Dear combinatorialists,

the Colloquium on Combinatorics was established in 1981 and has since been held annually (with the exceptions in 2005, 2020, and 2021) in seven cities throughout Germany. It has grown to an established conference that covers all areas of Combinatorics and Discrete Mathematics in a broad sense, including combinatorial aspects in Algebra, Geometry, Optimization and Computer Science.

It is our great pleasure to host the 39th Colloquium on Combinatorics, after a two-year break due to the Corona virus. This year we welcome 92 participants. The program includes 70 contributed talks, organised in up to five parallel sessions, and five invited talks on a broad range of combinatorial topics.

Please note that we have allocated 25-minute slots for the contributed talks, which includes 20 minutes for the presentation, two minutes for discussion, and three minutes for room change.

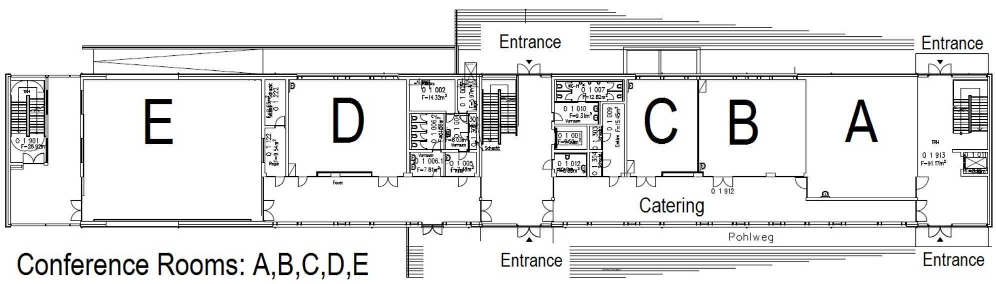
We sincerely thank our sponsors *Paderborn University* and the *Collaborative Research Centre (Sonderforschungsbereich 901) On-the-fly computing*.

We hope you enjoy the conference.

Kai-Uwe Schmidt
Eckhard Steffen

All **talks** will be in Building-O on the Main Campus (Pohlweg 51, 33098 Paderborn)

Invited talks	:	Room E
Contributed talks	:	Rooms A, B, C, D, E
Coffee and snacks	:	Foyer
Registration desk	:	Foyer
Library	:	Building-BI on the main campus



The **registration desk** is open on Friday from 8:00 to 18:00 and on Saturday from 8:00 to 16:00. The **library** is open on Friday from 7:30 to 24:00 and on Saturday from 9:00 to 20:30.

The **dinner** will take place at the restaurant *Bobberts* (Neuer Platz 3, Downtown Paderborn) on Friday at 19:00.

The restaurant can be reached by a 20-minute-walk or by bus followed by a walk of about 7 minutes.

To go by bus, take line 4 (bound to Heinz-Nixdorf Wendeschleife) or line 9 (bound to Hauptbahnhof) to *Kasseler Straße* or line UNI (bound to Hauptbahnhof) to *Rosentor*. The ride takes about 6 minutes followed by a walk through the Christmas market.

Busses leave at bus stop *Uni/Südring* south of the university westbound at 17:30 (Line 9), 17:36 (Line UNI), 17:48 (Line 4), 17:51 (Line UNI), 17:59 (Line 9), 18:06 (Line UNI), 18:13 (Line 4), 18:29 (Line 9), 18:43 (Line 4).

(The complete bus schedule is available at `www.padersprinter.de`.)

A visit to the **Paderborn Christmas market** on Friday or Saturday after the conference program is highly recommended.

Thursday, 17 November 2022

18:00 *Get together and registration* at **Bobberts** (Neuer Platz 3, Downtown Paderborn)

Friday, 18 November 2022

08:30 *Registration*

09:00 - 09:05 *Opening*

09:05 - 10:00 **Stefan Glock**
"The n-queens completion problem"

10:00 - 10:30 *Coffee break*

10:30 - 12:05 **Parallel sessions**

12:05 - 13:15 *Lunch*

13:15 - 14:50 **Parallel sessions**

14:50 - 15:20 *Coffee break*

15:20 - 16:15 **Christian Stump**
"Playing with combinatorial statistics"

16:15 - 16:25 *Short break*

16:25 - 17:20 **Patrice Ossona de Mendez**
"Back and forth between Graph Theory and Model Theory"

19:00 *Dinner* at **Bobberts** (Neuer Platz 3, Downtown Paderborn)

Saturday, 19 November 2022

08:50 - 10:00 **Parallel sessions**

10:00 - 10:30 *Coffee break*

10:30 - 12:05 **Parallel sessions**

12:05 - 13:20 *Lunch*

13:20 - 14:15 **William J. Martin**
"Quantum isomorphic graphs from association schemes"

14:15 - 14:30 *Short coffee break*

14:30 - 15:25 **Maria Chudnovsky**
"Even holes, excluded trees and tree-decompositions"

15:25 - 15:30 *Farewell*

COLLOQUIUM ON COMBINATORICS — 18/19 NOVEMBER 2022
DISCRETE MATHEMATICS — PADERBORN UNIVERSITY

Detailed program on Friday, 18 November 2022

Time	Section I Room: A	Section II Room: B	Section III Room: C	Section IV Room: D	Section V Room: E
09:00 - 09:05	*Opening* **Room: E**				
09:05 - 10:00	**Stefan Glock** The n-queens completion problem **Room: E**				
10:00 - 10:30	*Coffee break*				
10:30 - 10:50	**S. Keip** **1** Kirchberger's Theorem for Complexes of Oriented Matroids	**D. Crnković** **2** Pairwise balanced designs related to Periodic Golay pairs	**G. Zecua** **3** The number of subgroups of a finite abelian group, revisited and simplified	**P. Arras** **4** Partitioning 2-edge-coloured graphs into monochromatic cycles	**G. Rinaldi** **5** Some generalizations of the Oberwolfach Problem
10:55 - 11:15	**M. Kühn** **6** Conflict-free hypergraph matchings	**A. Švob** **7** LCD codes from equitable partitions of association schemes	**Y. Stanchescu** **8** Small doubling in torsion free groups	**A. Allin** **9** Analogues of Chvátal's Hamiltonicity theorem for randomly perturbed graphs	**C. T. Zamfirescu** **10** Counting cycles in regular and planar graphs
11:20 - 11:40	**A. Espuny Díaz** **11** Long running times for hypergraph bootstrap percolation	**L. Klawuhn** **12** Designs in the generalised symmetric group	**V. K. Bhat** **13** On mixed metric dimension of one-pentagonal carbon nanocone networks	**I. Schiermeyer** **14** 3-colourability and diamonds	**R. Hancock** **15** Blowup Ramsey numbers
11:45 - 12:05	**F. Joos** **16** Dirac's theorem in hypergraphs and much more	**K. Tabak** **17** Cubes of Designs	**R. Bachmann** **18** Application of the Galton-Watson Process to Network Formation in Polymers	**R. Lukotka** **19** Constructing graphs with known circular chromatic indices	**C. Cappello** **20** Frustration-critical signed graphs
12:05 - 13:15	*Lunch*				

Detailed program on Friday, 18 November 2022

Time	Section I Room: A	Section II Room: B	Section III Room: C	Section IV Room: D	Section V Room: E
13:15 - 13:35	**H. Harborth** **21** Rook Domination on Triangular Hexagon Boards	**D. Frettlöh** **22** Tilings with transcendental inflation factor	**H. Brinkop** **23** High-Multiplicity Scheduling on Uniform Machines	**J. Rollin** **24** Asymmetric Ramsey Equivalence	**G. Mazzuoccolo** **25** On d-dimensional nowhere-zero flows on a graph
13:40 - 14:00	**G. Brinkmann** **26** Plane Triangulations without Large 2-Trees	**R. Lang** **27** Tiling Combinatorial Structure	**S. Van Overberghe** **28** Efficient generation of polycylic hydrocarbons using blueprint generation	**T. Krill** **29** Universal graphs for the topological minor relation	**G. Tabarelli** **30** On complex nowhere-zero flows on a graph
14:05 - 14:25	**A. Elm** **31** Radial path-width	**K. Jansen** **32** New Algorithmic Results for Bin Packing and Scheduling	**I. Sabik** **33** Combinatorial Reconstruction of Metallic Foams from Tomography Data	**J. Kurkofka** **34** Canonical graph decompositions via coverings	**E. Máčajová** **35** Snarks with resistance n and flow resistance $2n$
14:30 - 14:50	**L. Chidiac** **36** From decorated permutation to Le-diagram	**C. Deppe** **37** Non-Adaptive and Adaptive Two-Sided Search with Fast Objects	**G. Istrate** **38** Mechanism design with predictions for obnoxious facility location	**F. Schröder** **39** Asymmetry in Planar Ramsey Graphs	**J. Rajník** **40** (3, 13)-cages are cyclically 13-edge-connected
14:50 - 15:20	*Coffee break*				
15:20 - 16:15	**Christian Stump** Playing with combinatorial statistics **Room: E**				
16:15 - 16:25	*Short break*				
16:25 - 17:20	**Patrice Ossona de Mendez** Back and forth between Graph Theory and Model Theory **Room: E**				

Detailed program on Saturday, 19 November 2022

Time	Section I Room: A	Section II Room: B	Section III Room: C	Section IV Room: D	Section V Room: E
08:50 - 09:10	**I. Tasoulas 41** Critical valleys in binary paths	**M. Ganzhinov 42** Levenstein-equality line packings associated with irreducible representations of finite groups SL(2,q).	**J. Renders 43** On K_2-hamiltonian graphs	**E. Dahlhaus 44** Bi-split decomposition of bipartite graphs	**D. Mattiolo 45** Highly edge-connected r-regular graphs without $r-2$ pairwise disjoint perfect matchings
09:15 - 09:35	**B. A. Berendsohn 46** Fixed-point cycles and EFX allocations	**C. Weiß 47** Packings and Steiner systems in polar spaces	**Z. Saygi 48** The number of diametral paths in Fibonacci cubes	**J. Pintér 49** Color-avoiding connected spanning subgraphs with minimum number of edges	**Y. Ma 50** Pairwise disjoint perfect matchings in r-edge-connected r-graphs
09:40 - 10:00	**B. Granet 51** Hamilton decompositions of regular bipartite tournaments	**R. Bailey 52** Cataloguing distance-regular graphs with primitive automorphism groups	**D. Labbate 53** A construction for a counterexample to the pseudo 2-factor isomorphic graph conjecture	**K. Varga 54** Edge-color-avoiding connected colorings and orientations	**I. H. Wolf 55** Edge-connectivity and pairwise disjoint perfect matchings in regular graphs
10:00 - 10:30	*Coffee break*				

