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ABSTRACTS

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LIST OF TALKS

Marcin Anholcer
Poznań University of Economics and Business

Every digraph is majority 4-choosable

A *majority coloring* of a digraph is a coloring of its vertices such that for each vertex at most half of its out-neighbors has the same color as that vertex. A digraph D is *majority k-choosable* if for any assignment of color lists of size k to the vertices there is a majority coloring of D from these lists. We prove the statement in the title. This gives a positive answer to a question posed recently in [1].

References

[1] S. Kreutzer, S. Oum, P. Seymour, D. van der Zypen, D. R. Wood, *Majority colourings of digraphs*, ArXiv:1608.03040.

Funmilola Balogun
Ahmadu Bello University

Mset chains and mset antichains of partially ordered multisets

In this work, we define multiset (or mset) chains and mset antichains on a partially ordered multiset (or pomset). We extend notions and results on chains and antichains of partially ordered set (or posets) to the case where the ordered structure is a pomset. In the sequel, we introduce a new concept of a semimset chain and present properties of this substructure.

Fabricio Benevides

Federal University of Ceará

Edge-colorings of graphs avoiding complete graphs with a prescribed coloring

Given a graph F and an integer $r \geq 2$, a partition $\widehat{F}$ of the edge set of F into at most r classes, and a graph G, define $c_{r,\widehat{F}}(G)$ as the number of r-colorings of the edges of G that do not contain a copy of F such that the edge partition induced by the coloring is isomorphic to the one of F. We think of $\widehat{F}$ as the pattern of coloring that should be avoided. The main question is, for a large enough n, to find the (extremal) graph G on n vertices which maximizes $c_{r,\widehat{F}}(G)$. This problem generalizes a question of Erdős and Rothschild, who originally asked about the number of colorings not containing a monochromatic clique (which is equivalent to the case where F is a clique and the partition $\widehat{F}$ contains a single class). We use Hölder's Inequality together with Zykov's Symmetrization to prove that, for any $r \geq 2$, $k \geq 3$ and any pattern $\widehat{K_k}$ of the clique K_k, there exists a complete multipartite graph that is extremal. Furthermore, if the pattern $\widehat{K_k}$ has at least two classes, with the possible exception of two very small patterns (on three or four vertices), every extremal graph must be a complete multipartite graph. In the case that $r = 3$ and $\widehat{F}$ is a rainbow triangle (that is, where $F = K_3$ and each part is a singleton), we show that an extremal graph must be an almost complete graph. Still for $r = 3$, we extend a result about monochromatic patterns of Alon, Balogh, Keevash and Sudakov to some patterns that use two of the three colors, finding the exact extremal graph. For the later two results, we use the Regularity and Stability Method.

Csaba Biró
University of Louisville

Random walk on the Cayley graph of the Baumslag–Solitar $(1, 2)$-group

The random walk described in the title can be equivalently defined as follows. Starting from $x = 0$, there are four types of moves: add one to x, subtract one from x, multiply x by two, divide x by two. Let p_i be the probability that in the ith step, multiplication or division happens. We study the recurrence properties of the random walk, and how it depends on the sequence p_i.

Joint work with Aaron Hill.

Bartłomiej Bosek
Jagiellonian University

A NEW VARIANT OF THE GAME OF COPS AND ROBBER

We consider the following metric version of the Cops and Robber game. Let G be a simple graph and let $k \geq 1$ be a fixed integer. In the first round Cop picks a subset of k vertices $B = \{v_1, v_2, \ldots, v_k\}$ and then Robber picks a vertex u but keeps it in a secret. Then Cop asks Robber for a vector $D_u(B) = (d_1, d_2, \ldots, d_k)$ whose components $d_i = d_G(u, v_i)$, $i = 1, 2, \ldots, k$, are the distances from u to the vertices of B. In the second round Robber may stay at the vertex u or move to any neighboring vertex which is kept in a secret. Then Cop picks another k vertices and asks as before for the corresponding distances to the vertex occupied by Robber. And so on in every next round. The game stops when Cop determines exactly the current position of Robber. In that case she is the winner. Otherwise, Robber is the winner (that is if Cop is not able to localize him in any finite number of rounds). Let $\zeta(G)$ denote the least integer k for which Cop has a winning strategy. Notice that this parameter is well defined since the inequality $\zeta(G) \leq |V(G)|$ holds obviously.

This game restricted to $k = 1$ was introduced by Seager [4] (with additional restriction that robber cannot occupy a vertex just picked be the cop), and studied further in [1], [2], [5]. It is also connected to the notion of *metric dimension* of a graph G, denoted by $\dim(G)$, introduced independently by Harary and Melter [3], and by Slater [6]. Indeed, $\dim(G)$ can be defined as the least number k such that Cop wins our game in one round by cleverly choosing k vertices of G. Hence, the parameter $\zeta(G)$ can be seen as the game theoretic variant of $\dim(G)$.

The aim of the talk is to present results concerning 2-trees, outerplanar graphs and planar graphs.

Joint work with Jarosław Grytczuk, Małgorzata Śleszyńska-Nowak and Joanna Sokół.

References

[1] A. Brandt, J. Diemunsch, C. Erbes, J. LeGrand, C. Moffatt, *Locating a robber on a tree*, manuscript, 2015.

[2] J. Carraher, I. Choi, M. Delcourt, L. H. Erickson, D. B. West, *Locating a robber on a graph via distance queries*, Theoretical Computer Science 463, 2012, pp. 54–61.

[3] F. Harary, R. A. Melter, *On the metric dimension of a graph*, Ars Combinatoria 2, 1976, pp. 191–195.

[4] S. Seager, *Locating a robber on a graph*, Discrete Mathematics 312, 2012, pp. 3265–3269.

[5] S. Seager, *Locating a backtracking robber on a tree*, Theoretical Computer Science 539, 2014, pp. 28–37.

[6] P. J. Slater, *Leaves of trees*, in: Proceedings of Sixth Southeastern Conference on Combinatorics, Graph Theory and Computing, Congressus Numerantium 14, 1975, pp. 549–559.

Jarosław Byrka
University of Wrocław

Optimization in algorithm design

It is standard to use solutions to LP-relaxations of studied complex optimization problems in the construction of LP-rounding approximation algorithms. We will discuss a more sophisticated approach in which linear models are used in the process of optimizing the algorithm being constructed. In the context of approximation algorithms it leads to the so-called factor-revealing linear programs.

The tutorial will cover the usage of a factor-revealing LP in two different contexts:

- first we will discuss a recent result, which is an improved online algorithm for the file migration problem [1];
- next we will cover a modern version of the analysis of the well known primal-dual JMS algorithm for the incapacitated facility location problem

Rather than presenting details of individual results, the tutorial will aim to encourage the participants to use LP-modelling as a tool to handle the complexity of arguments with multiple parameters.

References

[1] M. Bieńkowski, J. Byrka, M. Mucha, *Dynamic beats fixed: on phase-based algorithms for file migration*, ArXiv:1609.00831.

Sebastian Czerwiński
University of Zielona Góra

The vertex-distinguishing proper edge-coloring number of a regular graph

We present a new upper bound for the vertex-distinguishing proper edge-coloring number of a regular graph.

Dariusz Dereniowski
Gdańsk University of Technology

Searching partially ordered sets - a generalization of binary search

The problem of searching more general structures than a sorted array, namely partial orders, can be stated as searching for an unknown target node of an input graph by querying its nodes or edges. The goal is to locate the target node by performing as few queries as possible in the worst case. In the talk, we discuss the formulations of the problem, algorithmic techniques and some recent results.

Adam Doliwa

University of Warmia and Mazury

Generalized quasi-symmetric functions: Hopf algebra structure and geometric interpretation

The theory of symmetric functions is by now well established subject with numerous applications in combinatorics, algebraic topology, representation theory, integrable systems and geometry. Quasi-symmetric functions, introduced by Gessel, are extensions of symmetric functions that are becoming of comparable importance. As a graded Hopf algebra, the dual of the algebra of quasi-symmetric functions is the Hopf algebra of non-commutative symmetric functions introduced by Gelfand, Krob, Lascoux, Leclerc, Retakh, and Thibon. In my talk (based on [1]) I would like to introduce a generalization of the Hopf algebra of quasi-symmetric functions in terms of power series in partially commutative variables. This is the graded dual of the Hopf algebra of coloured non-commutative symmetric functions, described as a subalgebra of the Hopf algebra of rooted ordered coloured trees by Foissy.

