "Rathaus" and proceed as above.

- From **Hotel Weller** (bus stop "An der Trift") or the **Youth Hostel** (bus stop "Prinzenweiher/DJH"), you enter the bus at the same stop you left when coming from the train station and go on to "Universität Mensa" taking bus 101 with destination "Dudweiler Dudoplatz", bus 124 with destination "Universität Busterminal", or bus 150 with destination "Neuweiler Sternplatz" (seven/six stops). On the way back, the destinations are "Füllengarten Siedlung" (bus 101), "Betriebsbahnhof" (bus 124), and "Saarcenter" (bus 150).

Abstracts of Invited Talks

DOMINIQUE FOATA (Strasbourg) [Friday, November 12, 09:30–10:30, Room HS 02]

Descents and Decreases, Rises and Increases

There have been several successful attempts to construct a noncommutative version or a q-analog of the celebrated MacMahon Master Theorem. However those q-analogs sitting in noncommutative algebras remain so far noninstrumental in word enumeration. Another approach consists of embedding the MacMahon Master identity into a multivariable environment, taking classical word statistics, such as descents and rises, into account. This provides a new tool for calculating several q-factorial series of generating polynomials for symmetric groups by multivariable statistics.

GABRIELE NEBE (Aachen) [Friday, November 12, 17:30–18:30, Room HS 02]

An Extremal Even Unimodular Lattice of Dimension 72

From the theory of modular forms it is known that the minimum of an even unimodular lattice of dimension n is always $\leq 2\lfloor n/24 \rfloor + 2$. Lattices achieving this bound are called extremal. Of particular interest are extremal unimodular lattices in the so called “jump dimensions", these are the multiples of 24. There are four even unimodular lattices known in the jump dimensions, the Leech lattice $\wedge$, the unique even unimodular lattice in dimension 24 without roots, and three lattices called P_{48p}, P_{48q}, P_{48n}, of dimension 48 which have minimum 6. It was a long standing open problem whether there exists an extremal 72-dimensional unimodular lattice. Many people tried to construct such a lattice, or to prove its non-existence. Most of these attempts are not documented, all constructed lattices contained vectors of norm 6. On August 11 this year I discovered such an extremal lattice.

DANIELA KÜHN (Birmingham) [Saturday, November 13, 09:30–10:30, Room HS 02]

Hamilton Cycles in Graphs and Digraphs

In my talk I will discuss several conjectures on Hamilton cycles in graphs and directed graphs. Here are 2 examples of such conjectures. A classical result on Hamilton cycles is Dirac's theorem which states that every graph on n vertices with minimum degree at least n/2 contains a Hamilton cycle. Nash-Williams showed that such a graph even contains many edge-disjoint Hamilton cycle and in 1971 he proposed a conjecture about the maximal number of edge-disjoint Hamilton cycles one can guarantee. A conjecture of Kelly from 1968 states that every regular tournament can be decomposed into edge-disjoint Hamilton cycles. (A tournament is an orientation of a complete graph.) I will describe recent results towards these and related conjectures and mention some open problems. The results in this talk will be joint work with Demetres Christofides, Peter Keevash, Fiachra Knox, Richard Mycroft, Deryk Osthus and Andrew Treglown.

MARK NOY (Barcelona) [Saturday, November 13, 14:50–15:50, Room HS 02]

Asymptotic Enumeration of Maps and Graphs

In the 1960s, in his series of fundamental “censuspapers, Tutte founded the enumerative theory of planar maps. Since then, the theory has grown enormously, extending to maps on surfaces, to unembedded graphs on surfaces, and to minor-closed classes of graphs. We will pay particular attention to properties of random planar graphs, and discuss basic parameters and also extremal parameters like maximum degree, diameter, and largest k-connected components. For instance, with high probability a random (labelled) planar graph with n vertices has $2.21^{*}n$ edges, a connected component containing $n - O(1)$ vertices, a block (2-connected component) containing $0.96^{*}n$ vertices, maximum degree $2.53^{*}\log(n)$, and diameter of order roughly $n^{1/4}$. The talk will be kept at a non-technical level, giving at some point brief indications on the tools needed from complex analysis.