Detailed program on Saturday, 19 November 2022

Time	Section I Room: A	Section II Room: B	Section III Room: C	Section IV Room: D
10:30 - 10:50	**S. Sawant** **56** Distinguishing digraphs by its quasisymmetric B-polynomial	**J. Lansdown** **57** The existence of synchronising groups of diagonal type	**A. M. Limbach** **58** Clique Dynamics of Finite or Infinite Locally Cyclic Graphs with $\delta \geq 6$	**F. Romaniello** **59** Betwixt and between 2-factor Hamiltonian and Perfect-Matching-Hamiltonian graphs
10:55 - 11:15	**J. Schrodt** **60** Counting spanning trees in Dirac graphs	**Y. Choi** **61** On minimal admissible complexes in $\mathbb{F}_q^n$	**M. Pitz** **62** A representation theorem for end spaces of infinite graphs	**H. Van den Camp** **63** The Effect of Symmetry-preserving Operations on 3-Connectivity
11:20 - 11:40	**A. Gupte** **64** Large independent sets in Markov random graphs	**A. Bishnoi** **65** The trifference problem and blocking sets	**Z. Dahmani** **66** New results on continuous random variables using different fractional integrations	**W. Hochstättler** **67** An update on the 3-colorability of gammoids
11:45 - 12:05	**H. Ibrahim** **68** Edge Contraction and Forbidden Induced Subgraphs	**A. Ernst** **69** Erdős-Ko-Rado theorems for finite general linear groups		**C. S. Anabanti** **70** Group partitions yielding lower bounds for Ramsey numbers
12:05 - 13:20	*Lunch*			
13:20 - 14:15	**William J. Martin** Quantum isomorphic graphs from association schemes **Room: E**			
14:15 - 14:30	*Short coffee break*			
14:30 - 15:25	**Maria Chudnovsky** Even holes, excluded trees and tree-decompositions **Room: E**			
15:25 - 15:30	*Farewell*			

Invited talks

Maria Chudnovsky	: Even holes, excluded trees and tree-decompositions
Stefan Glock	: The n-queens completion problem
William J. Martin	: Quantum isomorphic graphs from association schemes
Patrice Ossona de Mendez	: Back and forth between Graph Theory and Model Theory
Christian Stump	: Playing with combinatorial statistics

Contributed talks

Alexander Allin	: Analogues of Chvátal's Hamiltonicity theorem for randomly perturbed graphs
Chimere Stanley Anabanti	: Group partitions yielding lower bounds for Ramsey numbers
Patrick Arras	: Partitioning 2-edge-coloured graphs into monochromatic cycles
Rolf Bachmann	: Application of the Galton-Watson Process to Network Formation in Polymers
Robert Bailey	: Cataloguing distance-regular graphs with primitive automorphism groups
Benjamin Aram Berendsohn	: Fixed-point cycles and EFX allocations
Vijay Kumar Bhat	: On mixed metric dimension of one-pentagonal carbon nanocone networks
Anurag Bishnoi	: The trifference problem and blocking sets
Gunnar Brinkmann	: Plane Triangulations without Large 2-Trees
Hauke Brinkop	: High-Multiplicity Scheduling on Uniform Machines
Chiara Cappello	: Frustration-critical signed graphs
Lamar Chidiac	: From decorated permutation to Le-diagram
Yunseo Choi	: On minimal admissible complexes in $\mathbb{F}_q^n$
Dean Crnković	: Pairwise balanced designs related to Periodic Golay pairs
Elias Dahlhaus	: Bi-split decomposition of bipartite graphs
Zoubir Dahmani	: New results on continuous random variables using different fractional integrations
Christian Deppe	: Non-Adaptive and Adaptive Two-Sided Search with Fast Objects
Ann-Kathrin Elm	: Radial path-width
Alena Ernst	: Erdős-Ko-Rado theorems for finite general linear groups
Alberto Espuny Díaz	: Long running times for hypergraph bootstrap percolation
Dirk Frettlöh	: Tilings with transcendental inflation factor
Mikhail Ganzhinov	: Levenstein-equality line packings associated with irreducible representations of finite groups SL(2,q).
Bertille Granet	: Hamilton decompositions of regular bipartite tournaments

Akshay Gupte	: Large independent sets in Markov random graphs
Robert Hancock	: Blowup Ramsey numbers
Heiko Harborth	: Rook Domination on Triangular Hexagon Boards
Winfried Hochstättler	: An update on the 3-colorability of gammoids
Hany Ibrahim	: Edge Contraction and Forbidden Induced Subgraphs
Gabriel Istrate	: Mechanism design with predictions for obnoxious facility location
Klaus Jansen	: New Algorithmic Results for Bin Packing and Scheduling
Felix Joos	: Dirac's theorem in hypergraphs and much more
Marcus Kühn	: Conflict-free hypergraph matchings
Sophia Keip	: Kirchberger's Theorem for Complexes of Oriented Matroids
Lukas Klawuhn	: Designs in the generalised symmetric group
Thilo Krill	: Universal graphs for the topological minor relation
Jan Kurkofka	: Canonical graph decompositions via coverings
Domenico Labbate	: A construction for a counterexample to the pseudo 2-factor isomorphic graph conjecture
Richard Lang	: Tiling Combinatorial Structure
Jesse Lansdown	: The existence of synchronising groups of diagonal type
Anna Margarethe Limbach	: Clique Dynamics of Finite or Infinite Locally Cyclic Graphs with $\delta \geq 6$
Robert Lukoťka	: Constructing graphs with known circular chromatic indices
Yulai Ma	: Pairwise disjoint perfect matchings in r-edge-connected r-graphs
Edita Máčajová	: Snarks with resistance n and flow resistance $2n$
Davide Mattiolo	: Highly edge-connected r-regular graphs without $r-2$ pairwise disjoint perfect matchings
Giuseppe Mazzuoccolo	: On d-dimensional nowhere-zero flows on a graph
József Pintér	: Color-avoiding connected spanning subgraphs with minimum number of edges
Max Pitz	: A representation theorem for end spaces of infinite graphs
Jozef Rajník	: (3, 13)-cages are cyclically 13-edge-connected
Jarne Renders	: On K_2-hamiltonian graphs
Gloria Rinaldi	: Some generalizations of the Oberwolfach Problem
Jonathan Rollin	: Asymmetric Ramsey Equivalence
Federico Romaniello	: Betwixt and between 2-factor Hamiltonian and Perfect-Matching-Hamiltonian graphs
Ihab Sabik	: Combinatorial Reconstruction of Metallic Foams from Tomography Data
Sagar Sawant	: Distinguishing digraphs by its quasisymmetric B-polynomial
Zülfükar Saygi	: The number of diametral paths in Fibonacci cubes

Ingo Schiermeyer	: 3-colourability and diamonds
Felix Schröder	: Asymmetry in Planar Ramsey Graphs
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Kitti Varga	: Edge-color-avoiding connected colorings and orientations
Charlene Weiß	: Packings and Steiner systems in polar spaces
Isaak H. Wolf	: Edge-connectivity and pairwise disjoint perfect matchings in regular graphs
Carol T. Zamfirescu	: Counting cycles in regular and planar graphs
Guillermo Zecua	: The number of subgroups of a finite abelian group, revisited and simplified

Further participants

Precious Agigor-Mike
Hasan Akin
Marko Berghoff
Jonathan Dahlke
Leonard Chidiebere Eze
Nazeran Idrees
Christoph Josten
Xizhi Liu
Seyyed Ali Mohammadiyeh
Marco Ricci
Elif Saygi
Kai-Uwe Schmidt
Louisa Schroeder
Eckhard Steffen
Nico Van Cleemput
Johanna Wiehe
Daniel Zhou

Friday, 18 Nov. 2022 — Time: 09:05 - 10:00 — Room: E

The n-queens completion problem

STEFAN GLOCK (University of Passau)

An n-queens configuration is a placement of n mutually non-attacking queens on an $n \times n$ chessboard. The n-queens completion problem, introduced by Nauck in 1850, is to decide whether a given partial configuration can be completed to an n-queens configuration. Since the n-queens completion problem has been used for decades in Artificial Intelligence papers as a benchmark problem, it is important to understand how hard it actually is. Perhaps surprisingly, we show that any placement of at most $n/60$ mutually non-attacking queens can always be completed. We also provide partial configurations of roughly $n/4$ queens that cannot be completed. Some interesting problems remain open for future research. In the talk, I will discuss our results and our main tools, which include a reduction to rainbow matchings in bipartite graphs, probabilistic arguments and linear programming duality. This is joint work with David Munhá Correia and Benny Sudakov.

Friday, 18 Nov. 2022 — Time: 15:20 - 16:15 — Room: E

Playing with combinatorial statistics

CHRISTIAN STUMP (Ruhr-Universität Bochum)

Abstract: The study of permutation statistics (this is, assigning numbers to permutations) is a fundamental concept in combinatorics. Among the most important are the Mahonian and Eulerian numbers given by the number of inversions and by the number of descents. In this talk, I present examples of how to use the online Combinatorial Statistics database www.FindStat.org to systematically study permutation statistics. Most importantly, I present a generalization of these statistics to finite Coxeter groups and how to semi-automatically guess their statistical behavior. This talk is based on collaborations with Thomas Kahle and Kathrin Meier.

Friday, 18 Nov. 2022 — Time: 16:25 - 17:20 — Room: E

Back and forth between Graph Theory and Model Theory

PATRICE OSSONA DE MENDEZ (CAMS UMR8557 (CNRS/EHESS) and IUUK (Charles University))

Sparse graph classes, such as planar graphs and graphs with boudned degree, play an important role in algorithmic graph theory, as many computational problems can be solved more efficiently when restricted to such classes. As natural generalizations of (topologically) minor closed classes, nowhere dense classes exhibit nice structural and algorithmic properties, which are missing in monotone somewhere dense classes.

It appeared that the graph theoretical notion of nowhere denseness essentially coincides with the notion of superflatness introduced by Podewski and Ziegler in their study of stability. More, for monotone classes, the model theoretic notions of stability and dependence collapse and are equivalent to the graph theoretic notion of nowhere denseness, as noticed by Adler and Adler.

This result is striking as translations between tameness in graph theory and in stability theory were elusive, partly because tameness notions in graph theory were generally not invariant under taking complements, whereas in stability theory they are preserved under interpretations. The key ingredient of this first move from graph theory to model theory was the monotonicity of the considered graph classes.

It became a natural challenge to extend the unveiled connections between graph theory and model theory to the more challenging realm of hereditary classes of graphs. In this context, the difficulty was to express the main model theoretic dividing lines in combinatorial terms for hereditary classes of finite graphs. In this talk, we survey recent advances in this direction.

Saturday, 19 Nov. 2022 — Time: 13:20 - 14:15 — Room: E

Quantum isomorphic graphs from association schemes

WILLIAM J. MARTIN (Worcester Polytechnic Institute)

Quantum games have emerged as useful tools to understand the power of shared entanglement. A simple classical game can be used to define graph isomorphism: two players, Alice and Bob, convince a referee that graphs G and H are isomorphic as follows. Alice and Bob may strategize beforehand but cannot communicate during the game. The referee gives Alice (Bob) a vertex x_A (x_B) in $V(G)\dot{\cup}V(H)$. Alice and Bob respond with vertices y_A, y_B of the opposite graph and win if the relationship (equal, adjacent, non-adjacent) between the two vertices of G matches the relationship between the two vertices (among x_A, y_A, x_B, y_B) belonging to H.

The question is how much the game changes if, as part of their strategizing, Alice and Bob prepare some quantum state on which they can later perform measurements. We say the graphs G and H are *quantum isomorphic* if there is a way for Alice and Bob to fool the referee with this additional resource.

Ada Chan and I showed that any two Hadamard graphs on the same number of vertices are quantum isomorphic. This follows from a more general recipe for showing quantum isomorphism of graphs arising from certain association schemes. The main result is built from three tools. A remarkable recent result of Mančinska and Roberson shows that graphs G and H are quantum isomorphic if and only if, for any planar graph F, the number of graph homomorphisms from F to G is equal to the number of graph homomorphisms from F to H. A generalization of partition functions called "scaffolds" affords some basic reduction rules such as series-parallel reduction and can be applied to counting homomorphisms. The final tool is the classical theorem of Epifanov showing that any plane graph can be reduced to a single vertex and no edges by extended series-parallel reductions and Delta-Wye transformations. This last sort of transformation is available to us in the case of exactly triply regular association schemes.