References

[1] A. Doliwa, *Hopf algebra structure of generalized quasi-symmetric functions in partially commutative variables*, arXiv:1603.03259.

Maciej Dziemiańczuk
University of Gdańsk

On directed lattice paths with vertical steps

This presentation is about non-simple directed lattice paths running between two fixed points and for which the set of allowed steps contains vertical step $V = (0, -1)$ and forward steps $S_k = (1, k)$ for some k in Z. These paths generalize the heavily-studied simple directed lattice paths that consist of only forward steps. Two special families of primary (restricted to the half-plane) and free (unrestricted) lattice paths are considered. It is shown that for any family of primary paths with vertical steps there is equinumerous family of proper weighted simple directed lattice paths. The relationship between primary and free paths is established and some combinatorial and statistical properties are obtained. Finally, four families of paths with vertical steps are presented and related to Łukasiewicz, Raney, Dyck, Motzkin, Schröder, and Delannoy paths.

Anna Fiedorowicz

University of Zielona Góra

Connected domination game on graphs

A new graph game is introduced, namely, a connected domination game on graphs. It is defined analogously to the well known domination game, first studied by Brešar, Klavžar and Rall in 2010. The game is played by two players, Dominator and Staller, on a connected graph G. The players alternate taking turns choosing a vertex of G (Dominator starts). A move of a player by choosing a vertex v is legal, if the following two conditions are satisfied: the vertex v dominates at least one new vertex of G and the set of all chosen vertices induces a connected subgraph of G. The game ends when none of the players has a legal move (i.e., G is dominated). The aim of Dominator is to finish as soon as possible, the aim of Staller is opposite.

We present some preliminary results concerning this game, as well as bounds and exact values of the corresponding graph parameter, called the connected game domination number, for some classes of graphs.

We also consider variations of the above described game. Namely, we let one of the players skip her/his move. We give some connections between the number of vertices played in these games and the connected game domination number.

Joint work with Mieczysław Borowiecki and Elżbieta Sidorowicz

Aram Gharibyan
Yerevan State University

Locally-balanced 2-partitions of complete multipartite graphs

A 2-partition of a graph G is a function $f : V(G) \to \{0, 1\}$. A 2-partition f of a graph G is locally-balanced with an open neighborhood if for every $v \in V(G)$, $||\{u \in N_G(v) : f(u) = 1\}| - |\{u \in N_G(v) : f(u) = 0\}|| \leqslant 1$, where $N_G(v) = \{u \in V(G) : uv \in E(G)\}$. A 2-partition f' of a graph G is locally-balanced with a closed neighborhood if for every $v \in V(G)$, $||\{u \in N_G[v] : f(u) = 1\}| - |\{u \in N_G[v] : f(u) = 0\}|| \leqslant 1$, where $N_G[v] = N_G(v) \cup \{v\}$. The concept of locally-balanced 2-partition of graphs was introduced by Balikyan and Kamalian [1] in 2005, and it can be considered as a special case of equitable colorings of hypergraphs [3]. In [1], Balikyan and Kamalian proved that the problem of existence of locally-balanced 2-partition with an open neighborhood of bipartite graphs with maximum degree 3 is NP-complete. Later, they also proved the similar result for locally-balanced 2-partitions with a closed neighborhood. In [2], the necessary and sufficient conditions for the existence of locally-balanced 2-partitions of trees were obtained. In this work we obtain the necessary and sufficient conditions for the existence of locally-balanced 2-partitions of complete multipartite graphs.

Joint work with Petros Petrosyan.

References

[1] S. V. Balikyan, R. R. Kamalian, *On NP-completeness of the problem of existence of locally-balanced* 2*-partition for bipartite graphs* G *with* $\Delta(G) = 3$, Doklady NAN RA 105 (1), 2005, pp. 21–27.

[2] S. V. Balikyan, *On existence of certain locally-balanced* 2*-partition of a tree*, Mathematical Problems of Computer Science 30, 2008, pp. 25–30.

[3] C. Berge, Graphs and Hypergraphs, Elsevier, 1985.

Modjtaba Ghorbani

Shahid Rajaee University

Polyhedral graphs via their automorphism group

Given a triple $t = (p_3, p_4, p_5)$, we denote by p_t the class of 3-valent polyhedral graph having p_3 triangular, p_4 quadrilateral, p_5 pentagonal and h hexagonal faces, and no other faces. The number of vertices of a polyhedral belonging to the class p_t is $n = 2p_3 + 2p_4 + 2p_5 + 2h - 4$.

In general, a $(4, 5, 6)$-polyhedron is a cubic planar graph whose faces are squares, pentagons and hexagons. A $(3, 5, 6)$-polyhedron is a cubic planar graph whose faces are triangles, pentagons and hexagons. In this paper we compute the symmetry group of both $(3, 5, 6)$ and $(4, 5, 6)$ polyhedral graphs. Our method can be applied for computing other polyhedral graphs as fullerenes.

Roman Glebov

Hebrew University of Jerusalem

THE NUMBER OF HAMILTONIAN DECOMPOSITIONS OF REGULAR GRAPHS

A Hamiltonian decomposition of Γ is a partition of its edge set into disjoint Hamilton cycles. One of the oldest results in graph theory is Walecki's theorem from the 19th century, showing that a complete graph K_n on an odd number of vertices n has a Hamiltonian decomposition. This result was recently greatly extended by Kühn and Osthus. They proved that every r-regular n-vertex graph Γ with even degree $r = cn$ for some fixed $c > 1/2$ has a Hamiltonian decomposition, provided $n = n(c)$ is sufficiently large. In this talk we address the natural question of estimating $H(\Gamma)$, the number of such decompositions of Γ. The main result is that $H(\Gamma) = r^{(1+o(1))nr/2}$. In particular, the number of Hamiltonian decompositions of K_n is $n^{(1+o(1))n^2/2}$.

Joint work with Zur Luria and Benny Sudakov.

Przemysław Gordinowicz
Łódź University of Technology

How much can be saved from planar graph on fire?

Let G be any connected graph on n vertices, $n \geq 2$. Let k be any positive integer. Suppose that a fire breaks out at some vertex of G. Then, in each turn firefighters can protect at most k vertices of G not yet on fire. Next the fire spreads to all unprotected neighbours of burning vertices. The above model was introduced by Hartnell in 1995.

It is not surprising that the number of vertices which can be saved highly depends on a choice of a vertex, where the fire has broken out. To manage this problem, it was defined some graphical parameter - *k-surviving rate* of G, denoted by $\rho_k(G)$, as the expected fraction of vertices that can be saved from the fire by k firefighters, providing that the starting vertex is chosen uniformly at random (Cai and Wang, 2009).

Another evident observation is that the surviving rate depends on a density of a graph; Sparse graphs are less flammable. Hence, it seems to be reasonable to investigate the surviving rate on such graph classes which are not only important from the applications point of view, but also which force sparsity of its members, eg. planar graphs.

During a presentation bounds on the surviving rate for some graph classes will be shown. In particular it will be shown that for any planar graph G with average degree $4\frac{1}{2} - \varepsilon$, where $\varepsilon \in (0, 1]$, we have $\rho_2(G) \geq \frac{2}{9}\varepsilon$. The result implies a significant improvement of the bound for 2-surviving rate for triangle-free planar graphs (Esperet, van den Heuvel, Maffray and Sipma, 2013) and for planar graphs without 4-cycles (Kong, Wang, Zhang, 2012). The proof is done using the separator theorem for planar graphs.

Izolda Gorgol

Lublin University of Technology

On extremal colorings without rainbow cycles

While defining the anti-Ramsey number Erdős, Simonovits and Sós mentioned that the extremal colorings may not be unique [1]. In the talk we define ESS colorings to formalize colorings proposed by Erdős, Simonovits and Sós and characterize some of the extremal colorings avoiding rainbow cycles. In case of rainbow triangles we count the number of different ESS colorings. Apart from that we show the recursive construction of such colorings. It occurs that the number of them is equal to an appropriate Fibonacci number. By a double counting technique we obtain a new identity for Fibonacci numbers.

References

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Aleksandra Gorzkowska
AGH University of Science and Technology

Distinguishing index and edge-cost of the Cartesian product of graphs

The *distinguishing index* $D'(G)$ of a graph G is the least number d such that G has an edge colouring with d colours that is only preserved by the identity automorphism. The *Cartesian product* of graphs G and H is a graph denoted $G \square H$ whose vertex set is $V(G) \times V(H)$. Two vertices (g, h) and (g', h') are adjacent if either $g = g'$ and $hh' \in E(H)$, or $gg' \in E(G)$ and $h = h'$. Consider the graphs with distinguishing index is equal to two. The *edge-cost* $\rho'(G)$ of a graph G is the least number of edges in one of the two colour classes.