Abstracts

Friday, November 12, 11:00–12:30

JAN-CHRISTOPH SCHLAGE-PUCHTA (Ghent) [11:00–11:25, Room SR 014]

Additive Combinatorics and Convex Geometry

This is joint work with G. Bhowmik. Let p be a large prime, $\mathbb{F}_p$ be the field with p elements. We show how a zero-sum problems in $\mathbb{F}_p^d$ can be reduced to a problem in combinatorial convex geometry in $\mathbb{R}^d$. As applications we show that every large prime p has property D, a generalization of property B, and that every sequence of $(9+\epsilon)p$ points in $\mathbb{F}_p^3$ contains a zero-sum subsequence of length p.

KAROLINA SOLTYS (Paris) [11:00–11:25, Room SR 015]

Scrabble is PSPACE-complete

We study the computational complexity of the game of Scrabble. We prove the PSPACE-completeness of a certain natural model of the game, showing NP-completeness of Scrabble solitaire game as an intermediate result.

OLIVER SCHAUDT (Cologne) [11:00–11:25, Room SR 016]

The Structure of Total Dominating Subgraphs

Recently, Bacsó and Tuza gave a full characterization of the graphs whose every induced subgraph has a connected dominating set satisfying an arbitrary prescribed hereditary property. Using their result, we derive a similar characterization of the graphs that hereditarily have a total dominating set whose connected components satisfy certain prescribed hereditary properties. In particular, we give a characterization of the graphs that hereditarily have a total dominating set inducing the disjoint union of complete graphs. This inherits a characterization of the graphs whose any subgraph has a vertex-dominating induced matching. Furthermore, we introduce the notion of total dominating sets with maximal structure and prove their existence on C_5-free graphs. We then show how they can be efficiently computed on $(5,2)$-chordal graphs.

LEIF JØRGENSEN (Aalborg) [11:30–11:55, Room SR 014]

Quotient Graphs from Subplane Partitions of Projective Planes

Fossorier, Ježek, Nation and Pogel (2004) considered partitions of a projective plane of order n into subplanes $\pi_1, \ldots, \pi_v$ of order q with the property that for each pair (i,j) either each point of π_i is incident with a line of π_j or no point of π_i is incident with a line of π_j.

They proved that the quotient digraph of such a partition with vertices $\pi_1, \ldots, \pi_v$ and an edge $\pi_i \to \pi_j$ if the points of π_i are incident with lines of π_j has the property that the number of common out-neighbours of two vertices joined by b edges is $q^2 + (1-b)(q+1)$.

In this talk I will consider subplane partitions of desarguesian planes and properties of their quotient graphs. These graphs can be constructed from a generalization of difference set in the cyclic group. I conjecture that if n is an odd power of q then the digraph has no directed 2-cycle.

Arash Rafiey (Switzerland) [11:30–11:55, Room SR 015]

On the Combinatorial Structure of Tractable Cases in Digraph Homomorphism Problem

We talk about List Homomorphism Problems and Minimum Cost Homomorphism Problems. In the list homomorphism problems we introduce the key concept "digraph asteroidal triple (DAT)". If a digraph H has a DAT, then the list homomorphism problem for H is NP-complete; and a DAT-free digraph H has a polynomial time solvable list homomorphism problem. DAT-free digraphs can be recognized in polynomial time.

In the minimum cost homomorphism problems, digraphs with Min-Max orderings play an important rule. These digraphs are analogues of proper interval graphs and bigraphs. They can be equivalently described by a geometric representation with two inclusion-free families of intervals, and we call them monotone proper interval digraphs. The minimum cost homomorphism problems to these digraphs (and to digraphs with certain extended Min-Max orderings) admit polynomial time algorithms. We give a forbidden structure characterization of monotone proper interval digraphs which implies a polynomial time recognition algorithm.

Deryk Osthus (Birmingham) [11:30–11:55, Room SR 016]

A Proof of Sumner's universal tournament conjecture for large tournaments

Sumner's universal tournament conjecture states that any tournament on $2n-2$ vertices contains a copy of any directed tree on n vertices. In my talk I will discuss a proof of this conjecture for large n as well as related results and open problems. This is joint work with Richard Mycroft and Daniela Kühn.

Madhusudan Manjunath (Saarbrüken) [12:00–12:25, Room SR 014]

Riemann-Roch for the Sublattices of the Root Lattice and its Applications

Recently, Baker and Norine (*Advances in Mathematics*, 215(**2**): 766-788, 2007) found new analogies between graphs and Riemann surfaces by developing a Riemann-Roch machinery on a finite graph G. In this talk, we outline a Riemann-Roch Theorem for sub-lattices of the root lattice A_n by following the work of Baker and Norine, and establish connections between the Riemann-Roch theory and the Voronoi diagrams of lattices under certain simplicial distance functions. In this way, we rediscover the work of Baker and Norine from a geometric point of view and generalise their results to other sub-lattices of A_n. In particular, we provide a geometric approach for the study of the Laplacian of graphs. We will also discuss some algorithmic aspects and applications to classification problems.