The goal of the talk is to walk through these ideas without making things unnecessarily technical. No knowledge of physics is assumed and, for this narrative, we will avoid the the quantum commuting framework and work in a finite-dimensional quantum tensor framework.

Saturday, 19 Nov. 2022 — Time: 14:30 - 15:25 — Room: E

Even holes, excluded trees and tree-decompositions

MARIA CHUDNOVSKY (Princeton University)

Tree decompositions are a powerful tool in structural graph theory, that is traditionally used in the context of forbidden graph minors. In this talk we will describe several new results concerning induced subgraph obstructions to bounded tree-width. We will also outline the proof of the following result, obtained in joint work with Tara Abrishami, Bogdan Alecu, Sepehr Hajebi and Sophie Spirkl: for every tree T and integer t, there exists a constant c such that every even-hole-free graph with no induced subgraph isomorphic to T and no clique of size t has tree-width at most c.

Friday, 18 Nov. 2022 — Time: 10:30 - 10:50

1 — Section I — Room A — 10:30 - 10:50

Kirchberger's Theorem for Complexes of Oriented Matroids

SOPHIA KEIP (Fernuniversität in Hagen)

In this talk we generalize an old, classical separation theorem, namely Kirchberger's Theorem, to complexes of oriented matroids (COMs). COMs have been recently introduced as a common generalization of oriented matroids (OMs), affine oriented matroids, and lopsided sets. They can be simply described by a groundset E and a set of sign vectors $\mathcal{L}$ together with just two axioms. The motivation for the generalization of Kirchberger's Theorem to COMs comes from the fact that the original theorem can be proved by a combination of Carathéodory's Theorem and Farkas' Lemma. These two theorems are at the heart of OMs, so it seems natural to generalize Kirchberger's Theorem to them (or to their generalization) as well.

This is joint work with Winfried Hochstättler (FernUniversität in Hagen) and Kolja Knauer (Universitat de Barcelona).

2 — Section II — Room B — 10:30 - 10:50

Pairwise balanced designs related to Periodic Golay pairs

DEAN CRNKOVIĆ (University of Rijeka)

In this talk we give a relation between certain pairwise balanced designs (PBDs) with v points and periodic Golay pairs (PGPs) of length v. Using this connection, we classify PGPs of length less than 40 and construct new PGPs of lengths greater than 40 where classifications remain incomplete. Further, we show that under certain conditions the incidence and orbit matrices of PBDs related to PGPs span quasi-cyclic self-orthogonal codes.

This is joint work with D. Dumičić Danilović, R. Egan and A. Švob.

3 — Section III — Room C — 10:30 - 10:50

The number of subgroups of a finite abelian group, revisited and simplified

GUILLERMO ZECUA (Universitatea Babeş-Bolyai Cluj-Napoca)

We give a formula for the number of subgroups of a given type in the group $(\mathbf{Z}_{p^k})^\ell = \mathbf{Z}_{p^k} \times \cdots \times \mathbf{Z}_{p^k}$ where p is a prime and k and ℓ are positive integers. The number of subgroups is directly related to the Gaussian multinomial coefficients. Our main idea is to use a certain partition of the endomorphisms of $(\mathbf{Z}_{p^k})^\ell$ along its subgroup lattice, a partition that arises naturally from simple algebraic observations. The partition yields weighted sums of Gaussian multinomial and binomial q-coefficients. Our motivation is to bring together the previous formulas of S. Delsarte (1948) and L. M. Butler (1994).

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4 — Section IV — Room D — 10:30 - 10:50

Partitioning 2-edge-coloured graphs into monochromatic cycles

PATRICK ARRAS (Heidelberg University)

In 2019, Letzter confirmed a conjecture of Balogh, Barát, Gerbner, Gyárfás, and Sárközy, proving that every large 2-edge-coloured graph G on n vertices with minimum degree at least $3n/4$ can be partitioned into two monochromatic cycles of different colours. Here, we propose a weaker condition on the degree sequence of G to also guarantee such a partition and prove an approximate version. This resembles a similar generalisation to an Ore-type condition achieved by Barát and Sárközy.

Continuing work by Allen, Böttcher, Lang, Skokan, and Stein, we also show that if $\deg(u)+\deg(v) \geq 4n/3 + o(n)$ holds for all non-adjacent vertices $u, v \in V(G)$, then all but $o(n)$ vertices can be partitioned into three monochromatic cycles.

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5 — Section V — Room E — 10:30 - 10:50

Some generalizations of the Oberwolfach Problem

GLORIA RINALDI (University of Modena and Reggio Emilia)

The classical Oberwolfach Problem was posed by G. Ringel in 1967 with the following formulation: "At a conference in Oberwolfach, $2n + 1$ participants are to be seated at k round tables for h meals so that each participant sits next to every other exactly once. Can this be achieved if the tables have sizes $n_1, \ldots, n_k$ with $n_1 + \cdots + n_k = 2n + 1$?" In terms of graphs, the OP problem asks for a decomposition of the complete graph K_{2n+1} into isomorphic $2-$factors, each consisting of k cycles of length $n_1, \ldots, n_k$. Many cases have been solved but the general problem is still open. Some variations are known as well, for example the so called spouse-avoiding variant which asks for a decomposition into isomorphic $2-$factors of the complete graph K_{2n} with a $1-$factor removed. Some variations can also be proposed when considering complete graphs plus a repeated $1-$factor. We show some old and new results in this direction, with a particular attention to solutions with symmetries.

Friday, 18 Nov. 2022 — Time: 10:55 - 11:15

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6 — Section I — Room A — 10:55 - 11:15

Conflict-free hypergraph matchings

MARCUS KÜHN (Heidelberg University)

A celebrated theorem of Pippenger, and Frankl and Rödl states that every almost-regular, uniform hypergraph $\mathcal{H}$ with small maximum codegree has an almost-perfect matching. We extend this result by obtaining a *conflict-free* matching, where conflicts are encoded via a collection $\mathcal{C}$ of subsets $C \subseteq E(\mathcal{H})$. We say that a matching $\mathcal{M} \subseteq E(\mathcal{H})$ is conflict-free if $\mathcal{M}$ does not contain an element of $\mathcal{C}$ as a subset. Under natural assumptions on $\mathcal{C}$, we prove that $\mathcal{H}$ has a conflict-free, almost-perfect matching. This has many applications, one of which yields new asymptotic results for so-called "high-girth" Steiner systems. Our main tool is a random greedy algorithm which we call the "conflict-free matching process".

This is joint work with Stefan Glock, Felix Joos, Jaehoon Kim and Lyuben Lichev.

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7 — Section II — Room B — 10:55 - 11:15

LCD codes from equitable partitions of association schemes

ANDREA ŠVOB (University of Rijeka)

Linear codes with complementary duals (shortly named LCD codes) are linear codes whose intersection with their duals are trivial. In this talk, we give a method of constructing these type of linear codes from equitable partitions of association schemes. The LCD codes constructed in this paper are of length $2n$ and dimension n and have the property of being formally self-dual. To illustrate the method we construct LCD codes from some distance-regular graphs.

This is a joint work with Dean Crnković.

8 — Section III — Room C — 10:55 - 11:15

Small doubling in torsion free groups

YONUTZ STANCHESCU (Afeka College and The Open University of Israel)

We will discuss a number of problems and results in combinatorial number theory and we will describe some structural results for finite subsets in torsion-free abelian groups.

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9 — Section IV — Room D — 10:55 - 11:15

Analogues of Chvátal's Hamiltonicity theorem for randomly perturbed graphs

ALEXANDER ALLIN (Technische Universität Ilmenau)

We consider Hamilton cycles in randomly perturbed graphs, that is, graphs obtained as the union of a deterministic graph H and a random graph. For this random pertubation we consider both the binomial random graph $G(n, p)$ and the geometric random graph $G(n, r)$. While most research into randomly perturbed graphs assumes a minimum degree condition on H, here we consider conditions on its degree sequence. Under the assumption of a degree sequence of H which is comparable with the classical condition of Chvátal (dependent on a parameter α analogous to the minimum degree condition in typical results in the area), we prove that there exists some constant $C = C(\alpha)$ such that taking $p = C/n$ suffices to a.a.s. obtain a Hamilton cycle in $H \cup G(n, p)$. Under the same conditions on H we further prove that there is a constant $K = K(\alpha)$ such that $r = \sqrt{K/n}$ ensures a.a.s. that $H \cup G(n, r)$ is Hamiltonian. Our results are best possible both in terms of the degree sequence condition and the asymptotic value of p and r, and extend the known results about Hamiltonicity in randomly perturbed graphs.

This is joint work with Alberto Espuny Díaz.

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10 — Section V — Room E — 10:55 - 11:15

Counting cycles in regular and planar graphs

CAROL T. ZAMFIRESCU (Ghent University, Belgium)

In the first part of the talk, motivated by an old conjecture of Sheehan and two recent conjectures of Haythorpe, we discuss the minimum number of hamiltonian cycles occurring in hamiltonian regular graphs.

In the second part we present results on the enumeration of cycles in triangulations; for instance, that every planar n-vertex triangulation with at most one separating triangle contains $\Omega(n)$ many k-cycles for every $k \in \{3, \ldots, n\}$. The results presented in the second part are based on joint work with On-Hei Solomon Lo.

Friday, 18 Nov. 2022 — Time: 11:20 - 11:40

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11 — Section I — Room A — 11:20 - 11:40

Long running times for hypergraph bootstrap percolation

ALBERTO ESPUNY DÍAZ (Technische Universität Ilmenau)

Consider the hypergraph bootstrap percolation process in which, given a fixed r-uniform hypergraph H and starting with a given hypergraph G_0, at each step we add to G_0 all edges that create a new copy of H. We are interested in maximising the number of steps that this process takes before it stabilises. For the case where $H = K_{r+1}^{(r)}$ with $r \geq 3$, we provide a new construction for G_0 that shows that the number of steps of this process can be of order $\Theta(n^r)$. This answers a recent question of Noel and Ranganathan. To demonstrate that different running times can occur, we also prove that, if H is $K_4^{(3)}$ minus an edge, then the maximum possible running time is $2n - \lfloor \log_2(n-2) \rfloor - 6$. However, if H is $K_5^{(3)}$ minus an edge, then the process can run for $\Theta(n^3)$ steps.

This is joint work with Barnabás Janzer, Gal Kronenberg and Joanna Lada.

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12 — Section II — Room B — 11:20 - 11:40

Designs in the generalised symmetric group

LUKAS KLAWUHN (Paderborn University)

It is known that the notion of a transitive subgroup of a permutation group G extends naturally to subsets of G. We study the wreath product $C_r \wr S_n$ of generalised permutations acting on subsets of $\{1, 2, \dots, n\}$, whose elements are coloured with one of r possible colours. This includes the symmetric group for $r = 1$ and the hyperoctahedral group for $r = 2$. We consider different notions of transitivity in $C_r \wr S_n$ and interpret these algebraically as designs in the conjugacy class association scheme of $C_r \wr S_n$, using the representation theory of $C_r \wr S_n$. We also give existence results showing that there exist transitive subsets of $C_r \wr S_n$ that are small compared to the size of the group. Many of these results extend results previously known for the symmetric group S_n.