In the talk we present the results for the distinguishing index of the Cartesian powers of connected graphs and Cartesian product of stars $K_{1,m}$ and $K_{1,n}$, where $2 < m \leq n$. We demonstrate the conditions under which $D'(K_{1,m} \square K_{1,n}) = 2$. We extend this result to any number of colours and determine the distinguishing number of $K_{1,m} \square K_{1,n}$ for nearly all m and n. Moreover, we present some results for edge-cost of Cartesian product of connected graphs.

Mariusz Grech
University of Wrocław

Road coloring and Černý conjecture

Road Coloring and Černý Conjecture are two of the long standing and important problems in automata theory. The first one was solved in 2009. The second one is much more difficult and is still opened. There is plenty of papers concerning this problems and solved it for some class of edge-colored digraphs (automatons). It seems that all these attempts do not give any hope for solving the all problem. We propose a more systematic way to attack the problem, that give some hope that the Černý Conjecture could be solved in a future.

Andrzej Grzesik
University of Warsaw

Applications of flag algebras in extremal graph theory

Flag algebras methods were introduced by Razborov only a few years ago, but already have a significant impact on extremal graph theory. Many long-standing open problems were solved or substantial improvements on the bounds were made.

During this talk we make a short introduction to the theory of flag algebras and present some important results obtained by the method. We focus on showing the broad possibilities of application for different combinatorial structures (simple graphs, oriented graphs, or graphs in a colored setting). In particular we prove the Erdős conjecture on five-cycles in triangle-free graphs, the Erdős-Faudree-Rousseau conjecture on edges in odd cycles, special case of the generalization of the Caccetta-Häggkvist conjecture, and provide a full description of the possible densities of all pairs of 3-vertex graphs.

David Gunderson

University of Manitoba

Extremal graphs for forbidding an odd cycle

For a finite simple graph F, say that a graph G is F-free iff G contains no copy of F as a (weak) subgraph. For each positive integer n, the extremal number $\mathrm{ex}(n; F)$ is the maximum number of edges in any F-free graph on n vertices, and $\mathrm{EX}(n; F)$ is the set of (extremal) F-free graphs with precisely $\mathrm{ex}(n; F)$ edges.

When F is a triangle, Mantel (and later, Turán) found $\mathrm{ex}(n, F)$ and showed that $\mathrm{EX}(n; F)$ consists of only one graph, namely the complete equibipartite graph on n vertices. In the 1970s, Bondy and Woodall showed that when F is any odd cycle, for n large enough, the extremal number $\mathrm{ex}(n, F)$ is the same as for the triangle, but their proof did not reveal what the extremal graphs are. On the other hand, Simonovits showed that for n sufficiently large, if F is an odd cycle, then $\mathrm{EX}(n; F)$ consists only of one graph.

In recent work with Füredi, when F is any odd cycle, for all n, we find $\mathrm{ex}(n; F)$, and in each case, we find all extremal graphs.

András Gyárfás
Hungarian Academy of Sciences

χ-BOUNDED GRAPH CLASSES - RESULTS AND PROBLEMS

A class of graphs is χ-bounded if the chromatic number of its members is bounded by a suitable function of its clique size. For example, the family of perfect graphs is the class χ-bounded by the identity function. I discuss questions and answers related to these classes.

Muhammad Hussain
COMSATS Institute of Information Technology

On constant metric dimensions of graphs obtained by rooted product

Let $G = (V, E)$ be a connected graph and $d(x, y)$ be the distance between the vertices x and y in G. A set of vertices W resolves a graph G if every vertex is uniquely determined by its vector of distances to the vertices in$W$. A metric dimension of G is the minimum cardinality of a resolving set of G and is denoted by $\dim(G)$. In this paper cycle, path, Harary graphs and their rooted product as well as their connectivity are studied and calculated their metric dimension. It is proved that metric dimension of the graphs is either three or four in certain cases.

Gabriel Jakóbczak
Jagiellonian University

Sign and sight additive chromatic number

Additive colouring of graph $G = (V, E)$ is an assignment to its vertices positive integers in such way that for every edge $uv \in E$ sum of the labels of the vertices belonging to the neighbourhood of v is different from analogous sum connected with vertex u. We present two modifications of that problem. They are both based on dividing the set of the vertices into two disjoint sets A and B. Here colour of vertex v is the sum of labels assigned to its neighbours which belong to the same set as v subtracted by the sum of the labels of the vertices from the neighbourhood which belong to the other set. We also prove that in one of these problems with some extra assumptions, we are able to label vertices properly, even if the weights are chosen from arbitrary lists of size five.

Mojtaba Jazaeri

Shahid Chamran University of Ahvaz

Distance-regular Cayley graphs

Distance-regular graphs are an important family of graphs in area of algebraic graph theory. There is a problem in [1] about the classification of distance-regular Cayley graphs. In this talk, we give an overview about ongoing progress in this problem and specially about the classification of distance-regular Cayley graphs with least eigenvalues at least -2.

References

[1] E. R. van Dam, J. H. Koolen, H. Tanaka, *Distance-regular graphs*, Electronic Journal of Combinatorics, 2016, #DS22.

Amir Kafshdar Goharshady
Institute of Science and Technology Austria

New dominating sets results in graphs with constant treewidth

In this work, we consider graphs with fixed treewidth and study the formulation of dominating sets and their extensions using groups to obtain general (fixed-parameter) linear algorithms for answering various questions related to them such as domination number, number of minimal dominating sets, the optimal set according to a given weight function, etc.

We are interested to devise a simple generalized method for proving the existence of linear algorithms and to solve various types of domination-like problems in constant treewidth graphs. In some cases, this is going to be the first known linear solution to the problem.

Rafał Kalinowski

AGH University of Science and Technology

Dense arbitrarily partitionable graphs

A graph $G = (V, E)$ is called *arbitrarily partitionable* if for every partition $\tau = (\tau_1, \ldots, \tau_k)$ of the order n of G, there exists a partition $(V_1, \ldots, V_k)$ of V such that each V_i induces a connected subgraph of order n_i. This concept was introduced to model a problem in the design of computer networks by Barth, Baudon and Puech, and independently by Horňák and Woźniak.

The on-line version of this notion was defined by Horňák, Tuza and Woźniak. Suppose that the whole sequence $\tau = (\tau_1, \ldots, \tau_k)$ is unknown at the beginning, but its elements are requested on-line, i.e., one by one. In the i-th stage, where $i = 1, \ldots, k$, a positive integer n_i arrives and we have to choose a connected subgraph G_i of G of order n_i that is vertex-disjoint with all subgraphs $G_1, \ldots, G_{i-1}$ chosen in the previous stages. If this procedure can be accomplished for any sequence of positive integers $\tau = (n_1, \ldots, n_k)$ summing up to the order n of G, then G is called *on-line arbitrarily partitionable.*

It will be shown that for dense graphs (in a prescribed sense) these two notions are equivalent.

Ludmila Koliechkina
Poltava University of Economics and Trade

Graph and Euclidean combinatorial approaches to the subset sum problem

A well-known problem: $\max_{B_n} a^T x,\ a^T x \leq$ b where B$_n$=$\{0,1\}^n$, $a, x \in$ R^n, called the subset sum problem (SSP), is studied. This NP-complete problem is reducible to the knapsack problem (KP) where utility and weight of items are equal: $\max_{B_n} a'^T x'$, $a'x' \leq b$, $a' > 0$, $a_i^{'} < a_{i+1}^{'}$, $i = \overline{1, n-1}$. (KP) is traditionally formulated as a binary or integer program. Another way is its representation as a combinatorial problem over the general combination set $S_{\eta k}^n(A^0)$. The set is generated by a multiset $A^0 = \left\{0^{\eta - n}, a_1^{'}, ..., a_n^{'}\right\}$ of k different elements by adding $\eta - n$ dummy zeros to the weights for representing all possible knapsacks. This statement allows using various properties of the combinatorial set in solving (KP). Thus, the first presented approach (A1) to (SSP) is a Branch&Bound algorithm based on geometric and extreme peculiarities of $S_{\eta k}^n(A^0)$.

Two other approaches ((A2), (A3)) to (SSP), based on graph construction, are as follow.