This is joint work with Omid Amini, École Normale Supérieure, Paris, France.

Regina Hildenbrandt (Ilmenau) [12:00–12:25, Room SR 015]

Partitions-Requirements-Matrices and Perturbed Partitions

Partitions-requirements-matrices (PRMs) ("in the strict meaning") are matrices of transition probabilities of so-called SDDP problems which are formulated as Markov decision processes. (The **S**tochastic **D**ynamic **D**istance Optimal **P**artitioning problem is an extremely complex Operations Research problem. It shows several connections with k-server problems).

PRMs themselves represent interesting almost self-evident combinatorial structures, which are not otherwise found in literature. PRMs are constructed on the basis of restricted partitions of integers. The definition of PRMs includes that PRMs can be initially computed by means of simple enumeration, however a laborious method. In addition, there is a main difficulty to deal with: No formulas are known for most of the.

A polynomial, and sometimes an exponential, dependence of the elements of PRMs on the parameters, which determines the restrictions of the partitions, can be shown in the case of discrete uniformly distributed requirements by means of "perturbed partitions".

Nicolas Lichiardopol (Salon) [12:00–12:25, Room SR 016]

Vertex-Disjoint Directed Cycles in Regular Tournaments

J-C. Bermond and C. Thomassen conjectured in 1981 that for given $r \geq 1$, every digraph of minimum out-degree at least $2r-1$ contains at least r vertex-disjoint directed cycles. In 2006, J-S. Sereni, A. Por and the author, proved that for $r \geq 1$, every regular tournament T of degree $2r-1$ contains at least r vertex-disjoint directed triangles, which shows that the Bermond-Thomassen conjecture is true for such a tournament. In this talk, I give a sharper lower bound on the maximum number of vertex-disjoint directed triangles of T.

Friday, November 12, 14:00–16:30

Andreas Paffenholz (Darmstadt) [14:00–14:25, Room SR 014]

Cyclic Permutation Polytopes

A permutation polytope is the convex hull of a subgroup of permutation matrices. These polytopes are a special class of 0/1-polytopes. A well-known example is the is the Birkhoff polytope defined by the symmetric group S_n. This has been extensively studied in the literature. Much less is known for general permutation polytopes.

In my talk I will start with some basics about permutation polytopes and connections between the group and the polytope. The main focus will be on recent results in the special class of permutation polytopes defined by cyclic groups. This class coincides with certain marginal polytopes. I will explain basic properties and give some results on their combinatorial structure. In particular, this will completely characterize the polytope if the generator of the group has two orbits. For generators with three orbits I will show that they have exponentially many facets.

This is joint work with Barbara Baumeister, Christian Haase, and Benjamin Nill.

Jane Gao (Saarbrüken) [14:00–14:25, Room SR 015]

Probabilities of Large Induced Subgraphs in Sparse Random Regular Graphs

We compute the probability that the subgraph induced by a given set of vertices in a random regular graph $\mathcal{G}_{n,d}$ is a graph H, where the size of H can be arbitrary between 1 and n. Our result holds for all $d = o(n^{1/3})$. We also extend the result to random graphs with given degree sequences. The result has several applications. This is a collaboration with Yi Su and Nick Wormald.

David Pritchard (Lausanne) [14:00–14:25, Room SR 016]

Edge-Colouring Hypergraphs Properly (Covering with Matchings) or Polychromatically (Packing Covers)

Let the *chromatic index* of a hypergraph be the smallest number of colours needed to colour the edges such that similarly-coloured edges are disjoint. Likewise, let the *cover index* be the maximum number of colours so that each colour class covers all vertices. Trivially the chromatic index is at least the maximum degree, and the cover index is at most the minimum degree. We survey some classes of structured hypergraphs and ask how far the trivial bounds are from tight. We are motivated by a large amount of recent work in this area for geometric settings.

This is joint work with Thomas Rothvoß, available at arXiv:1009.6144.

Timo de Wolff (Frankfurt) [14:30–14:55, Room SR 014]

Polytopes with Special Simplices

For a polytope P a simplex S with vertex set V(S) is called a special simplex if every facet of P contains all but exactly one vertex of S.