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13 — Section III — Room C — 11:20 - 11:40

On mixed metric dimension of one-pentagonal carbon nanocone networks

VIJAY KUMAR BHAT (Shri Mata Vaishno Devi University)

Minimum resolving sets (edge or vertex) have become an integral part of molecular topology and combinatorial chemistry. Resolving sets for a specific network provide crucial information required for the identification of each item contained in the network, uniquely. If $d(a_1, u) \neq d(a_2, u)$, then we say that the vertex u resolves (distinguishes) two elements a_1 and a_2 in a connected graph G (where $a_1, a_2 \in V(G) \cup E(G)$). A subset of vertices R_m in G is said to be a mixed resolving set for G, if for every two distinct elements b_1 and b_2 in G we have $d(b_1, u) \neq d(b_2, u)$ for at least one vertex $u \in R_m$. A mixed metric basis for G is a mixed resolving set with minimum cardinality and this cardinality is called the mixed metric dimension $mdim(G)$ of G. In this article, we determine the mixed metric dimension for the complex molecular graph of one-pentagonal carbon nanocone (1-PCNC). We also show that the mixed resolving set for 1-PCNC is independent.

This is a joint work with Sunny Kumar Sharma.

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14 — Section IV — Room D — 11:20 - 11:40

3-colourability and diamonds

INGO SCHIERMEYER (Technische Universität Bergakademie Freiberg)

The 3-colourability problem is an NP-complete problem which remains NP-complete for claw-free graphs and for graphs with maximum degree four. In this talk we will consider induced subgraphs, among them are the *claw* ($K_{1,3}$), the *bull* (a triangle with two pendent edges), and the *diamond* (the graph $K_4 - e$).

Our main result is a complete characterization of all 3-colourable $(claw, bull)$-free graphs. We will present a description of all non 3-colourable $(claw, bull)$-free graphs in terms of diamonds. Moreover, we will show extensions of this characterization to larger graph classes by taking supergraphs of the claw or the bull.

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15 — Section V — Room E — 11:20 - 11:40

Blowup Ramsey numbers

ROBERT HANCOCK (Heidelberg University)

Given graphs G and H, we say $G \xrightarrow{r} H$ if every r-colouring of the edges of G contains a monochromatic copy of H. Let $H[t]$ denote the t-blowup of H. The blowup Ramsey number $B(G \xrightarrow{r} H; t)$ is the minimum n such that $G[n] \xrightarrow{r} H[t]$. Fox, Luo and Wigderson refined an upper bound of Souza, showing that, given G, H and r such that $G \xrightarrow{r} H$, there exist constants $a = a(G, H, r)$ and $b = b(H, r)$ such that for all positive integers t, $B(G \xrightarrow{r} H; t) \leq ab^t$. They conjectured that there exist some graphs H for which the constant a depending on G is necessary. We prove this conjecture by showing that the statement is true in the case of H being 3-chromatically connected, which in particular includes triangles. On the other hand, perhaps surprisingly, we show that for forests F, the function $B(G \xrightarrow{r} F; t)$ is independent of G. This is joint work with António Girão.

Friday, 18 Nov. 2022 — Time: 11:45 - 12:05

16 — Section I — Room A — 11:45 - 12:05

Dirac's theorem in hypergraphs and much more

FELIX JOOS (Heidelberg University)

We all know Dirac's theorem and Rödl, Ruciński, and Szémeredi extended Dirac's theorem to k-uniform hypergraphs by proving that every k-uniform n-vertex hypergraph H admits a (tight) Hamilton cycle whenever $\delta(H) \geq (1/2 + o(1)n$. We prove that such hypergraphs in fact contain many edge-disjoint Hamilton cycles, in fact as many as they can possibly have. This is joint work with Marcus Kühn and Bjarne Schülke.

17 — Section II — Room B — 11:45 - 12:05

Cubes of Designs

KRISTIJAN TABAK (Rochster Institute of Techology, Zagreb campus)

We present a construction of cubes of designs, where a cube of a design is 3-dimensional matrix with $(0, 1)$-entries such that each 2-dimensional submatrix is an incidence matrix of a symmetric design. Furthermore, we describe a connection between a large class of cubes of designs with a developments of difference sets.

This is a joint work with M.O. Pavčević and V. Krčadinac.

18 — Section III — Room C — 11:45 - 12:05

Application of the Galton-Watson Process to Network Formation in Polymers

ROLF BACHMANN (Covestro Deutschland AG)

Describing the molecular weight distribution of branched polymers – industrially important materials – leads to challenging problems in combinatorics and discrete analysis. Using the Galton-Watson process, a general solution was found for the branching of primary chains – that is a statistical combination of chains which themselves form distributions, which then transforms into a complex network. Solutions – most of them in closed form – will be presented together with some open questions. The hope is, to discuss these questions and gain new ideas.

19 — Section IV — Room D — 11:45 - 12:05

Constructing graphs with known circular chromatic indices

ROBERT LUKOŤKA (Comenius University)

Circular chromatic index of a graph is the smallest r, such that it is possible to color edges of the graph with real numbers modulo r so that neighboring edges differ by at least 1 modulo r. In this talk we complement an existing lower bound construction with a lifting construction giving corresponding upper bound for the circular flow number of a graph. Using this techniwue we construct cyclically 4-edge-connected snarks of girth 5 with circular chromatic number r, for each $r \in (3, 3+1/3]$. We also construct snarks with girth g having circular chromatic number r for each $r \in (3, 3+\varepsilon_g)$.

20 — Section V — Room E — 11:45 - 12:05

Frustration-critical signed graphs

CHIARA CAPPELLO (Paderborn University)

A signed graph (G, Σ) is a graph G together with a set $\Sigma \subseteq E(G)$ of negative edges. A circuit is positive if the product of the signs of its edges is positive. A signed graph (G, Σ) is balanced if all its circuits are positive. The frustration index $l(G, \Sigma)$ is the minimum cardinality of a set $E \subseteq E(G)$ such that $(G - E, \Sigma - E)$ is balanced. A signed graph (G, Σ) is k-critical if $l(G, \Sigma) = k$ and $l(G - e, \Sigma - e) < k$, for every $e \subseteq E(G)$. We present decomposition and subdivision of critical signed graphs and completely determine the set of t-critical signed graphs, for $t \leq 2$. Critical signed graphs are characterized. We then focus on non-decomposable critical signed graphs. In particular, we characterize the set S^* of non-decomposable k-critical signed graphs not containing a decomposable t-critical signed subgraph for every $t \leq k$. We show that S^* consists of cyclically 4-edge-connected projective-planar cubic graphs. Furthermore, we provide k-critical signed graphs of S^* for every $k \geq 1$.

Friday, 18 Nov. 2022 — Time: 13:15 - 13:35

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21 — Section I — Room A — 13:15 - 13:35

Rook Domination on Triangular Hexagon Boards

HEIKO HARBORTH (TU Braunschweig)

Consider a triangular part T_n of the Euclidean tessellation of the plane by regular hexagons such that there are n hexagons at each side of T_n. A rook can move on straight line sequences of edge-adjacent hexagons. It will be asked for the domination number $\gamma(n)$, which is the smallest number of rooks, so that every hexagon of T_n is either occupied or threatened by a rook.

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22 — Section II — Room B — 13:15 - 13:35

Tilings with transcendental inflation factor

DIRK FRETTLÖH (Universität Bielefeld)

Tile substitutions are a fundamental tool to construct aperiodic tilings like the Penrose tilings. Such a tile substitution is a rule how to inflate the prototiles (the building blocks of the tiling) by some common factor and dissect the inflated tiles into copies of the original prototiles. If the number of prototiles is finite the inflation factor is necessarily an algebraic number. Here we present the first examples of tile substitutions where the inflation factor is a transcendental number.

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23 — Section III — Room C — 13:15 - 13:35

High-Multiplicity Scheduling on Uniform Machines

HAUKE BRINKOP (Kiel University)

In high-multiplicity scheduling, jobs of the same size are encoded in an efficient way, that is, for each size the number of jobs of that size is given instead of a list of jobs. Similarly, machines are encoded. We consider scheduling on uniform machines where a job of size p_j takes time p_j/s_i on a machine of speed s_i. Classical (NP-hard) objectives are Makespan Minimization ($C_{\max}$) and Santa Claus ($C_{\min}$). We show that both objectives can be solved in time $\mathcal{O}(p_{\max}^{(\mathcal{O}(d^2))}) \cdot \mathrm{poly}|I|$ where $p_{\max}$ is the largest jobs size, d the number of different job sizes and $|I|$ the encoding length of the instance. We investigate the case where $p_{\max}$ and hence also d are small, while the number of jobs, machines, and machine types might be arbitrarily large as well as the machine speeds.

Our approach incorporates two structural theorems: The first allows us to replace machines of large speed by multiple machines of smaller speed. The second tells us that some fractional assignments can be used to reduce the instance significantly. Using only the first theorem, we show some additional results. For the problem Envy Minimization (C_{envy}), we propose an $\mathcal{O}(s_{\max} \cdot p_{\max}^{(\mathcal{O}(d^3))}) \cdot \text{poly}|I|$ time algorithm (where $s_{\max}$ is the largest speed). For $C_{\max}$ and $C_{\min}$ in the Restricted Assignment setting, we give an $\mathcal{O}((d \cdot p_{\max})^{(\mathcal{O}(d^3)}) \cdot \text{poly}|I|)$ time algorithm. As far as we know, those running times are the best known. Note that while the result from *Parameterized complexity of configuration integer programs* of Knop, Koutecký, Levin, Mnich, Onn might be used to achieve similar running times for $C_{\max}$ and $C_{\min}$, our approach gives a new insight into the structure of the solution. In particular, if there are sufficiently many jobs and machines are not arbitrary slow, we show how many jobs can be distributed a priori such that per machine there are only $\mathcal{O}(\text{poly}\, p_{\max})$ are left to be distributed.

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24 — Section IV — Room D — 13:15 - 13:35

Asymmetric Ramsey Equivalence

JONATHAN ROLLIN (FernUniversität in Hagen)

A graph F is Ramsey for a pair of graphs (G, H) if any red/blue-coloring of the edges of F yields a copy of G with all edges colored red or a copy of H with all edges colored blue. Two pairs of graphs are called Ramsey equivalent if they have the same collection of Ramsey graphs. The symmetric setting, that is, the case $G = H$, received considerable attention. All known pairs of Ramsey equivalent graphs involve a disconnected graph. This led to the open question whether there are connected graphs G and G' such that (G, G) and (G', G') are Ramsey equivalent.

We study the asymmetric version of this question and will see several non-trivial families of Ramsey equivalent pairs of connected graphs. Most of the talk focuses on pairs of the form (T, K), where T is a tree and K is a complete graph. We show that, if T belongs to a certain family of trees, including all non-trivial stars, then (T, K) is Ramsey equivalent to a family of pairs of the form (T, H), where H is obtained from K by attaching disjoint smaller cliques to some of its vertices. In addition, we briefly sketch that for (T, H) to be Ramsey equivalent to (T, K), H must have roughly this form. For many other trees T, including all odd-diameter trees, we show that (T, K) is not equivalent to any such pair, not even to the pair (T, H), where H is K with a single edge attached.

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25 — Section V — Room E — 13:15 - 13:35

On d-dimensional nowhere-zero flows on a graph

GIUSEPPE MAZZUOCCOLO (University of Verona)

The theory of integer nowhere-zero flows on finite graphs represents a very active research area in graph theory. The generalization to real numbers is also well-studied, while very few is known in the complex case or, more in general, for flows taking values in $\mathbb{R}^d$. We define a d-dimensional nowhere-zero r-flow on a graph G, (r, d)-NZF from now on, as a nowhere-zero flow such that the flow value assigned to each edge is an element of $\mathbb{R}^d$ whose (Euclidean) norm lies in the interval $[1, r-1]$. In this talk, we mainly consider the parameter $\phi_d(G)$, which is the minimum of the real numbers r such that G admits a (r, d)-NZF. For every bridgeless graph G, the 5-flow Conjecture claims that $\phi_1(G) \leq 5$, while a conjecture by Jain suggests that $\phi_d(G) = 2$, for all $d \geq 3$. Here, we address the problem of finding a possible upper-bound in the case $d = 2$ and we discuss some connections between this problem and some other well-known conjectures.