In framework of (A2) the following generalization of the hypercube graph is considered: a skeleton graph $H_n(k_1, k_2)$ of a polytope of the binary subset $B_n(k_1, k_2)$ with limited multiplicities of zeros and ones is complemented by Johnson graphs $J(n,k)$, k=$\overline{\mathrm{k}_1, k_2}$. Those connect nodes with labels of the same number of ones. This graph, denoted by $H_n^{'}(k_1, k_2)$, where k_1, k_2 - are the lower and upper limits for one-multiplicity, inherits known properties of the hypercube and Johnson graphs, such as small diameter, easy routing, etc. These properties allow using this topology as an alternative to the popular hypercube topology for designing the multi-processor networks. It is reasonable if a cost of connecting computers is negligible in comparison with a cost of the computers and an aim is increasing an information transmission speed within the whole network and its subnetworks. The second area of application is linear constrained boolean optimization, in particular, solving (SSP). (A2) outline: 1) transform (SSP) to an equivalent problem (KP); 2) introduce a partial ordering: $x_i \leq x_{i+1}\ \forall i:\ a_i^{'} = a_{i+1}^{'}$; 3) determine a set of cuts $\{\Pi_k\colon \mathrm{ex} = \mathrm{k}\}_{k=\overline{k_1,k_2}}$ intersected by a hyperplane Π: $\mathrm{a}'\mathrm{x}' = \mathrm{b}'$ based on solutions of an unconstrained linear problems: $z^{\min,k} = \min\limits_{B_n(k)} a'x'$, $z^{\max,k} = \max\limits_{B_n(k)} a'x'$ where $B_n(k) = B_n \cap \Pi_k$; 4) construct a directed subgraph, rooted at $x^{\min} = \left(1^{k_1}, 0^{n-k_1}\right)$, with edges oriented towards increasing the objective function. Any two vertices $x^1, x^2 \in B_n(k_1, k_2)$ are adjacent iff they are adjacent in $H_n^{'}(k_1, k_2)$ and $a'^T x^1 \neq a'^T x^2$. The process of constructing this digraph and solving (SSP) continues until no leafs remain, which could allow improvement of a current record.

The next graph approach (A3) is based on construction of a structural graph of (SSP) and the following decomposition: $B_n(k_1, k_2) = \bigcup\limits_{k=k_1}^{k_2} B_n(k)$. This digraph consists of $k_2 - k_1 + 1$ subgraphs, corresponding to each $B_n(k)$: $S_n^{'}(k_1, k_2) = \bigcup\limits_{k=k_1}^{k_2} S_n^{'}(k)$. The subgraphs $\left\{S_n^{'}(k)\right\}_k$ are analyzed sequentially. These subgraphs are binary trees, where lower and upper bounds are improved, based on solution of linear problems over $B_n(k)$-type sets.

The above-mentioned approaches are promising for the solution of the (SPP), as well as many other problems.

Joint work with Oksana Pichugina.

Jerzy Konarski

AGH University of Science and Technology

Near packing of two graphs

A packing of two graphs is a pair of edge-disjoint copies of those graphs (regarded as the subgraphs of a complete graph). Well known result states that two graphs of order n have a packing when they have less than or equal to $3/2n - 2$ edges. In this talk we study the case when the copies overlap such that common edges form a graph which belongs to a given family of graphs. We present results for three families:

1) family of graphs of size at most k;

2) a family of graphs of maximum degree at most k;

3) a family of graphs of clique number at most k.

Wojciech Kordecki

The Witelon State University of Applied Sciences in Legnica

On the q-analog of the secretary problem

In the classical secretary problem there are n linearly ordered elements. They are observed at some random order $\omega = (\omega_1, \omega_2, \ldots, \omega_n)$. At the moment $t = i$ the observer knows only the relative ranks $w(t)$ of the elements e_t examined so far. The algorithm: observe and reject the first $v = \lfloor n/e \rfloor$ elements, note their maximum, and then select the next element that exceeds this maximum value if such an element appears. Once rejected, an element cannot be recalled [1].

The multichoice secretary problem is a variation in which the algorithm is allowed to choose k elements, and the goal is to maximize their sum [2]. Let $PG(r-1, q)$ be a finite projective geometry of dimension $r-1$, where q is a prime power [3]. In the q-analog of the secretary problem the algorithm checks subsequent elements and decides to either reject irrevocably or accept the current element, which can be accepted only if it does not belong to the subgeometry spanned over all the elements rejected so far. A case similar to the multichoice secretary problem is considered: observe and reject the first elements until they span a subgeometry of fixed dimension $v-1$. Then select at most k next elements that exceed all the rejected observations and do not belong to the subgeometry spanned by the rejected elements. The goal of the algorithm is to obtain the set of k elements with maximal sum. The algorithm is studied for the simplest $PG(r-1, q)$, for example for $q = 2$ and small r, and also for $r = 3$, i.e. for projective planes.

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Tomasz Krawczyk

Jagiellonian University

Extending partial representations of trapezoid graphs

A trapezoid graph is an intersection graph of trapezoids spanned between two horizontal lines. The partial representation extension problem for trapezoid graphs is a generalization of the recognition problem: given a graph G and an assignment ϕ of trapezoids to some vertices of G, decide whether ϕ can be extended to an intersection model of the entire graph G. We prove that this problem can be decided in polynomial time. This way, we solve the partial representation extension problem for one of the two major remaining classes of geometric intersection graphs (circular-arc graphs being the other), for which recognition is decidable in polynomial time, but the complexity of partial representation extension has been unknown. As a corollary, we also provide a polynomial-time algorithm for partial representation extension of co-bipartite circular-arc graphs.

Joint work with Bartosz Walczak.

Matjaž Krnc

University of Salzburg & University of Primorska

Kronecker double covers and the family of generalized Petersen graphs

The family of generalized Petersen graphs GP, introduced by Coxter et al. (1950) and named by Mark Watkins (1969), is a family of cubic graphs formed by connecting the vertices of a regular polygon to the corresponding vertices of a star polygon. The Kronecker cover of a simple undirected graph G is a a special type of bipartite covering graph of G, isomorphic to the direct (tensor) product of G and K_2. In the short talk we will identify the generalized Petersen graphs that are Kronecker covers and discuss some related questions.

Krzysztof Krzywdziński
Adam Mickiewicz University

Distributed algorithms on random graphs: minimal independent set and colouring problems

In many distributed systems, such as for example internet network, ad hoc networks or sensor networks, there are many entities, which operate in the system. Their processors are active at any moment and may perform some local computations. Moreover the entities have ability to communicate with each other to achieve some goals. The model of computation, which use the architecture of those systems is the distributed LOCAL model and algorithms in this model are called distributed

Most of the known distributed algorithms either work on general graphs, i.e. study the worst cases, or concentrate on a particular family of graphs, such as for example: trees, bounded growth graphs, planar graphs or bounded degree graphs. In this talk we will analyze distributed algorithms on average graphs represented by the Erdős–Rényi random graph model $G(n, p)$ with independent edges. We will concentrate on two classical problems from the field of distributed algorithms: finding a maximal independent set and finding a proper colouring of a graph. We will analyze the performance on $G(n, p)$ of known classical distributed algorithms, which work for general graphs. Then we will compare results with algorithms designed specially for $G(n, p)$.

Joint work with Katarzyna Rybarczyk.

Michał Lasoń
Polish Academy of Sciences

White's conjecture and other intriguing problems on matroids

When an ideal is defined only by combinatorial means, one expects to have a combinatorial description of its set of generators. An attempt to achieve this description often leads to surprisingly deep combinatorial questions.

White's conjecture is an example. It asserts that the toric ideal associated to a matroid is generated by quadratic binomials corresponding to symmetric exchanges. In the combinatorial language it means that if two multisets of bases of a matroid have equal union (as a multiset), then one can pass between them by a sequence of symmetric exchanges between pairs of bases.

White's conjecture resisted numerous attempts since its formulation in 1980. We will review the progress made in last years, which led to confirmation of the conjecture for high degrees (with respect to the rank of a matroid). We will also discuss its relations with other intriguing problems on matroids.

Anna Lechowska
Lublin University of Technology

Rainbow number for Hanoi graphs

A graph G is rainbow colored if each of its edge is in different color. The rainbow number of graph G is the minimum number of colors needed to get G rainbow colored in any edge-coloring. In the talk we present an exact value of the rainbow numbers for the Hanoi graphs, which represent Tower of Hanoi puzzle. Vertices of this graph correspond to state, while edges correspond to moves of n discs, which are distributed among p pegs. We will calculate the rainbow numbers for pairs $(H_3^n; H_3^m)$, $(H_4^n; H_4^m)$ and finally $(H_p^n; H_p^m)$.