Polytopes with special simplex have applications in Ehrhart theory, toric rings and were just used by F. Santos to construct a counter-example disproving the Hirsch conjecture.

In this talk we give an overview about the class of polytopes with special simplex: We motivate a distinction between meek and wild polytopes with special simplex and show that a combinatorial classification and an explicit geometric construction of the meek ones are possible. Furthermore we demonstrate that wild polytopes with special simplex may be constructed out of meek ones by intersection with certain hyperplanes.

NIKOLAOS FOUNTOULAKIS (Saarbrücken) [14:30–14:55, Room SR 015]

Finding Maximum Matchings in Sparse Random Graphs

This work deals with finding augmenting paths in sparse random graphs. Working on the $G_{n,c/n}$ model of random graphs, where on a set of n vertices each potential edge appears independently with probability c/n, we show that for any fixed $c > 1$, with high probability given a matching which leaves at least two unmatched vertices in any one of the components of the random graph, there exists an augmenting path between them that has length $O(\log n)$. This has implications on the average-case running time of known algorithms that find maximum matchings on graphs and improves on a result of Bast, Mehlhorn, Schäfer and Tamaki, who showed this for large enough c.
(This is joint work with K. Panagiotou.)

VERA WEIL (Cologne) [14:30–14:55, Room SR 016]

In Search of Counterexamples to Reed's Conjecture that are Minimal or Regular

In 1998, Reed conjectured that for any graph G the following inequality holds: $\chi(G) \leq \left\lceil \frac{\Delta(G)+1+\omega(G)}{2} \right\rceil$, where $\Delta(G)$ denotes the maximum degree, $\omega(G)$ denotes the clique number and $\chi(G)$ denotes the chromatic number of G. In order to investigate the conjecture for simple, finite and undirected graphs, we gather properties of counterexamples to Reed's conjecture.
Let $p \in \mathbb{N}$. A p-crown consists of a p-clique in which every node has exactly one further neighbor of degree 1. A $K_p - e$ is obtained by removing exactly one edge from the complete graph K_p. We prove the following:

Theorem. *Let G be a minimal counterexample to Reed's conjecture and let $p \in \mathbb{N}$. Then G contains a $p+1$-crown or a $K_{\lceil \frac{\omega(G)}{p} \rceil + 2} - e$.*

Moreover, we describe a construction which embeds an irregular counterexample G in a regular graph preserving $\chi(G)$, $\omega(G)$ and $\Delta(G)$ and in some cases even the girth of G. This implies that it suffices to prove Reed's conjecture for regular graphs.

CAROL T. ZAMFIRESCU (Dortmund) [15:00–15:25, Room SR 014]

Hamiltonian Properties of Generalized Pyramids

Following work of Tutte, Dirac, and Robertson, Halin studied those n-connected graphs for which the deletion of an arbitrary edge decreases their connectedness. As an example he gave the following construction. Let T be a tree without vertice of degree 2. We now add to T a cycle C with the leaves of T as vertices such that the resulting graph $H = T \cup C$ is planar. Lovász and Plummer later coined the term *Halin graph* for above construction. A polytope P is called a *k-pyramid*, if it has at most k pairwise disjoint cubic facets $F_1, ..., F_k$, called *bases*, such that every other facet has some neighbouring base. Of course, a pyramid is a particular case of a 1-pyramid, while any combinatorial prism is a particular case of a 2-pyramid. The 1-skeletons of 1-pyramids are precisely Halin graphs. It was proven by Bondy that they are all hamiltonian. Is hamiltonicity preserved in k-pyramids for larger values of k? This is the question we will address in the talk.

BERNHARD GITTENBERGER (Wien) [15:00–15:25, Room SR 015]

On the Complexity of Boolean Functions Represented by Trees in Implicational Logic

This is joint work with Hervé Fournier (Université Paris 7), Danièle Gardy (Université de Versailles), and Antoine Genitrini (Université Pierre et Marie Curie).

We consider Boolean expressions built on the single connector implication and positive literals. Assuming all expressions of a given size to be equally likely, we prove that we can define a probability distribution on the set of Boolean functions expressible in this system. We show how to approximate the probability of a function f when the number of variables grows to infinity, and that this asymptotic probability is related to the complexity of f. We also prove that most expressions computing any given function in this system are simple in a certain sense. The probability of all read-once functions of a given complexity is also evaluated in this model.