Friday, 18 Nov. 2022 — Time: 13:40 - 14:00

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26 — Section I — Room A — 13:40 - 14:00

Plane Triangulations without Large 2-Trees

GUNNAR BRINKMANN (Universiteit Gent)

Leizhen Cai asked whether each plane triangulation has a spanning 2-tree. A first example on 38 vertices without a spanning 2-tree was given by Bickle. We give a smaller counterexample on 29 vertices and show that for each $c > 0$ there are plane triangulations $P = (V, E)$, so that each 2-tree that is a subgraph of P contains fewer than $c|V|$ vertices.

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27 — Section II — Room B — 13:40 - 14:00

Tiling Combinatorial Structure

RICHARD LANG (Universität Hamburg)

We give an asymptotic characterisation of combinatorial structures that contain perfect tilings. There are three natural obstructions to containing a perfect tiling that correspond to cover, space and divisibility barriers. We show that any large enough combinatorial structure, which robustly overcomes each of these obstacles must already contain a perfect tiling.

This generalises the geometric theory of hypergraph matching of Keevash and Mycroft. The proof is short and self-contained apart from using a few classic insights from combinatorics. Since our notion of robustness is closely related to random sampling, stability results can be obtained via the theory of property testing.

As an application, we recover recent work for codegree conditions, ordered graphs and quasirandom hypergraphs. In addition, we determine the minimum $(k-2)$-degree threshold for perfect F-tilings when F is a complete k-partite k-uniform hypergraph satisfying certain divisibility conditions.

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28 — Section III — Room C — 13:40 - 14:00

Efficient generation of polycylic hydrocarbons using blueprint generation

STEVEN VAN OVERBERGHE (Ghent University)

There exist a number of general approaches for the isomorph-free enumeration of combinatorial structures, including *orderly generation*, the *homomorphism principle*, the *canonical construction path*

method, etc. All of them have certain advantages and disadvantages which prohibit using them for every generation problem.

A (combinatorial) polycyclic hydrocarbon is a plane graph where every face (except the outer face) is either a hexagon or a pentagon, and every vertex has either degree 2 or 3, the former vertices all lying in the outer face. They can also be thought of as *patches* cut out of fullerenes.

In this talk, we present a novel generation technique called *blueprint generation* and apply it to the enumeration of polycyclic hydrocarbons having a fixed number of carbon and hydrogen atoms (vertices of degree 3 and 2 respectively).

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29 — Section IV — Room D — 13:40 - 14:00

Universal graphs for the topological minor relation

THILO KRILL (Universität Hamburg)

A subgraph-/topological minor-universal graph in a class of graphs $\mathcal{G}$ is a graph in $\mathcal{G}$ which contains every graph in $\mathcal{G}$ as a subgraph/topological minor. Of the two notions, only subgraph-universal graphs are well-investigated. In this talk, I will present some of the first results on topological minor-universal graphs. For example, we see that the class $\mathcal{P}$ of all countable planar graphs does not contain a topological minor-universal graph, which strengthens a result of Pach stating that there is no subgraph-universal graph in $\mathcal{P}$. Furthermore, we discuss the existence of topological minor-universal graphs in graph classes which are characterised by a forbidden topological minor, in particular a forbidden subdivided star.

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30 — Section V — Room E — 13:40 - 14:00

On complex nowhere-zero flows on a graph

GLORIA TABARELLI (University of Trento)

Let $r \geq 2$ be a real number. A complex nowhere-zero r-flow on a graph G is an orientation of G together with an assignment $\varphi\colon E(G) \to \mathbb{C}$ such that, for all $e \in E(G)$, the modulus of the complex number $\varphi(e)$ lies in the interval $[1, r-1]$ and, for every vertex, the incoming flow is equal to the outgoing flow. The complex flow number of a bridgeless graph G, denoted by $\phi_{\mathbb{C}}(G)$, is the minimum of the real numbers r such that G admits a complex nowhere-zero r-flow. The exact value of $\phi_{\mathbb{C}}$ is known only for graphs belonging to families where a lower bound can be trivially proved. In this talk we focus on the problem of finding a non-trivial lower bound for $\phi_{\mathbb{C}}(G)$. We describe a geometric approach which leads to the computation of the complex flow number of the wheel graph W_n, and we use this exact result to give a non-trivial lower bound for $\phi_{\mathbb{C}}(G)$ in terms of the odd-girth of G, when G is a cubic graph.

Friday, 18 Nov. 2022 — Time: 14:05 - 14:25

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31 — Section I — Room A — 14:05 - 14:25

Radial path-width

ANN-KATHRIN ELM (Universität Heidelberg)

Usually, the width of a tree decomposition of a graph is measured in terms of the size of the parts of the tree decomposition, and size means number of vertices. The grid theorem states that a graph either has a tree decomposition of low width or a large grid as a minor. The radial width of a tree decomposition is computed similarly to the usual width of the tree decomposition, only now the size of a part means its radius. There is no analogon of the grid theorem known for radial tree-width yet, but we show that there is for the cases where the decomposition trees are paths or subdivided stars.

This is joint work with Sandra Albrechtsen, Reinhard Diestel, Eva Fluck, Raphael W. Jacobs, Paul Knappe and Paul Wollan.

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32 — Section II — Room B — 14:05 - 14:25

New Algorithmic Results for Bin Packing and Scheduling

KLAUS JANSEN (University of Kiel)

In this talk we present an overview about new results for bin packing and related scheduling problems on identical machines. During the last years we have worked on the design of efficient exact and approximation algorithms for packing and scheduling problems. In order to obtain faster algorithms we studied integer linear programming (ILP) formulations for these problems, developed new parameterized algorithms based on the Steinitz lemma and discrepancy bounds, and proved structural results for optimum solutions of the corresponding ILPs and lower bounds on the running time.

This is joint work with Lin Chen, Kim-Manuel Klein, Lars Rohwedder, José Verschae, and Gouchuan Zhang.

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33 — Section III — Room C — 14:05 - 14:25

Combinatorial Reconstruction of Metallic Foams from Tomography Data

IHAB SABIK (TU Berlin)

We present a combinatorial low-dimensional topology approach to model the cellular structure of cellular materials from measured data.

Canonical graph decompositions via coverings

JAN KURKOFKA (University of Birmingham)

We present a canonical way to decompose finite graphs into highly connected local parts. The decomposition depends only on an integer parameter whose choice sets the intended degree of locality. The global structure of the graph, as determined by the relative position of these parts, is described by a coarser *model*. This is a simpler graph determined entirely by the decomposition, not imposed.

The model and decomposition are obtained as projections of the tangle-tree structure of a covering of the given graph that reflects its local structure while unfolding its global structure. In this way, the tangle theory from graph minors is brought to bear canonically on arbitrary graphs, which need not be tree-like.

Our theorem extends to locally finite quasi-transitive graphs, and in particular to locally finite Cayley graphs. It thereby offers a canonical decomposition for finitely generated groups into local parts, whose relative structure is displayed by a graph.

Joint work with Reinhard Diestel, Raphael W. Jacobs and Paul Knappe. The article is available online: https://arxiv.org/abs/2207.04855

Snarks with resistance n and flow resistance $2n$

EDITA MÁČAJOVÁ (Comenius University)

We examine the relationship between two measures of uncolourability of cubic graphs – their resistance and flow resistance. The resistance of a cubic graph G, denoted by $r(G)$, is the minimum number of edges whose removal results in a 3-edge-colourable graph. The flow resistance of G, denoted by $r_f(G)$, is the minimum number of zeroes in a 4-flow on G. Fiol et al. [1] made a conjecture that $r_f(G) \leq r(G)$ for every cubic graph G. We disprove this conjecture by presenting a family of cubic graphs G_n of order $34n$, where $n \geq 3$, with resistance n and flow resistance $2n$. For $n \geq 5$ these graphs are nontrivial snarks. This is a joint work with Imran Allie, Martin Škoviera.

REFERENCES

[1] M. A. Fiol, G. Mazzuoccolo, E. Steffen, Measures of edge-uncolourability of cubic graphs, Electron. J. Combin. 25 (2018), #P4.54.

Friday, 18 Nov. 2022 — Time: 14:30 - 14:50

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36 — Section I — Room A — 14:30 - 14:50

From decorated permutation to Le-diagram

LAMAR CHIDIAC (FernUniversität in Hagen)

Positroids introduced by Postnikov in 2006 are matroids realizable by a matrix where all full subdeterminants are non-negative. They are in bijection with several combinatorial objects. In particular, every positroid can be presented as a decorated permutation or as a Le-diagram. Ardila et. al. presented a simple algorithm to compute the decorated permutation from a given Le-diagram. However, we are unaware of a simple algorithm to compute the Le-diagram from the decorated permutation. In this talk we present a simple algorithm that takes a decorated permutation as an input and gives back the corresponding Le-diagram.

This is joint work with Winfried Hochstättler, Santiago Guzman-Pro and Anthony Youssef.

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37 — Section II — Room B — 14:30 - 14:50

Non-Adaptive and Adaptive Two-Sided Search with Fast Objects

CHRISTIAN DEPPE (Technical University of Munich)

In 1946 Koopman introduced a two-sided search model. In this model, a searched object is active and can move at most one step after each test. We analyze the model of a combinatorial two-sided search by allowing more moves of the searched object after each test. We give strategies and show that they are optimal. We consider adaptive and non-adaptive strategies. We show the surprising result that with the combinatorial two-sided search on a path graph, the optimal non-adaptive search needs the same number of questions as the corresponding adaptive strategy does. The strategy obtained can also be used as encoding strategy to sent the position of a moving element through a transmission channel.

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38 — Section III — Room C — 14:30 - 14:50

Mechanism design with predictions for obnoxious facility location

GABRIEL ISTRATE (University of Bucharest)

The theory of *algorithms with predictions* is one of the most exciting recent research directions in algorithmics: when supplemented by a (correct) *predictor*, often based on machine learning, the newly-developed algorithms are capable of outcompeting their worst-case classical counterparts. A desirable feature of such algorithms is, of course, to perform comparably to the (worst-case) algorithms when the predictors are really wrong. This requirement often results in tradeoffs between two measures of algorithm performance for algorithms with predictions, robustness and consistency.

Recently, the idea of augmenting algorithms by predictions has been adapted to the game-theoretic setting of *mechanism design*: indeed, strategyproof mechanisms often yield solutions that are only approximately optimal. On the other hand, if the designer has access to a predictor for the desired outcome it could conceivably take advantage of this information by creating mechanisms that improve upon their existing (worst-case) counterparts. Tradeoffs between robustness and consistency apply to this setting as well. This is best exemplified by the recent results of Agrawal et al. (EC'2022): the authors considered the classical problem of *facility location* in a setting with predictions, and improved on the approximation algorithms of Procaccia and Tennenholtz in the setting without predictions.