Magdalena Łysakowska
University of Zielona Góra

Properties of systems of cubes

In 1930 Ott-Heinrich Keller conjectured that every unit cube tiling of the n-dimensional Euclidean space contains a column of cubes. One proved that Keller's conjecture is true in all dimensions less than 7 and in dimension 8 one found a counterexample. This implies that the conjecture is false in all dimensions greater than 7. For $n = 7$ the conjecture is still open. Known solutions to the Keller's conjecture, the structure of cube tilings and unextendible systems of cubes in low dimensions will be presented.

Robert Malona
University of Opole

On non-isomorphic tournaments with the possibility of a draw

At the beginning, the basic definitions, properties and theorems concerning digraphs, tournaments and score sequences will be given. The problem considered is an attempt to determine the number of non-isomorphic tournaments with the possibility of a draw for small number of vertices. It will be shown how to calculate the number of non-isomorphic tournaments without draws. After that, we will calculate the number of non-isomorphic tournaments with with the possibility of a draw on small number of vertices.

Piotr Micek
Jagiellonian University

Planar posets have dimension linear in height

We prove that the dimension of planar posets is bounded by a linear function of their height: $\dim(P) \leqslant 192h + 96$ for every planar poset P of height h. This improves on previous exponential bounds and is best possible up to a constant factor.

Joint work with Gwenaël Joret and Veit Wiechert.

Piotr Miska

Jagiellonian University

A simple note on p-adic valuation of Stirling numbers of the second kind

The Stirling number of the second kind $S(n,k)$, where $n,k \in \mathbb{N}$ and $0 \leq k \leq n$, counts the number of partitions of a set with n elements into exactly k nonempty subsets. The problem of p-adic valuations (with emphasize on 2-adic valuations) of Stirling numbers of the second kind and their relatives generated a lot of literature. It was considered by i.a. Lengyel, Clarke, De Wannemaker, Bennet and Mosteig. In 2008 Amdeberhan, Manna and Moll stated a conjecture on general description of 2-adic valuation of Stirling numbers of the second kind. Later, in 2010, Berrizbeitia, Medina, Moll, Moll and Noble generalized this conjecture on p-adic valuations of numbers $S(n,k)$ for arbitrary prime number p. In this talk we will establish these conjectures.

Natasha Morrison
University of Oxford

Bootstrap percolation in the hypercube

The *r-neighbour bootstrap process* on a graph G starts with an initial set of "infected" vertices and, at each step of the process, a healthy vertex becomes infected if it has at least r infected neighbours (once a vertex becomes infected, it remains infected forever). If every vertex of G becomes infected during the process, then we say that the initial set *percolates*. In this talk I will discuss the proof of a conjecture of Balogh and Bollobás: for fixed r and $d \to \infty$, the minimum cardinality of a percolating set in the d-dimensional hypercube is $\frac{1+o(1)}{r}\binom{d}{r-1}$.

Joint work with Jonathan Noel.

Guilherme Mota

University of São Paulo

Thresholds for anti-Ramsey properties of cycles and cliques

Given a graph H, we are interested in the following 'anti-Ramsey' type property of the random graph $G = G(n, p)$: for every proper edge-colouring of G, there exists a rainbow copy of H in G, i.e., a copy of H with no two edges of the same colour. Let $p_r(H)$ be the threshold for this property. It was proved in [1] that $p_r(H) \leq n^{-1/m^{(2)}(H)}$ for any fixed graph H. When H is a cycle on at least 7 vertices or a complete graph on at least 19 vertices, Nenadov, Person, Škorić and Steger [2] proved that in fact $p_r(H) = n^{-1/m^{(2)}(H)}$. They state that, as far as they know, this result could be extended for all cycles and cliques of size at least 4. We prove that this is the case for all cycles and cliques of size at least 5, but not for C_4 and K_4. In fact, we show that $p_r(C_4) = n^{-3/4} < n^{-2/3} = n^{-1/m^{(2)}(C_4)}$, and if H is a graph isomorphic to K_4^- or K_4, then $p_r(H)$ is asymptotically smaller than $n^{-1/m^{(2)}(H)}$, where K_4^- is the graph obtained by removing one edge from K_4.

Joint work with Yoshiharu Kohayakawa, Olaf Parczyk and Jakob Schnitzer.

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Nikolaos Pantelidis
Waterford Institute of Technology

Riordan arrays - the Riordan group

A Riordan array is a lower triangular infinite matrix, constructed by two formal power series in such a way that each of the columns is generated by them. The entries of each column are the coefficients of the polynomial that is generated by these two functions and the elements of the matrix can be determined by a recursive formula. Objects that can be expressed by a sequence of numbers are used to construct Riordan arrays, such as Fibonacci or Catalan numbers. The area of Riordan arrays has been researched since the early 1990s and applications of them have been found in many areas of computing such as algorithm analysis, error correcting codes and wireless communications. Additionally, Riordan arrays have been used in different scientific areas beyond the borders of Mathematics as parts of their theory and techniques have been successfully applied in Molecular Biology for RNA secondary structure enumeration and Chemistry. Our research focuses on the structure of the Riordan group that is determined by these arrays, properties of it and relations between already known subgroups of the main group.

Olaf Parczyk

Goethe University

Explicit construction of universal hypergraphs

A hypergraph H is called universal for a family cF of hypergraphs, if it contains every hypergraph $F \in$ cF as a copy. For the family of r-uniform hypergraphs with maximum vertex degree bounded by Δ and at most n vertices any universal hypergraph has to contain $\Omega(n^{r-r/\Delta})$ many edges. We exploit constructions of Alon and Capalbo to obtain universal r-uniform hypergraphs with the optimal number of edges $O(n^{r-r/\Delta})$ when r is even, $r \mid \Delta$ or $\Delta = 2$. Further, we generalize the result of Alon and Asodi about optimal universal graphs for the family of graphs with at most m edges and no isolated vertices to hypergraphs.

Joint work with Samuel Hetterich and Yury Person.

Roberto Parente

University of São Paulo

Packing arborescences in random digraphs

We study the problem of packing arborescences in the random digraph Dnp, where each possible arc is included uniformly at random with probability $p = p(n)$. Let $\lambda(\text{Dnp})$ denote the largest integer $\lambda \geq 0$ such that, for all $0 \leq \ell \leq \lambda$, we have $\sum_{i=0}^{\ell-1}(\ell - i)|\{v : d^{\text{in}}(v) = i\}| \leq \ell$. We show that the maximum number of arc-disjoint arborescences in Dnp is $\lambda(\text{Dnp})$ asymptotically almost surely. We also give tight estimates for $\lambda(\text{Dnp})$ depending on the range of p. Moreover, we prove that if $p = (\log(n) - h(n))/(n-1)$ with $h(n) = \omega(1)$, then $\lambda(\text{Dnp}) = 0$ asymptotically almost surely; if $p = (\log(n) + h(n))/(n-1)$ with $h(n) = o(\log n)$ and $h(n) = O(\log \log n)$, then $\lambda(\text{Dnp}) \in \{\delta^{\text{in}}, \delta^{\text{in}} + 1\}$ asymptotically almost surely; if $p = (\log(n) + h(n))/(n-1)$ with $h(n) = o(\log n)$ and $h(n) = \Omega(\log \log n)$, then $\lambda(\text{Dnp}) \sim \delta^{\text{in}}$ asymptotically almost surely.

Joint work with Carlos Hoppen and Cristiane M. Sato.

Leila Parsaei Majd

Shahid Rajaee University

Zero-sum flows on Steiner systems

In this talk, we focus on zero-sum flows on Steiner triple and quadruple systems. we will consider a well-known construction STS($2v$+7) which can be used to construct non-resolvable Steiner triple systems and by using a zero-sum flow on STS(v), we can be able to construct a new zero-sum flow on STS($2v+7$). Moreover, consider STS(v) and STS(w) (SQS(v) and SQS(w)) for some appropriate v and w. We are going to state some conditions for the existence of zero-sum flow on STS(vw) (SQS(vw)). In part, we try to understand some relations between the zero-sum flows on SQS(v) and its derived Steiner triple system, STS($v-1$).

Joint work with S. Akbari and H. R. Maimani.