JAN FONIOK (Zurich) [15:00–15:25, Room SR 016]

On Cutting Points in the Homomorphism Order

TA *homomorphism* of digraphs is a mapping between the vertex sets that preserves all arcs. The relation "existence of a homomorphism" on the class of all digraphs is a preorder. By factorising over the obvious equivalence relation, we become a partially ordered set, called the *homomorphism order*.

This poset has many interesting properties. For instance, it is an embedding-universal countable poset. Moreover, it is almost dense. All non-dense parts correspond to so-called *homomorphism dualities*. Also, all its finite maximal antichain correspond to homomorphism dualities.

A *cutting point* in a poset P is an element c of P such that there exist $a < b$ and the interval $[a, b] = [a, c] \cup [c, b]$. In other words, every element of the interval $[a, b]$ is comparable with c.

To characterise all cutting points in the homomorphism order is still an open problem. I will show some cutting points (once again, corresponding to homomorphism dualities) and maybe conjecture that no other cutting points exist. Counterexamples are welcome.

GEORG SEITZ (Vienna) [16:00–16:25, Room SR 014]

The number of inversions in simply generated trees

Consider a rooted tree T labelled with the integers $1, \dots, n$, where n is the number of nodes of T. An *inversion* in T is a pair of nodes (i, j), such that $i > j$ and node i lies on the (unique) path from the root to node j.

For some important tree families exact results on the number of inversions are known, e.g., for Cayley trees, ordered trees and cyclic trees. These are examples of *simply generated* tree families, i.e., families $\mathcal{T}$ which can be described by a formal equation of the form $\mathcal{T} = \circ \times \varphi(\mathcal{T})$, where $\circ$ is a node and $\varphi(\mathcal{T})$ a substituted structure.

We extend the existing work by a study of the limiting behaviour of the number of inversions in arbitrary simply generated tree families.

NICO VAN CLEEMPUT (Ghent) [16:00–16:25, Room SR 015]

Generation of Generalized Classes of Cubic Graphs

In this talk we describe a generator for more general classes of cubic graphs, like cubic graphs with loops, cubic multigraphs, cubic graphs with semi-edges (i.e. dangling edges) and any combination of these. The generator is based on a generator for simple cubic graphs. We will describe how the graphs can be constructed from simple graphs and will describe the isomorphism rejection methods which are based on McKay's canonical construction path method and the homomorphism principle. The problem is first translated to the generation of (multi)graphs with degree 1 and 3. In a later phase the vertices with degree 1 give rise to the loops and/or the semi-edges. We will also present the results of our generation. This is joint work with Gunnar Brinkmann and Tomaž Pisanski.

Susanna Reiss (Chemnitz) [16:00–16:25, Room SR 016]

Optimizing the Maximum Eigenvalue of the Weighted Laplacian of a Graph

Let $G = (N, E)$ be a simple, undirected graph with at least one edge. Our main purpose is to study the connection of eigenspaces of the graphs Laplacian $L(G)$ and graph properties. Therefore we analyse optimal solutions of

$$\min \lambda_{\max}(L_w),$$

i.e. the minimal maximum eigenvalue of the (edge-) weighted Laplacian and the semidefinite dual program. We get an embedding of the graph in $\mathbb{R}^{|N|}$ and connections to its separator structure.
(Joint work with Frank Göring and Christoph Helmberg.)

Veronika Kraus (Vienna) [16:30–16:55, Room SR 014]

On vertices of given degree in Pólya trees

Let $\mathcal{T}_n$ be the set of rooted unlabelled non-plane trees, known as Pólya trees, on n vertices. It has been shown that the random variable $X_n^{(d)}$, counting the number of vertices of degree d in a tree $T \in \mathcal{T}_n$ drawn uniformly at random, has expected value $\mathbb{E}(X_n^{(d)}) = \mu_d n + \mathcal{O}(1)$, with $\mu_d = \frac{2C}{b^2\sqrt{\rho}}\rho^d$, where $\rho \approx 0.3383219$ is the singularity of the generating function $T(x)$ of Pólya trees and $C \approx 7.7581604$ and $b \approx 2.6811266$ are known constants.
Let $L_n^{(d)}(k)$ be the number of nodes of degree d at distance k from the root in a random Pólya tree $T \in \mathcal{T}_n$ of size n, and $L_n^{(d)}(t)$ be the stochastic process obtained by linear interpolation. We prove the following refinement.