We contribute to this research direction by studying, in the setting of mechanism design with predictions, another version of facility location: the *obnoxious facility location* problem. We present deterministic strategyproof mechanisms that display tradeoffs between robustness and consistency on segments, squares, circles and trees. All these mechanisms are actually group strategyproof, with the exception of the case of squares, where manipulations from coalitions of two agents exist. We prove that these tradeoffs are optimal in the 1-dimensional case. This is joint work with Cosmin Bonchiş, West University of Timişoara.

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39 — Section IV — Room D — 14:30 - 14:50

Asymmetry in Planar Ramsey Graphs

FELIX SCHRÖDER (Technische Universität Berlin)

We say that G is avoidable versus H in planar graphs if for any planar graph P, there is a way to color the edges with red and blue, such that no red G or blue H is a subgraph of P. The study of the symmetric case of $G = H$ was introduced by Axenovich et al. They observe that for G to be unavoidable, G has to be bipartite and outerplanar and prove that C_4 is unavoidable. We give a proof that cycles of size at least 6 are simultaneously avoidable in simply nested graphs and classify, which kinds of graphs G are avoidable versus paths in some subclasses of planar graphs.

This is joint work with Simona Boyadzhiyska, Raphael Steiner and Tibor Szabó.

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40 — Section V — Room E — 14:30 - 14:50

(3, 13)-cages are cyclically 13-edge-connected

JOZEF RAJNÍK (Comenius University in Bratislava)

The famous cage problem asks for finding a smallest k-regular graph with girth g (that is the length of a shortest cycle) also called a (k, g)-*cage*. As our main result, we prove that any $(3, 13)$-cage is cyclically 13-edge-connected, that is it contains no set of fewer than 13 edges that separates two cycles. Note that all 3-regular cages are known up to girth 12 and each of them has its cyclic edge-connectivity equal to its girth. The girth 13 is thus the smallest girth for which the exact order of a cage is not known (it lies between 202 and 272).

Our main idea consists of extending the cubic case of the cage problem to subcubic graphs: we ask for a smallest graph with a finite girth at least g, exactly l vertices of degree 2 and all the remaining vertices of degree 3. We develop techniques for approaching this problem and present our results in small cases. We believe our results will shed some new light on the cage problem and perhaps lead to some improvements in exhaustive computer searches.

This is a joint work with Edita Máčajová.

Saturday, 19 Nov. 2022 — Time: 08:50 - 09:10

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41 — Section I — Room A — 08:50 - 09:10

Critical valleys in binary paths

IOANNIS TASOULAS (University of Piraeus)

Let $\mathcal{P}_n$, where n is a positive integer, be the set of all (binary) paths P of length $|P| = n$, i.e., lattice paths $P = p_1 p_2 \cdots p_n$ where each *step* p_i, $i \in [n]$, is either an *upstep* $u = (1,1)$ or a *downstep* $d = (1,-1)$ and connects two consecutive points of the path P. The number of u's (reps. d's) in P is denoted by $|P|_u$ (resp. $|P|_d$). An *ascent* is a maximal sequence of u's (resp. d's) in P (resp. *descent*) of P. A *peak* (resp. *valley*) of the path is the last point of an ascent (resp. descent). Clearly, every peak (resp. valley) corresponds to either an occurrence of ud (resp. du), or an occurrence of u (resp. d) at the end of the path.

A path P is decomposed with respect to a certain valley as $P = LduR$, or $P = Ld$ if this valley is the last step of P, where L, R are also paths. We call this valley *critical* whenever both $|L|_u$ and $|L|_d$ are even. Equivalently, a valley is critical iff one of its coordinates is equivalent to 1 and the other one is equivalent to 3 modulo 4. In a recent joint work with Kostas Manes and Aris Sapounakis, the authors gave a sufficient and necessary condition for the Hamiltonicity of the interval which contains all paths in $\mathcal{P}_n$ that are dominated by a path P (except the lowest two). In the case where P starts with u, ends with d and has at least two peaks, a necessary condition for this Hamiltonicity is that P has no critical valleys.

In this work, we study the set of paths with k critical valleys, obtaining some enumeration results and some new bijections between this set and other combinatorial objects e.g., partitions and compositions of n.

This is joint work with Kostas Manes (University of Piraeus).

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42 — Section II — Room B — 08:50 - 09:10

Levenstein-equality line packings associated with irreducible representations of finite groups SL(2,q).

MIKHAIL GANZHINOV (Aalto University)

A line system is said to be optimal if its coherence is minimized. Line systems which are optimal by achieving equality in one of the Levenstein bounds are considered especially valuable. The first Lenvenstein bound is better known as the Welch bound, equality here is achieved exactly by equiangular tight frames (ETFs). We know multiple infinite families of ETFs. The equality in the second Levenstein bound is achieved exactly by 0,a-angular projective 2-designs. One way to construct real and complex infinite families of such line systems is to use extremal sets of mutually unbiased bases (MUBs). Here we describe line systems of different origin, related to irreducible representations of finite groups SL(2,q) achieving equality in the second Levenstein bound.

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43 — Section III — Room C — 08:50 - 09:10

On K_2-hamiltonian graphs

JARNE RENDERS (KU Leuven Kulak)

Using theoretical and computational tools, we investigate K_2-*hamiltonian* graphs, i.e. graphs in which the removal of any pair of adjacent vertices yields a hamiltonian graph. This concept is similar to that of hypohamiltonian graphs, i.e. non-hamiltonian graphs in which every vertex-deleted subgraph is hamiltonian. The study of K_2-hamiltonian graphs is motivated by a conjecture of Grünbaum, who claimed that there do not exist graphs in which the length of a longest cycle is two less than the order of the graph, but any two vertices are missed by some longest cycle. This is still unsolved in the K_2-hamiltonian case, where we only require any two adjacent vertices to be missed by a longest cycle.

Perhaps surprisingly, there exist graphs that are both hypohamiltonian and K_2-hamiltonian, e.g. Petersen's graph. Grünbaum conjectured that planar hypohamiltonian graphs cannot exist; Thomassen disproved this conjecture. Here we show that there even exist both hypohamiltonian and K_2-hamiltonian planar graphs. Furthermore, motivated by results of Aldred, McKay, and Wormald and work of Thomassen, we determine for every integer n whether there exists a non-hamiltonian K_2-hamiltonian graph of order n, and characterise all orders for which such cubic graphs and such snarks exist. We also determine the smallest cubic planar K_2-hypohamiltonian graph as well as the smallest planar K_2-hypohamiltonian graph of girth 5, which are of order 68 and 48, respectively.

The talk is based on joint work with Jan Goedgebeur, Gábor Wiener and Carol T. Zamfirescu.

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44 — Section IV — Room D — 08:50 - 09:10

Bi-split decomposition of bipartite graphs

ELIAS DAHLHAUS (Darmstadt University of Technology)

The concept of split decomposition is transfered to bipartite graphs. Contrary to graphs in general, the two parts of a split are not joined by one complete bipartite graph, but by two complete bipartite graphs. Moreover, let the vertex set of the bipartite graph be $AcupB$ such that each edge joins a vertex from A with a vertex from B. Then the partition of the vertex set of the bipartite graph into two disjoint sets X and Y defines a bi-split if the edges between $X \cap A$ and $Y \cap B$ and the edges between $Y \cap A$ and $X \cap B$ form complete bipartite graphs. One can easily interpret the bi-split decomposition of bipartite graphs as a special case of split decomposition of direted graphs. Vice versa, a split of a directed graph can also be interpreted as a bi-split of a bipartite graph. While the split decomposition of cyclically connected (diconnected, biconnected) directed graphs has been studied very well, the split decomposition structure of directed graphs in general and therefore also the bi-split decomposition structure is still open. Also in this talk, a final result will not be presented.

Ongoing research and some difficulties to find a decomposition structure as a decomposition tree will be described .

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45 — Section V — Room E — 08:50 - 09:10

Highly edge-connected r-regular graphs without $r-2$ pairwise disjoint perfect matchings

DAVIDE MATTIOLO (KU Leuven)

In this talk we present infinite families of highly edge-connected r-regular graphs of even order which do not contain $r-2$ pairwise disjoint perfect matchings. For even r, the result solves a problem stated by Thomassen in [C. Thomassen, *Factorizing regular graphs*, J. Combin. Theory Ser. B 141 (2020) 343–351].

The talk is based on joint works with Yulai Ma, Eckhard Steffen and Isaak H. Wolf.

Saturday, 19 Nov. 2022 — Time: 09:15 - 09:35

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46 — Section I — Room A — 09:15 - 09:35

Fixed-point cycles and EFX allocations

BENJAMIN ARAM BERENDSOHN (Freie Universität Berlin)

Consider a labeling of the complete bidirected graph $\overset{\leftrightarrow}{K}_n$ with functions from $[d]$ to itself. We call a cycle in $\overset{\leftrightarrow}{K}_n$ a *fixed-point cycle* if composing the labels of its edges results in a map that has a fixed point, and we say that a labeling is *fixed-point-free* if no fixed-point cycle exists. For a given d, we ask for the largest value of n for which there exists a fixed-point-free labeling of $\overset{\leftrightarrow}{K}_n$.

This problem was recently introduced by Chaudhury, Garg, Mehlhorn, Mehta, and Misra, who showed that the problem has close connections to *EFX allocations*, a central problem of fair allocation in social choice theory.

In this talk, we present improvements to Chaudhury et al.'s result. We also consider the special case where edge labels must be permutations, and discuss connections to *zero-sum* problems.

(Based on joint work with Simona Boyadzhiyska and László Kozma.)

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47 — Section II — Room B — 09:15 - 09:35

Packings and Steiner systems in polar spaces

CHARLENE WEISS (Paderborn University)

A finite classical polar space of rank n consists of the totally isotropic subspaces of a finite vector space equipped with a nondegenerate form such that n is the maximal dimension of such a subspace. A t-Steiner system in a finite classical polar space of rank n is a collection Y of totally isotropic n-spaces such that each totally isotropic t-space is contained in exactly one member of Y. Nontrivial examples are known only for $t = 1$ and $t = n - 1$. We give an almost complete classification of such t-Steiner systems, showing that such objects can only exist in some corner cases. This classification result arises from a more general result on packings in polar spaces, which we obtain by studying the association scheme arising from polar spaces and applying the powerful linear programming method due to Delsarte.

This is a joint work with Kai-Uwe Schmidt.

48 — Section III — Room C — 09:15 - 09:35

The number of diametral paths in Fibonacci cubes

ZÜLFÜKAR SAYGI (TOBB University of Economics and Technology)

Given a connected graph G, one of the basic and interesting problem is to enumerate the number of shortest paths, not necessarily disjoint, between any pair of vertices in G. A solution to this problem can provide an important topological property of an interconnection network, in terms of its connectivity, fault-tolerance, and routing flexibility. For instance, it is well known that there are $H(u \oplus v)!$ distinct shortest paths between the vertices u and v in the hypercube, where H is the Hamming weight, and $\oplus$ is the exclusive-or operation.

Let G be a graph with vertex set $V(G)$ and edge set $E(G)$. The distance $d(u, v)$ between two vertices $u, v \in V(G)$ in a graph G is the number of edges in a shortest path between u and v. The diameter of G is defined as the maximum distance between two vertices in $V(G)$ and is denoted by $diam(G)$. A pair of vertices $u, v \in V(G)$ with $d(u, v) = diam(G)$, are called diametrically opposite vertices and the collection of shortest paths between diametrically opposite vertices are referred to as diametral paths.

In this work we enumerate the number of diametral paths for Fibonacci cubes. We present a bijective proof of our result, showing that these numbers are related to alternating permutations and are enumerated by Euler numbers.