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Paweł Petecki
AGH University of Science and Technology

The distinguishing chromatic polynomial

Let G be a graph, and let $\Gamma = \operatorname{Aut} G$. A coloring c of G is symmetry-breaking if for every non-identity automorphism $\varphi \in \Gamma$, there is some vertex v of G such that $c(v) \neq c(\varphi(v))$. There has been a lot of work on the minimum number of colors in a symmetry-breaking coloring of G. We discuss here a different problem: counting the number of k-colorings that are symmetry breaking. The tool, as is frequently the case for problems such as this one, is Möbius inversion. To solve this problem we define symmetry breaking polynomial ψ_G. For positive integer k (number of colors), $\psi_G(k)$ is the number of k-colorings that break all non-trivial symmetries of the graph G.

Oleg Pikhurko
University of Warwick

Measurable Combinatorics

This tutorial will consider measurable versions of classical combinatorial problems (vertex/edge colourings, matchings, spanning trees, etc). The main object of study will be graphings (that is, bounded-degree graphs whose vertex set is a standard probability space and whose edge set is the union of finitely many measure-preserving matchings). Graphings appear in various areas such as the limit theory of bounded-degree graphs, measure-preserving group actions, descriptive set theory, etc. The existence of a measurable function F that satisfies given combinatorial constraints (such as being a proper vertex colouring) is of interest because it may be used, for example, to distinguish non-isomorphic graphings in orbit equivalence theory or be transferred to finite graphs in the context of property testing. We will mostly concentrate on positive results. Here, a powerful tool for constructing the desired function F is to design a parallel decentralized algorithm that converges to it almost everywhere.

Michał Pilipczuk
University of Warsaw

On tree-like graphs

The notions of treewidth and tree decompositions capture the concept of decomposing graphs along small separators into simple pieces. While originating in the Graph Minors project of Robertson and Seymour, treewidth has found multiple algorithmic applications, and is by now one of the crucial tools in the design of algorithms for computationally hard graph problems. Moreover, deep connections between treewidth and monadic-second order logic on graphs has also been studied. During the talk we will present the main combinatorial and algorithmic properties of treewidth, and survey the most important results: from classic ones to the most recent. Some larger focus will be put on the results obtained by the speaker.

Monika Pilśniak

AGH University of Science and Technology

Distinguishing graphs by proper colourings

A vertex-, edge- or total colouring of a graph G is called *distinguishing* if it is preserved only by the trivial automorphism. In [1], the *distinguishing chromatic number* $\chi_D(G)$ of a graph G was defined as the least number of colours in a proper distinguishing vertex-colouring. Corresponding invariants, the *distinguishing chromatic index* $\chi'_D(G)$ for proper edge-colourings, and the *total distinguishing chromatic number* $\chi''_D(G)$ for proper total colourings, were introduced in [2] and [3], respectively.

General bounds for $\chi_D(G)$, $\chi'_D(G)$ and $\chi''_D(G)$ will be discussed, also for infinite graphs.

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Leonid Płachta
AGH University of Science and Technology

On discretized configuration spaces

In this talk, we discuss some algebraic and topological problems arising in the study of configuration spaces associated with graphs and puzzles. The braid groups of the "discretized" objects are considered in particular cases. We also indicate the relationship between the "discretized" configuration spaces and the configuration spaces of hard discs in the square.

Makar Plakhotnyk

University of São Paulo

On the automorphisms of the max-plus algebra of exponent matrices

Exponent matrices appeared in the study of tiled orders, i.e. prime Noetherian semi-prefect semi-distributive rings with non-zero Jacobson radical. Any semi-maximal ring is isomorphic to a direct product of tiled orders. Let $\mathcal{O}$ be a (non-necessarily commutative) discrete valuation ring in a division ring with prime element π. A *tiled order* over $\mathcal{O}$ is a ring of the form

$$\Lambda = (\pi^{\alpha_{ij}}\mathcal{O}) \subseteq M_n(\mathcal{O}),$$

where $(\alpha_{ij}) \in M_n(\mathbb{Z})$ is such that $a_{ii} = 0$ for all i and

$$\alpha_{ij} + \alpha_{jk} \geq \alpha_{ik},$$

for any i, j and k. The matrix (α_{ij}) is called an *exponent matrix* completely characterizes Λ. It is known, that up to isomorphisms of tiled orders, each entry α_{ij} can be assumed non-negative. All non-negative exponent matrices form a max-plus algebra. In our talk we will pay attention to the automorphisms of the max-plus algebra of non-negative exponent matrices.

Joint work with M. Dokuchaev, V. Kyrychenko and G. Kudryavtseva.

This work is partially supported by FAPESP.

Joanna Polcyn

Adam Mickiewicz University

A hierarchy of maximal intersecting triple systems

We reach beyond the celebrated theorems of Erdős-Ko-Rado and Hilton-Milner, and, a recent theorem of Han-Kohayakawa, and determine all maximal intersecting triples systems. It turns out that for each $n \geq 7$ there are exactly 15 pairwise non-isomorphic such systems (and 13 for $n = 6$). We present our result in terms of a hierarchy of Turán numbers $\mathrm{ex}^{(s)}(n; M_2^3)$, $s \geq 1$, where M_2^3 is a pair of disjoint triples. Moreover, owing to our unified approach, we provide short proofs of the above mentioned results (for triple systems only).

The triangle C_3 is defined as $C_3 = \{\{x_1, y_3, x_2\}, \{x_1, y_2, x_3\}, \{x_2, y_1, x_3\}\}$. Along the way we show that the largest intersecting triple system H on $n \geq 6$ vertices, which is not a star and is triangle-free, consists of $\max\{10, n\}$ triples. This facilitates our main proof's philosophy which is to assume that H contains a copy of the triangle and analyze how the remaining edges of H intersect that copy.

Joint work with Andrzej Ruciński.

Michał Przykucki

University of Oxford

On the purity of minor-closed classes of graphs

Given a graph H, let $\mathrm{Ex}(H)$ denote the class of graphs with no minor H, and let $\mathrm{gap}_H(n)$ denote the maximum difference between the numbers of edges in two n-vertex edge-maximal graphs in $\mathrm{Ex}(H)$. We show that for exactly four connected graphs H the class $\mathrm{Ex}(H)$ is pure, that is, $\mathrm{gap}_H(n) = 0$ for all $n \geq 1$; and for each connected graph H, we have the dichotomy that either $\mathrm{gap}_H(n) = O(1)$ or $\mathrm{gap}_H(n) = \Theta(n)$. We also give some partial results when H is not connected or when there are two or more excluded minors.

Joint work with Colin McDiarmid.

Shahram Rayat Pisheh
Shahid Rajaee University

Some generalizations of Cayley graph

Cayley graphs were introduced by Arthur Cayley in 1878. In addition various generalizations of Cayley graphs have been introduced for example: generalized Cayley graph by Marušič et al., quasi-Cayley graphs by Gauyacy, various kinds of groupoid graphs by Mwambene, group action graphs by Annexstein et al., general semigroup graphs by Kelarev and Praeger. A generalized Cayley digraphs that were introduced by Anvil in 2012, and renamed to two-sided group digraphs and graphs by Iradmusa and Praeger.

We introduce a new family of digraphs and graphs that can be considered as the generalization of the class of Cayley digraphs and graphs. For two subgroup L, R of a group G and a subset S of G, we define double coset digraph $(G; L, R, S)$ to have vertex set of all double cosets of L, R in G and an arc from LxR to LyR if and only if $y = lsl'xr$ for some l, l' in L, s in S and r in R. We show that when this graph is empty, undirected, complete and connected. Moreover, in this paper we show that when this graph is vertex-transitive, Eulerian, Hamiltonian and planar.

Christian Reiher

University of Hamburg

A generalization of Mantel's theorem to uniformly dense hypergraphs

A well known theorem of Mantel asserts that the Turán density of the triangle is $1/2$. More recently, Glebov, Král', and Volec proved that every large 3-uniform hypergraph with the property that all linearly sized subsets of its vertex set induce subhypergraphs of density $> 1/4$ contains four vertices spanning at least three edges. The constant $1/4$ appearing here is optimal as a random tournament construction shows.

When thinking about a possible common generalization of these two facts to k-uniform hypergraphs, one easily observes that the tournament construction generalizes to a hypergraph having the density 2^{1-k} in a very uniform sense but not containing the hypergraph $F^{(k)}$ consisting of $(k+1)$ vertices and three edges.

Our main result specifies a precise sense of 'uniformly dense' such that the generalized tournament construction does indeed have the largest density among $F^{(k)}$-free hypergraphs that are uniformly dense in this sense. Such variations of Turán's problem were first suggested by Erdős and Sós. For $k = 2$ our density notions coincides with the usual density and for $k = 3$ it is the same as the 'vertex uniform density' considered in the result of Glebov, Král', and Volec mentioned above. Our proof relies on the regularity method for hypergraphs.