Theorem. *Let $l_n^{(d)}(t) = \frac{1}{\sqrt{n}} L_n^{(d)}(t\sqrt{n})$, and $l(t)$ denote the local time of a standard Brownian excursion. Then $l_n^{(d)}(t)$ converges weakly to the local time of a Brownian excursion, i.e., we have*

$$(l_n^{(d)}(t))_{t\geq 0} \xrightarrow{w} \mu_d \frac{b\sqrt{b}}{2\sqrt{2}} \cdot l\left(\frac{b\sqrt{\rho}}{2\sqrt{2}}t\right)_{t\geq 0}.$$

Jan Goedgebeur (Ghent) [16:30–16:55, Room SR 015]

Fast Generation of Snarks

In the literature the connectivity requirements for a cubic graph to be called a snark vary in strength. Here a snark is a simple, cyclically 4-edge connected cubic graph with girth ≥ 4 and chromatic index 4 (i.e. the edges cannot be coloured with 3 colours). Existing generators for snarks apply a filter to the output generated by fast generators for all cubic graphs. The generator we will present in this talk uses the colourability conditions already during the construction. The methods to reject isomorphic copies are based on McKay's canonical construction path method. We will provide details on how to efficiently implement these methods for snarks and give some optimizations. Furthermore we will explain how to predict that an intermediate graph cannot produce a snark by updating colourings of intermediate graphs and using Kempe chains. The generator presented here is more than 23 times faster than former generators for snarks.

This is joint work with Gunnar Brinkmann.

TONY NIXON (Lancaster) [16:30–16:55, Room SR 016]

The Rigidity of Graphs on Surfaces

In combinatorial rigidity theory it is well known that minimally rigid 2-dimensional (bar-joint) frameworks can be characterised in purely combinatorial terms, using inductive constructions, vertex-edge counting or spanning tree decompositions. In this talk we will show that such characterisations are also possible on frameworks constrained to certain 2-dimensional surfaces. In particular the main result of the talk is that a graph $G = (V, E)$ has a minimally rigid generic realisation on a cylinder if and only if $|E| = 2|V| - 2$ and for every subgraph $G' = (V', E')$ of G $|E'| \leq 2|V'| - 2$.

Saturday, November 13, 11:00–12:30

JANNIK MATUSCHKE (Berlin) [11:00–11:25, Room SR 014]

Approximation Algorithms for Capacitated Location Routing

The *location routing problem* integrates the two classical optimization problems of *facility location* and *vehicle routing*, addressing both location and tour planning decisions in a single step. Given a graph whose vertex set consists of facilities and clients with given demands, the problem is to find a subset of facilities that have to be opened, and a set of tours originating from those facilities, serving all clients while at the same time respecting the (uniform) capacity limitation of the vehicles in use and minimizing the incurred opening and connection costs.

We derive the first constant factor approximation algorithm for this problem and several variants, including a prize-collecting version, a group version, and a variant where cross-docking is allowed. Our results originate from combining algorithms for facility location and spanning tree problems that provide lower bounds on the value of an optimal solution.

MARTIN TRINKS (Mittweida) [11:00–11:25, Room SR 015]

The Merrifield-Simmons Conjecture for a Generalization of Cycles

Let $G = (V, E)$ be a graph and $\sigma(G)$ the number of independent (vertex) sets in G. Then the Merrifield-Simmons conjecture states that the sign of the term $\sigma(G_{-u}) \cdot \sigma(G_{-v}) - \sigma(G) \cdot \sigma(G_{-u-v})$ only depends on the parity of the distance of the vertices $u, v \in V$ in G. We restate that the conjecture holds for cycles by a proof using properties of Fibonacci numbers and generalize this result.

ECKHARD STEFFEN (Paderborn) [11:00–11:25, Room SR 016]

Nowhere-Zero r-Flows

The talk will be about well known conjectures on nowhere-zero flows on graphs, e.g. 5-flow conjecture (Tutte, 1954), 3-flow-conjecture (Tutte 1966), and conjectures of Jaeger. In the first part of the talk, we show that highly cyclically edge-connected cubic graphs have a nowhere-zero 5-flow. In the second part we prove some flow conjectures to be true for nearly nowhere-zero r-flow graphs (r rational number). A graph G is a nearly nowhere-zero r-flow graph, if it has an edge $e \in E(G)$, such that $G - e$ has a nowhere-zero r-flow.