* This work is partially supported by TUBİTAK under grant no. 120F125 and is a joint work with Elif Saygı and Ömer Eğecioğlu.

49 — Section IV — Room D — 09:15 - 09:35

Color-avoiding connected spanning subgraphs with minimum number of edges

JÓZSEF PINTÉR (Budapest University of Technology)

We call an edge-colored graph edge-color-avoiding connected if with the removal of edges of any single color, the graph remains connected. With some modifications, two similar definitions can be obtained for vertex-colored graphs as well. In this talk, we investigate the problem of determining the maximum number of edges that can be removed such that the graph remains color-avoiding connected. First, we prove that this problem is NP-hard, then we give polynomial-time approximation algorithms for it. To analyze the approximation factors of these algorithms, we determine the minimum number of edges of color-avoiding connected graphs on a given number of vertices and with a given number of colors. This is joint work with Kitti Varga.

50 — Section V — Room E — 09:15 - 09:35

Pairwise disjoint perfect matchings in r-edge-connected r-graphs

YULAI MA (Paderborn University)

Thomassen [Factorizing regular graphs, *J. Combin. Theory Ser. B*, 141 (2020), 343-351] proposed a question that whether every r-edge-connected r-graph has $r-2$ pairwise disjoint perfect matchings. It has been showed by Mattiolo and Steffen [Highly edge-connected regular graphs without large factorizable subgraphs, *J. Graph Theory*, 99 (2022), 107-116] that this is not true when $r \equiv 0$ mod 4. Recently, we extended the above result and constructed counterexamples for the case $r \equiv 2$ mod 4. It turns out that our methods are limited to the even case, and so the odd case is still open.

In this talk, motivated by the study of the odd case of Thomassen's question, we present some equivalences of statements on pairwise disjoint matchings in highly edge-connected regular graphs, where the matchings contain or avoid fixed sets of edges.

Based on these results we relate statements on pairwise disjoint perfect matchings of 5-regular graphs to well-known conjectures for cubic graphs, such as the Fan-Raspaud Conjecture, the Berge-Fulkerson Conjecture and the 5-Cycle Double Cover Conjecture.

Joint work with Davide Mattiolo, Eckhard Steffen, and Isaak H. Wolf.

Saturday, 19 Nov. 2022 — Time: 09:40 - 10:00

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51 — Section I — Room A — 09:40 - 10:00

Hamilton decompositions of regular bipartite tournaments

BERTILLE GRANET (Universität Heidelberg)

A *regular bipartite tournament* is an orientation of a complete balanced bipartite graph $K_{2n,2n}$ where every vertex has its in- and outdegree both equal to n. In 1981, Jackson conjectured that any regular bipartite tournament can be decomposed into Hamilton cycles. We prove this conjecture for sufficiently large n. Along the way, we also prove several further results, including a conjecture of Liebenau and Pehova on Hamilton decompositions of dense bipartite digraphs.

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52 — Section II — Room B — 09:40 - 10:00

Cataloguing distance-regular graphs with primitive automorphism groups

ROBERT BAILEY (Grenfell Campus, Memorial University)

The GAP computer algebra system contains libraries of primitive permutation groups on up to 4095 points. We discuss a detailed analysis of these libraries to obtain distance-regular (and strongly regular) graphs which arise from these group actions. Many of the graphs obtained belong to well-known families or are well-known sporadic examples, but not all. Some of the unsolved cases lead to interesting questions, including about association schemes arising from actions of the group $\mathrm{PSL}(2,q)$, and about strongly regular Cayley graphs of elementary abelian groups.

53 — Section III — Room C — 09:40 - 10:00

A construction for a counterexample to the pseudo 2-factor isomorphic graph conjecture

DOMENICO LABBATE (Università degli Studi della Basilicata - Potenza (Italy))

A graph G admitting a 2-factor is pseudo 2 -factor isomorphic if the parity of the number of cycles in all its 2-factors is the same. The speaker with some co–authors gave (2008) a partial characterisation of pseudo 2-factor isomorphic bipartite cubic graphs and conjectured that $K_{3,3}$, the Heawood graph H_0 and the Pappus graph P_0 are the only essentially 4-edge-connected ones. Jan Goedgebeur (2015) computationally found a graph G of order 30 that is a counterexample to the above conjecture. In this talk, we describe how such a graph can be constructed.

54 — Section IV — Room D — 09:40 - 10:00

Edge-color-avoiding connected colorings and orientations

KITTI VARGA (Budapest University of Technology and Economy)

A (not necessarily properly) edge-colored graph is called edge-color-avoiding connected if after the removal of the edges of any color, the remaining graph is connected; such an edge-coloring is called an edge-color-avoiding connected coloring. First, we show that we can decide in polynomial time whether a graph has an edge-color-avoiding connected coloring, and if it does, then we can also determine the minimum number of colors needed in such an edge-coloring. However, the problem becomes NP-complete if the edges of the graph have weights and we require that not only an arbitrary spanning tree remains in the graph after the removal of any color, but one whose weight is not larger than a given number. We also prove that deciding whether the edges of an edge-color-avoiding connected graph can be oriented so that after the removal of the arcs of any color, the remaining graph is strongly connected, is NP-complete.

This is joint work with Roland Molontay and József Pintér.

55 — Section V — Room E — 09:40 - 10:00

Edge-connectivity and pairwise disjoint perfect matchings in regular graphs

ISAAK H. WOLF (Paderborn University)

For $0 \leq t \leq r$ let $m(t,r)$ be the maximum number s such that every t-edge-connected r-graph has s pairwise disjoint perfect matchings. There are only a few values of $m(t,r)$ known, for instance $m(3,3) = m(4,r) = 1$, and $m(t,r) \leq r-2$ for all $t \neq 5$, and $m(t,r) \leq r-3$ if r is even. In a joint work with Yulai Ma, Davide Mattiolo and Eckhard Steffen we recently proved that $m(2l,r) \leq 3l-6$ for every $l \geq 3$ and $r \geq 2l$. In the talk, this result will be presented.

Saturday, 19 Nov. 2022 — Time: 10:30 - 10:50

56 — Section I — Room A — 10:30 - 10:50

Distinguishing digraphs by its quasisymmetric B-polynomial

SAGAR SAWANT (Indian Institute of Technology, Madras)

The quasisymmetric B-polynomial defined by J. Awan and O. Bernardi is a simultaneous generalization of chromatic symmetric function and Tutte Polynomial to digraphs. The well-known Stanley's Tree Conjecture states that the chromatic symmetric function distinguishes all trees. An analogous question to Stanley's Tree Conjecture can be asked for digraphs; does quasisymmetric B-polynomial distinguishes all acyclic digraphs?

In this talk, we will prove the digraph analogue of Stanley's Tree conjecture for proper caterpillars. We will see that the quasisymmetric B-polynomial distinguishes a class of oriented paths and oriented proper caterpillars. We will then express the quasisymmetric B-polynomial using a recurrence formula involving deletion of a source or a sink adjacent to all other vertices. As a consequence, we will prove that a class of digraph $\mathcal{D}$ is distinguishable if and only if the class $\mathcal{D}^\vee$ obtained by taking directed join of K_1 with each digraph in $\mathcal{D}$ is distinguishable. Thus, we show that analogue of Stanley's Tree conjecture holds for a large class of acyclic digraphs. Further, we will see that the symmetricity of quasisymmetric B-polynomial characterizes some oriented trees that are isomorphic to their reverse. We conclude the talk by posing some further open problems regarding characterization of digraphs by its quasisymmetric B-polynomial.

57 — Section II — Room B — 10:30 - 10:50

The existence of synchronising groups of diagonal type

JESSE LANSDOWN (The University of Western Australia)

Motivated originally by synchronisation in automata, there is ongoing work to classify primitive permutation groups within the sychronisation hierarchy. This hierarchy consists of natural classes of groups - synchronising, separating, and spreading - which lie between primitive and 2-transitive. Synchronising primitive groups must be of affine, almost simple, or diagonal type. Until recently, no synchronising groups of diagonal type were known. In this talk I will present recent work (with John Bamberg, Michael Giudici, and Gordon Royle) in which we show that $\mathrm{PSL}(2, \mathrm{q}) \times \mathrm{PSL}(2, \mathrm{q})$ acting in its diagonal action on $\mathrm{PSL}(2, \mathrm{q})$ is separating, and hence synchronising, for $q = 13$ and $q = 17$, and non-spreading for all prime powers of q. We achieve this using techniques involving graphs and association schemes.

58 — Section III — Room C — 10:30 - 10:50

Clique Dynamics of Finite or Infinite Locally Cyclic Graphs with $\delta \geq 6$

ANNA MARGARETHE LIMBACH (RWTH Aachen University)

We prove that the clique graph operator k is divergent on a (not necessarily finite) locally cyclic graph G (i. e. $N_G(v)$ is a circle for every vertex v) with minimum degree $\delta(G) \geq 6$ if and only if the universal cover of G contains arbitrarily large triangular-shaped subgraphs. For finite G, this is equivalent to G being 6-regular.

The clique graph G of a graph G has the maximal complete subgraphs of G as vertices and its edges are given by non-empty intersections. The $(n+1)$-st iterated clique graph is inductively defined as the clique graph of the n-th iterated clique graph. If all iterated clique graphs of G are pairwise non-isomorphic, the graph G is called k-divergent; otherwise, it is k-convergent.

Locally cyclic graphs with $\delta \geq 6$ which induce simply connected simplicial surfaces are isomorphic to their universal covers. On this graph class, we prove our claim by explicit construction of the iterated clique graphs. After that, we show that locally cyclic graphs with $\delta \geq 6$ are k-convergent if and only if their universal covers are k-convergent. This way, we can drop the condition of simple connectivity.

This talk is based on joint work with Markus Baumeister and Martin Winter.

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59 — Section IV — Room D — 10:30 - 10:50

Betwixt and between 2-factor Hamiltonian and Perfect-Matching-Hamiltonian graphs

FEDERICO ROMANIELLO (Università degli Studi della Basilicata)

A graph is 2-factor Hamiltonian (2FH) if each one of its 2-factors is a Hamiltonian cycle. A similar, but weaker, property is the Perfect-Matching-Hamiltonian property (PMH-property): a graph is said to admit this property if each one of its perfect matchings can be extended to a Hamiltonian cycle. In [J. Combin. Theory Ser. B 87 (2003)], Funk et al. introduce the star product and show that this graph operation between two bipartite 2FH-graphs is a necessary and sufficient condition for a bipartite graph admitting a 3-edge-cut to be 2FH. The same cannot be said when dealing with the PMH-property, and in this talk we discuss how one can use star products to obtain graphs (which are not necessarily bipartite, regular and 2FH) admitting the PMH-property from smaller graphs, with the help of malleable vertices. The presence of a malleable vertex in a graph implies that the graph has the PMH-property, but does not necessarily imply that it is 2FH. Funk et al. also conjecture that if a graph is a bipartite cubic 2FH-graph, then it can only be obtained from the complete bipartite graph $K_{3,3}$ and the Heawood graph by using star products. Here, we show that a cubic graph (not necessarily bipartite) is 2FH if and only if all of its vertices are malleable. We also show that the above conjecture is equivalent to saying that every bipartite cyclically 4-edge-connected cubic graph having the PMH-property, except for the Heawood graph, admits a perfect matching which can be extended to a Hamiltonian cycle in exactly one way.