Joint work with V. Rödl and M. Schacht.

Jonathan Rollin

Karlsruhe Institute of Technology

Chromatic number of ordered graphs with forbidden ordered subgraphs

It is well-known that the graphs not containing a given graph H as a subgraph have bounded chromatic number if and only if H is acyclic. Surprisingly, the situation is very different for *ordered graphs*, that is, for graphs equipped with a linear ordering $<$ on their vertex set.

Call an ordered graph H *unavoidable* if any ordered graph of sufficiently large chromatic number contains a copy of H, and *avoidable* otherwise. As in the case of unordered graphs, any ordered graph that contains a cycle is avoidable. However, we also give an infinite family of avoidable ordered forests. For example the ordered path with vertices $a < b < c < d$ and edges ab, ad, and bc is avoidable.

We completely characterize all avoidable ordered graphs that do not have crossing edges and reduce the case of connected ordered graphs to a well-behaved class of trees. Although this identifies large classes of avoidable ordered forests, we don't know whether the matching with vertices $a < b < c < d < e < f$ and edges ac, be, df is avoidable.

Joint work with Maria Axenovich and Torsten Ueckerdt.

Katarzyna Rybarczyk

Adam Mickiewicz University

Algorithms for finding Hamilton cycles in random intersection graphs

In the random intersection graph model $G(n,m,p)$ to each vertex from a vertex set V ($|V|=n$) we assign a random set of its features $W(v)$ from an auxiliary set W ($|W|=m$). For each $w \in W$ we have $\Pr(w \in W(v)) = p$ independently of all other elements from V and W. We connect vertices v and v' by an edge if the sets $W(v)$ and $W(v')$ intersect. The random intersection graph model has real-life applications such as wireless networks modelling or complex networks analysis. In the talk we will present the algorithmic aspects of Hamilton cycle problem. We will analyze the efficiency on $G(n,m,p)$ of known algorithms which construct Hamilton cycles in random graphs.

Paweł Rzążewski

Warsaw University of Technology & Hungarian Academy of Sciences

Complexity of token swapping and its variants

In the Token Swapping problem we are given a graph with a token placed on each vertex. Each token has exactly one destination vertex, and we try to move all the tokens to their destinations, using the minimum number of swaps, i.e., operations of exchanging the tokens on two adjacent vertices. As the main result of this talk, we show that Token Swapping is W[1]-hard parameterized by the length k of a shortest sequence of swaps. In fact, we prove that, for any computable function f, it cannot be solved in time $f(k)n^{o(k/\log k)}$ where n is the number of vertices of the input graph, unless the ETH fails. This lower bound almost matches the trivial $n^{O(k)}$-time algorithm.

We also consider two generalizations of the Token Swapping, namely Colored Token Swapping (where the tokens have different colors and tokens of the same color are indistinguishable), and Subset Token Swapping (where each token has a set of possible destinations). To complement the hardness result, we prove that even the most general variant, Subset Token Swapping, is FPT in nowhere-dense graph classes.

Finally, we consider the complexities of all three problems in very restricted classes of graphs: graphs of bounded treewidth and diameter, stars, cliques, and paths, trying to identify the borderlines between polynomial and NP-hard cases.

Joint work with Édouard Bonnet and Tillmann Miltzow.

Maycon Sambinelli
University of Campinas

On Gallai's conjecture for series-parallel graphs and graph with maximum degree 4

A path decomposition of a graph G is a set of edge-disjoint paths of G that covers the edge-set of G. Gallai (1966) conjectured that every graph on n vertices admits a path decomposition of size at most $\lfloor (n+1)/2 \rfloor$. Geng, Fang and Li (2015) verified this conjecture for maximal outerplanar graphs and 2-connected outerplanar graphs, and Favaron and Kouider (1988) verified it for Eulerian graphs with maximum degree 4. In this paper, we generalize the technique introduced by Geng, Fang and Li, and verify Gallai's Conjecture for series–parallel graphs, and for graphs with maximum degree 4. Moreover, we show that the only graphs in these classes that do not admit a path decomposition of size at most $\lfloor n/2 \rfloor$ are isomorphic to K_3, $K_5 - e$ or K_5.

Mohammed Senhaji

University of Bordeaux

Bounded acyclic and oriented colourings

Introduced by P. Hanse, A. Hertz and J. Kuplinsky in [1], the bounded colouring problem is a variant of proper colouring where the colours classes are of bounded size. Formally the problem is the following :

- **Input :** A graph G and positive integer B, k.
- **Output :** Is there a proper colouring $c : V(G) \mapsto \{1,..,k\}$ such that $\forall i \in \{1,..,k\}, |c^{-1}(i)| \leq B$.

The problem is NP-complete when $B \geq 3$, but for many graphs families the problem is polynomial (split, co-chordals, co-intervals ...), see [2].
In [1], Hanse, Hertz and Kuplinsky proved that if χ_B is the chromatic parameter associated with the problem with input B, then for each graph G with n vertices and chromatic number χ, we have :

$$\max\left\{\chi, \left\lceil \frac{n}{B} \right\rceil\right\} \leq \chi^B(G) \leq \left\lfloor \frac{n-\chi}{B} \right\rfloor + \chi.$$

Moreover, they proved that those bounds are sharp.
We present the extension of this theorem, and other results to bounded acyclic and oriented colourings. Acyclic colouring is a proper colouring of a graph where the induced graph by the vertices of any 2 colours classes is a forest. Oriented colouring of an oriented graph $\overrightarrow{G}$ is a proper colouring where all the arcs between any 2 colours classes have the same direction. The *oriented* chromatic number of an undirected graph is the maximum of the oriented chromatic numbers of all its orientations. If we denote by $\chi_a(G)$ (resp. $\chi_o(G)$), the acyclic (resp. oriented) chromatic number of a graph G, and by $\chi_a^B(G)$ (resp. $\chi_o^B(G)$), the *bounded* acyclic (resp. oriented) chromatic number of a graph G, then we can write our first theorem as follows.

Theorem 1 (M.S., O. Baudon, É. Sopena '15) *For each graph G over n vertices, and positive integer B, we have :*

$$\max\left\{\chi_a(G), \left\lceil\frac{n}{B}\right\rceil\right\} \leq \chi_a^B(G) \leq \left\lfloor\frac{n-\chi_a(G)}{B}\right\rfloor + \chi_a(G).$$

And those bounds are sharp. And :

$$\max\left\{\chi_o(G), \left\lceil\frac{n}{B}\right\rceil\right\} \leq \chi_o^B(G) \leq \left\lfloor\frac{n-\chi_o(G)}{B}\right\rfloor + \chi_o(G).$$

The sharpness is not yet proved for oriented colouring.
We then characterize the bounded chromatic number of some graphs families:

Theorem 2 (M.S., O. Baudon, É. Sopena '15) *Let $\overrightarrow{G}$ be an oriented graph over $n > 0$ vertices such that $\chi_o(\overrightarrow{G}) = 2$, and $B > 0$, and $d = \max\{2, \lceil\frac{n}{B}\rceil\}$. Then $d \leq \chi_o^B(\overrightarrow{G}) \leq d+1$.*

Theorem 3 (M.S., O. Baudon, É. Sopena '15) *For $n \geq 3$, and $B > 0$ we have :*
- $\chi_o^B(\overrightarrow{P_n}) = \max\{\chi_o(P_n), \lceil\frac{n}{B}\rceil\}$;
- $\chi_o^B(\overrightarrow{C_n}) = \max\{\chi_o(C_n), \lceil\frac{n}{B}\rceil\}$;
- $\chi_o^B(\overrightarrow{C_n^*}) = \max\{\chi_o(Q_n), \lceil\frac{n}{B}\rceil\}$.