XUJIN CHEN (China) [11:30–11:55, Room SR 014]

The Maximum-weight Stable Matching Problem: Duality and Efficiency

Given a preference system $(G, \prec)$ and an integral weight function defined on the edge set of G (not necessarily bipartite), the maximum-weight stable matching problem is to find a stable matching of $(G, \prec)$ with maximum total weight. In this talk, we consider this NP-hard problem using linear programming and polyhedral approaches. Theoretically, we show that the Rothblum system for defining the fractional stable matching polytope of $(G, \prec)$ is totally dual integral if and only if this polytope is integral if and only if $(G, \prec)$ contains no so-called semistable partitions with odd cycles. Algorithmically, we present a combinatorial polynomial-time algorithm for the maximum-weight stable matching problem and its dual on any preference system containing no semistable partitions with odd cycles. (Joint work with Guoli Ding, Xiaodong Hu, and Wenan Zang)

Heiko Harborth (Braunschweig) [11:30–11:55, Room SR 015]

A Conjecture on Pascal's Triangle

For a prime number p consider Pascal's triangle reduced modulo p. Let $a_i(n)$ count the number of residues in row n. If the equations

$$c_0a_0(n) + c_1a_1(n) + ... + c_p - 1a_p - 1(n) = 0$$

are fulfilled for all n then it is conjectured by H.-D. Gronau and M. Krüppel that $c_i = 0$ for $0 <= i <= p - 1$.

A partial proof for infinitely many prime numbers is presented.

Alois Panholzer (Wien) [11:30–11:55, Room SR 015]

Permutation Statistics for Generalized Stirling Permutations

Stirling permutations are a class of restricted permutations of multisets introduced by Gessel and Stanley. We consider Stirling permutations and generalizations and establish bijective links between these combinatorial objects and certain families of increasing trees. Our main interest is the distributional analysis of several "permutation statistics" for these objects, i.e., describing the exact and asymptotic behaviour of various parameters in generalized Stirling permutations. In our analysis we show results for the number of ascents, descents and plateaux, the number of blocks, the sizes of the blocks, the number of left-to-right minima and left-to-right maxima, the distance between occurrences of elements, and the number of inversions. To get the results we first use the before mentioned bijections, which also link the parameters under consideration with certain quantities in increasing trees. Then we use several techniques ranging from generating functions, connections to Pólya urn models, martingales, and Stein's method for analyzing them.

Carola Winzen (Saarbrücken) [12:00–12:25, Room SR 014]

Black-Box Complexities for Randomized Search Heuristics

Consider the following game. Carole fixes an arbitrary bit-string $x \in 0, 1^n$. Paul tries to determine it. In each round, he may ask an arbitrary bit-string and Carole will answer in how many positions the two strings agree. How many questions does Paul need? Does this number increase if Carole does not answer exactly in how many bits the strings agree but only ranks Paul's queries?

We call games like this black-box models. They have been introduced to analyze the performance of classes of algorithms on different problems. Here, the underlying idea is to define a class of algorithms and to analyze it via some joint properties. If successfully analyzed, black-box models immediately yield upper and/or lower bounds for the whole class of algorithms. Our main motivation is the analysis of random search heuristics. In this talk we present 3 different models (each covering a different class of search heuristics). They will provide unexpected answers to the above mentioned game between Carole and Paul.

Matthias Lenz (Berlin) [12:00–12:25, Room SR 015]

Hierarchical Zonotopal Power Ideals

Zonotopal algebra deals with ideals and vector spaces of polynomials that are related to several combinatorial and geometric structures defined by a finite sequence of vectors. Given such a sequence X, an integer $k \geq -1$ and an upper set in the lattice of flats of the matroid defined by X, we define and study the associated *hierarchical zonotopal power ideal*. This ideal is generated by powers of linear polynomials. Its Hilbert series depends only on the matroid structure of X. It is related to various other matroid invariants, *e. g.* the Tutte polynomial.

This work unifies and generalizes results by Ardila-Postnikov on power ideals and by Holtz-Ron and Holtz-Ron-Xu on (hierarchical) zonotopal algebra.

Carsten Lange (Berlin) [12:00–12:25, Room SR 015]

Minkowski Decompositions of Associahedra

An n-dimensional associahedron is an n-dimensional convex polytope of a certain combinatorial type. Associahedra are hidden in many mathematical theories and the number of their vertices is counted by the Catalan numbers. After explaining how to recognise an associahedron, I will first describe a family of realisations in a purely combinatorial way. Then I will explain how to compute a Minkowski decomposition into faces of a standard simplex for these realisations in an economic way. Such a Minkowski decomposition is an equation that only involves Minkowski sums of one realised associahedron and of faces of the standard simplex, where the Minkowski sum $A+B$ of polytopes A and B is $\{a+b \mid a \in A,\ b \in B\}$.ra.