Saturday, 19 Nov. 2022 — Time: 10:55 - 11:15

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60 — Section I — Room A — 10:55 - 11:15

Counting spanning trees in Dirac graphs

JONATHAN SCHRODT (Heidelberg University)

Let T be an oriented tree on n vertices with maximum degree at most $e^{\gamma\sqrt{\log n}}$ for some $\gamma > 0$. If G is a digraph on n vertices with minimum semidegree $\delta^0(G) \geq (\frac{1}{2} + \varepsilon)n$ for some $\varepsilon > 0$, then G contains T as a spanning tree, as recently shown by Kathapurkar and Montgomery. This generalizes the corresponding result by Komlós, Sárközy and Szemerédi for graphs. We investigate the natural question how many copies of T the digraph G contains. We prove that every such G contains at least $\frac{1}{2^{n-1}} \frac{n!}{|\mathrm{Aut}(T)|}(1 - o(1))^n$ copies of T, which is optimal. This implies the analogous result in the undirected case.

This is joint work with Felix Joos.

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61 — Section II — Room B — 10:55 - 11:15

On minimal admissible complexes in $\mathbb{F}_q^n$

YUNSEO CHOI (Harvard)

Motivated by the chain of studies on the Radon transform in discrete settings, we ask and answer the following question: what are the smallest subsets S of $\mathbb{F}_q^n$ for which for any $f : \mathbb{F}_q^n \to \mathbb{C}$, the values of f on S can be recovered from the sums of f across the $k-$dimensional affine spaces of $\mathbb{F}_q^n$ that are contained in S?

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62 — Section III — Room C — 10:55 - 11:15

A representation theorem for end spaces of infinite graphs

MAX PITZ (Universität Hamburg)

End spaces of infinite graphs sit at the interface between graph theory, group theory and topology. They arise as the boundary of an infinite graph in a standard sense generalising the theory of the Freudenthal boundary developed by Freudenthal and Hopf in the 1940's for infinite groups.

A long-standing quest in infinite graph theory, with contributions by Halin, Thomassen, Seymour & Robertson, Diestel, Polat, Carmesin, and others, seeks to describe the possible end structures of graphs by a set of low-complexity representatives.

In this talk I will explain our recent solution to this fifty-year-old problem, how end spaces can be represented by the set of rays of certain order trees.

This is joint work with Jan Kurkofka, see *arXiv:2111.12670* for details.

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63 — Section IV — Room D — 10:55 - 11:15

The Effect of Symmetry-preserving Operations on 3-Connectivity

HEIDI VAN DEN CAMP (Ghent University)

Polyhedra have fascinated people ever since the Ancient Greeks. During this time numerous symmetry-preserving operations on polyhedra have been studied. In 2017, Brinkmann, Goetschalckx and Schein introduced a very general way of describing operations on polyhedra that preserve all orientation-preserving symmetries of the polyhedron. This description includes all well-known operations such as Dual, Truncation and Ambo. As these operations are applied locally, they are called local orientation-preserving symmetry-preserving operations, or lopsp-operations. In this talk I will use the general description of these operations to determine their effect on 3-connectivity. I will present a simple condition that characterizes exactly which lopsp-operations preserve 3-connectivity for all embedded graphs, even for those that are not polyhedral. This very general result proves that almost all well-known operations such as Dual, Truncation, Ambo, Capra, Gyro, Snub and many others preserve 3-connectivity of embedded graphs.

Saturday, 19 Nov. 2022 — Time: 11:20 - 11:40

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64 — Section I — Room A — 11:20 - 11:40

Large independent sets in Markov random graphs

AKSHAY GUPTE (University of Edinburgh)

Computing the maximum size of an independent set in a graph is a famously hard combinatorial problem that has been well-studied for various classes of graphs. When it comes to random graphs, only the classical binomial random graph $G_{n,p}$ has been analysed and shown to have largest independent sets of size $\Theta(\log n)$ w.h.p. This classical model does not capture any dependency structure between edges that can appear in real-world networks. We initiate study in this direction by defining random graphs $G^r_{n,p}$ whose existence of edges is determined by a Markov process that is also governed by a decay parameter $r \in (0, 1]$. We prove that w.h.p. $G^r_{n,p}$ has independent sets of size $\frac{1-r}{2+\epsilon} \frac{n}{\log n}$ for arbitrary $\epsilon > 0$, which implies an asymptotic lower bound of $\Omega(\pi(n))$ where $\pi(n)$ is the prime-counting function. This is derived using bounds on the terms of a harmonic series, Turán bound on stability number, and a concentration analysis for a certain sequence of dependent Bernoulli variables that may also be of independent interest. Since $G^r_{n,p}$ collapses to $G_{n,p}$ when there is no decay, it follows that having even the slightest bit of dependency (any $r < 1$) in the random graph construction leads to the presence of large independent sets and thus our random model has a phase transition at its boundary value of $r = 1$. For the maximal independent set output by a greedy algorithm, we deduce that it has a performance ratio of at most $1 + \frac{\log n}{(1-r)}$ w.h.p. when the lowest degree vertex is picked at each iteration, and also show that under any other permutation of vertices the algorithm outputs a set of size $\Omega(n^{1/(1+\tau)})$, where $\tau = 1/(1-r)$, and hence has a performance ratio of $O(n^{1/(2-r)})$.

Joint work with Yiran Zhu.

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65 — Section II — Room B — 11:20 - 11:40

The trifference problem and blocking sets

ANURAG BISHNOI (Delft University of Technology)

A trifferent code, also known as a perfect 3-hash code, is a set of ternary strings with the property that for any three distinct strings in the set there is a position where they all differ. Finding the maximum (asymptotic) size of a trifferent code as a function of its length is known as *the trifference problem*. We prove new lower and upper bounds on the maximum size of a *linear* trifferent code by establishing connections with a problem in finite geometry on affine blocking sets. We also outline a new method for giving explicit constructions of trifferent codes using expander graphs and asymptotically good error-correcting codes.

Joint work with Jozefien D'haeseleer, Dion Gijswijt and Aditya Potukuchi.

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66 — Section III — Room C — 11:20 - 11:40

New results on continuous random variables using different fractional integrations

ZOUBIR DAHMANI (University of Mostaganem)

In this presentation, we use differente approaches of fractional integration to discuss new results for some important integral estimations of continuous random variables (CRV for short). The obtained results include those of classical integration as special cases. Some applications, for CRVs having probability density functions with compact supports, are discussed.

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67 — Section IV — Room D — 11:20 - 11:40

An update on the 3-colorability of gammoids

WINFRIED HOCHSTÄTTLER (FernUniversität in Hagen)

Hadwiger's Conjecture states that a graph without a proper k-coloring must have a K_{k+1}-minor. Goddyn and Hochstättler proved that Hadwiger's Conjecture can be extended to regular (oriented) matroids in such a way that it includes Tutte's 4- and 5-Flow-Conjectures. That extension might also be true for aritrary oriented matroids, but here already the case $k = 3$ is open.

A natural class of matroids without K_4-minor is the class of gammoids, the smallest class closed under duality that includes the transversal matroids. Goddyn, Hochstättler and Neudauer introduced *generalized series-parallel (GSP)* matroids, proved that they are 3-colorable and that they contain bicircular matroids, a special class of transversal matroids. In their proof they used a so-called *positive coline* and conjectured such a coline to exist in any simple gammoid.

We present a large class of gammoids without a positive coline disproving that conjecture. Moreover, we show by a different method that this class, nevertheless, is GSP and hence 3-colorable.

This is joint work with Santiago Guzmán-Pro

Saturday, 19 Nov. 2022 — Time: 11:45 - 12:05

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68 — Section I — Room A — 11:45 - 12:05

Edge Contraction and Forbidden Induced Subgraphs

HANY IBRAHIM (University of Applied Science Mittweida)

A graph obtained from a graph G by contracting an edge in $E(G)$ is G-contraction. Let $\mathcal{H}$ be a set of graphs, we call a graph G $\mathcal{H}$-free if any induced subgraph of G is non-isomorphic to any graph in $\mathcal{H}$, otherwise, we call G $\mathcal{H}$-exist. Given a set of graphs $\mathcal{H}$, we present sufficient and necessary conditions for G such that G/e is $\mathcal{H}$-free for any edge e in $E(G)$. Afterwards, we use these conditions to characterize claw-free, $2K_2$-free, C_4-free, C_5-free, split, matrogenic, and line graphs.

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69 — Section II — Room B — 11:45 - 12:05

Erdős-Ko-Rado theorems for finite general linear groups

ALENA ERNST (Paderborn University)

A subset Y of the symmetric group $\mathcal{S}_n$ is *t-intersecting* if $x^{-1}y$ fixes t elements in $[n]$ for all $x, y \in Y$ and it is *t-set-intersecting* if $x^{-1}y$ fixes a t-set of $[n]$ for all $x, y \in Y$. Deza and Frankl conjectured in 1977 and Ellis, Friedgut, and Pilpel proved in 2011 that the size of a t-intersecting set in $\mathcal{S}_n$ is at most $(n-t)!$ for n sufficiently large compared to t. Moreover equality holds if and only if the t-intersecting set is a coset of the stabiliser of a t-tuple. It is also known that the size of a t-set-intersecting set in $\mathcal{S}_n$ is at most $t!(n-t)!$ for n sufficiently large compared to t and equality holds if and only if the t-set-intersecting set is a coset of the stabilizer of a t-set.

In this talk we discuss q-analogs of these results. We define a subset Y of $\mathrm{GL}(n, q)$ to be *t-intersecting* if $x^{-1}y$ fixes a t-dimensional subspace of $\mathbb{F}_q^n$ pointwise for all $x, y \in Y$. Whereas we define Y to be *t-space-intersecting* if $x^{-1}y$ fixes a t-dimensional subspace of $\mathbb{F}_q^n$ for all $x, y \in Y$. It is shown that the size of a t-intersecting subset of $\mathrm{GL}(n, q)$ is at most

$$[n-t]_q! \frac{(q-1)^n q^{\binom{n}{2}}}{(q-1)^t q^{\binom{t}{2}}}$$

for n sufficiently large compared to t. In addition it is shown that the size of a t-space-intersecting subset of $\mathrm{GL}(n, q)$ is at most

$$[t]_q![n-t]_q!(q-1)^n q^{\binom{n}{2}}$$

for n sufficiently large compared to t. Moreover we give a characterisation of the cases for which equality holds.

This is a joint work with Kai-Uwe Schmidt.

Group partitions yielding lower bounds for Ramsey numbers

CHIMERE STANLEY ANABANTI (University of Pretoria)

The Ramsey number $R_n(3)$ is the smallest positive integer such that colouring the edges of a complete graph on $R_n(3)$ vertices in n colours forces the appearance of a monochromatic triangle. A lower bound on $R_n(3)$ is obtainable by partitioning the non-identity elements of a finite group into disjoint union of n symmetric product-free sets. Exact values of $R_n(3)$ are known for $n < 4$; in particular, $R_1(3) = 3$, $R_2(3) = 6$ and $R_3(3) = 17$. The best known lower bound that $R_4(3) \geq 51$ was given by Chung. In 2006, Kramer proved that $R_4(3) \leq 62$. He then conjectured that $R_4(3) = 62$. We say that the Ramsey number $R_n(3)$ is solvable by group partition means if there is a finite group G such that $|G| + 1 = R_n(3)$ and the non-identity elements of G can be partitioned as a disjoint union of n symmetric product-free sets. For $n < 4$, the Ramsey number $R_n(3)$ is solvable by group partition means. We show that $R_4(3)$ is not solvable by group partition means. This gives the first example of a Ramsey number which is not solvable by group partition means. We conclude with a conjecture that $R_5(3) \geq 257$.

Speakers