Saturday, November 13, 13:30–14:30

RAYMOND LAPUS (Mittweida) [13:30–13:55, Room SR 014]

On the Lower Bound for the Spread Process in a Graph

Let $G = (V, E)$ be a finite, nontrivial and loopless graph. We assume that $s \in V$ is labelledät the start of the process. This label independently propagates along the edges of G to the neighbouring vertices in one discrete time step with the probability p. Define $T_{st}(G)$ to be the expected time that the process of spreading the label reaches the target vertex t for the first time. In this talk, we propose a lower bound for $T_{st}(G)$ in terms of the reliability polynomial of G.

FELIX EFFENBERGER (Stuttgart) [13:30–13:55, Room SR 014]

simpcomp – A GAP toolbox for simplicial complexes

simpcomp is an extension to GAP (a so called *package*), the well known system for computational discrete algebra. The package enables the user to compute numerous properties of (abstract) simplicial complexes, provides functions to construct new complexes from existing ones and an extensive library of combinatorial triangulations of manifolds. In our talk we will present the latest changes and extensions of simpcomp, in particular the support for simplicial blowups.

ÂNGELA MESTRE (Lisbon) [13:30–13:55, Room SR 014]

Riordan Arrays via Umbral Calculus

We use the classical umbral calculus to define the Riordan group. We give umbral expressions for the elements of the Appell, associated, Bell and stabilizer subgroups. To this end, we derive several useful identities which involve the primitive or derivative of the composition umbra.We also study the effects of several transformation rules on the entries of a Riordan array when regarded as functions of two integer variables. This is joint work with José Agapito and Maria Manuel Torres.

TOBIAS FRIEDRICH (Saarbrücken) [14:00–14:25, Room SR 014]

Quasirandom Load Balancing

We propose a simple distributed algorithm for balancing indivisible tokens on graphs. The algorithm is completely deterministic, though it tries to imitate (and enhance) a random algorithm by keeping the accumulated rounding errors as small as possible.

Our new algorithm surprisingly closely approximates the idealized process (where the tokens are divisible) on important network topologies. On d-dimensional torus graphs with n nodes it deviates from the idealized process only by an additive constant. In contrast to that, the randomized rounding approach of Friedrich and Sauerwald [STOC '09] can deviate up to $\Omega(\text{polylog}(n))$ and the deterministic algorithm of Rabani, Sinclair and Wanka [FOCS '98] has a deviation of $\Omega(n^{1/d})$. This makes our quasirandom algorithm the first known algorithm for this setting which is optimal both in time and achieved smoothness. We further show that also on the hypercube our algorithm has a smaller deviation from the idealized process than the previous algorithms.

Jonathan Spreer (Stuttgart) [14:00–14:25, Room SR 015]

Simplicial Blowups

Blowups provide a useful way to study singularities in algebraic varieties. We make this concept available to researchers in the field of combinatorial topology by constructing a combinatorial realization of this method. As an example we start with a minimal 16-vertex triangulation of the 4-dimensional abstract Kummer variety K^4 we resolve its 16 isolated singularities – step by step – by simplicial blowups. We finally obtain a combinatorial triangulation of the $K3$ surface with standard PL structure. A key step is the construction of a triangulated version of the mapping cylinder of the Hopf map from the real projective 3-space onto the 2-sphere with the minimum number of vertices.

Timo Kötzing (Saarbrücken) [14:00–14:25, Room SR 016]

An Application of Graph Theory to Inductive Inferences

Inductive Inference is (in parts) the study of finding a description for a set of natural numbers, given more and more elements of that language. While usually recursion theory provides the main tools for the analysis, some proofs benefit from combinatorial reasoning. We study the setting where an iteration-based learner is presented with one datum per iteration, and may ask queries about whether certain data have been presented previously. After each iteration the learner announces a description as a guess for a description of the input language. The learner is successful if, after finite time, he never changes his guess, and his guess is correct. We desire our learner to never abandon a guess once it is correct. However, we will show that there are sets of languages learnable in the above setting which are not learnable by a learner exhibiting the desired property.

List of Speakers