And if $k \geq 2$ and $n_1, \ldots, n_k \geq 1$, and G is the complete k-partite graph, $K_{n_1,n_2,\ldots,n_k}$, then :

$$\chi_a^B(K_{n_1,n_2,\ldots,n_k}) = \left\lfloor\frac{\sum_{i=1}^{k} n_i - \chi_a}{B}\right\rfloor + \chi_a.$$

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Rinovia Simanjuntak

Bandung Institute of Technology

Finding D-distance magic and antimagic graphs

For an arbitrary set of distances $D \subset \{0, 1, \ldots, d\}$, a graph G is said to be D-distance magic if there exists a bijection $f : V \to \{1, 2, \ldots, v\}$ and a constant k such that for any vertex x, $\Sigma_{y \in N_D(x)} f(y) = k$, where $N_D(x) = \{y \in V | d(x, y) \in D\}$. Additionally, a graph G is said to be D-distance antimagic if the $\Sigma_{y \in N_D(x)} f(y)$ is unique for each vertex x. A D-distance graph of a graph G is the graph with vertex set $V(G)$ and edge set $\{(x, y) | d_G(x, y) \in D\}$. In this talk we shall construct D-distance magic and antimagic graphs for various D by using the notion of D-distance graph.

Anurag Singh
Indian Institute of Technology

Homotopy type of neighborhood complexes of Kneser graphs

Schrijver identified a family of vertex critical subgraphs of Kneser graphs called the stable Kneser graphs $SG_{n,k}$. Björner and de Longueville proved that the neighborhood complex of the stable Kneser graph $SG_{n,k}$ is homotopy equivalent to a k-sphere. It is also known that the neighborhood complex of $KG_{n,k}$ is homotopy equivalent to the wedge sum of k-spheres. The main objective here is to give the exact number for $KG_{2,k}$ i.e. to show that the homotopy type of the neighborhood complex of $KG_{2,k}$ is a wedge sum of $(k + 4)(k + 1) + 1$ spheres of dimension k. Further we will construct a subgraph $S_{2,k}$ of $KG_{2,k}$ whose neighborhood complex deformation retracts onto the neighborhood complex of $SG_{2,k}$.

Fiona Skerman
University of Bristol

Guessing numbers of odd cycles

For a given number of colours, s, the guessing number of a graph is the base s logarithm of the size of the largest family of colourings of the vertex set of the graph such that the colour of each vertex can be determined from the colours of the vertices in its neighbourhood. We show that, for any given integer $s \geqslant 2$, if a is the largest factor of s less than or equal to $\sqrt{s}$, for sufficiently large odd n, the guessing number of the cycle C_n with s colours is $(n-1)/2 + \log_s(a)$. This answers a question posed by Christofides and Markström in 2011.

Guessing numbers are related to index coding and our results show that the information defect of the coding problem where the side information is a large odd cycle is $(n+1)/2 - \log_s(a)$.

Joint work with Ross Atkins and Puck Rombach.

Heather Smith
Georgia Institute of Technology

Saturation for induced subposets

Graph saturation was first introduced in 1964 by Erdős, Hajnal, and Moon. The notion of saturation can be extended to posets as follows: Fix a target poset P. A family F of points in the Boolean lattice is called (induced)-P-saturated if

(1) contains no copy of P as an (induced) subposet;

(2) every strict superset of F contains a copy of P as an (induced) subposet.

For each n, the (induced) saturation number for P is the size of the smallest family in B_n which is (induced)-P-saturated. Gerbner et. al. (2013) first studied this notion of saturation for the chain where the saturation number and the induced saturation number are identical. We turn our attention to induced saturation, determining bounds on this value for several small posets in addition to proving a logarithmic lower bound for target posets from an infinite family.

Joint work with Michael Ferrara, Bill Kay, Lucas Kramer, Ryan Martin, Benjamin Reiniger, and Eric Sullivan.

Joanna Sokół

Warsaw University of Technology

Localization games on graphs

We present game version of metric and centroidal bases of graphs, inspired by localization problems in wireless networks. Given the network as a graph of wi-fi access points, we try to localize a person walking with a cell phone solely by wi-fi signals. The strength of the signals measured by the cell phone is proportional to the distances from access points. In our approach Robber is walking on the graph and Cop tries to catch him. In each round Cop chooses which access points will be active in this round. Then Robber moves to an adjacent vertex or stays where he is. After that Cop receives some information about the distances between Robber and active access points. Cop wins the game if able to determine the exact location of Robber in finite number of rounds. The question is how many access points Cop activates in each round in order to win. This parameter is bounded by the cardinality of metric and centroidal basis respectively for two variants of the game. We determine the number of active access points for some classes of graphs, such as trees, outerplanar graphs and unit distance graph on the plane.

Joint work with Jarosław Grytczuk and Małgorzata Śleszyńska-Nowak.

Éric Sopena

University of Bordeaux

Combinatorial games on graphs

Combinatorial game theory has already a long and rich history. A combinatorial game is played by two players who alternate taking turns. At each step of the game, the number of available moves is finite and the game ends after a finite number of turns. All along the game, there is no hidden information and no random elements. Under normal convention, the first player unable to move looses the game.

In this talk, I will discuss several combinatorial games played on graphs. Some of them can be viewed as extensions to graphs of classical combinatorial games, while others are more directly related to the structure of graphs or to some well-known graph invariants.

Dragan Stevanović
Serbian Academy of Sciences and Arts

Comparing closed walk counts in trees consisting of three paths

Spectral moments of adjacency matrix of a graph, which also represent counts of its closed walks, are useful objects in dealing with spectral radius and Estrada indices of graphs. For $k \geq 0$, let $M_k(G)$ denote the number of closed walks in G of length k. Let $G \preceq H$ denote that $M_k(G) \leq M_k(H)$ for all $k \geq 0$. For example, if $G \preceq H$ then the spectral radius and the Estrada index of G are smaller than or equal to the spectral radius and the Estrada index of H, respectively.

Let $P_{a,b,c}$ denote the tree obtained from the union of paths P_{a+1}, P_{b+1} and P_{c+1} by identifying one endvertex from each of the three paths. We show that for any a, b, c, d, e, f holds either

$$P_{a,b,c} \preceq P_{d,e,f} \quad \text{or} \quad P_{a,b,c} \succeq P_{d,e,f}.$$

This is well known in the case that $\min\{a, b, c\} = \min\{d, e, f\}$, but its proof needs to play with both characteristic polynomials and walk embeddings when $\min\{a, b, c\} + 1 = \min\{d, e, f\}$.

Małgorzata Sulkowska
Wrocław University of Science and Technology

On the improvement of result in best choice problem for powers of paths

The vertices of the power of a directed path are exposed one by one to a selector in some random order. At any time the selector can see the graph induced by the vertices that have already appeared. The selector's aim is to choose on-line the maximal vertex (i.e., the vertex with no outgoing edges). We give upper and lower bounds for the asymptotic behaviour of the probability of success under the optimal algorithm. In order to derive the upper bound, we consider a model in which the selector obtains some extra information about the edges that have already appeared. We give the exact asymptotic of the probability of success under the optimal algorithm in this case. In order to derive the lower bound, we analyze a site percolation process on a sequence of powers of a directed path.

John Sylvester
University of Warwick

Hitting times and effective resistances in Erdős-Rényi random graphs

In this talk I will discuss effective resistance in graphs and how this is related to the strength of connectivity. In particular, I determine the expectation for random walk hitting times and effective resistances in $\mathcal{G}\left(n,p\right)$ where $c\log(n) \leq np < n^{1/10}$, $c > 1$. I also show concentration results for hitting times and effective resistances then explain how these follow from showing a certain strong edge-connectivity property holds with high probability for $\mathcal{G}(n,p)$ in this regime.

Konstanty Junosza-Szaniawski
Warsaw University of Technology

On-line coloring and $L(2,1)$-labeling of unit disks intersection graphs

Graphs representing intersections of families of geometric objects are intensively studied for their practical applications and for their interesting theoretical properties. In particular, unit disk intersection graphs are interesting for applications in radio network modeling. We consider the problem of classical coloring, as well as the $L(2,1)$-labeling of such graphs.

Unit disk intersection graphs can be colored on-line with competitive ratio equal to 5. We improve this ratio using j-fold colorings of the so-called unit distance graph (see [2]). (The unit distance graph is an infinite graph, whose vertex set is $\mathbb{R}^2$, and two points are adjacent if their Euclidean distance is exactly 1).

Fiala, Fishkin and Fomin [1] presented an on-line algorithm for $L(2,1)$-labeling of unit disk intersection graphs with competitive ratio $50/3 \approx 16.66$. We improve this algorithm to the one with competitive ratio $40/3 \approx 13.33$. Moreover, using the j-fold coloring, we manage to improve this ratio for unit disks intersection graphs with a large clique number.

We also consider off-line $L(2,1)$-labeling. Shao *et al.* [3] proved that $\lambda(G) \leq \frac{4}{5}\Delta^2 + 2\Delta$ for unit disk intersection graph G with maximum degree Δ. We improve this result to $\lambda(G) \leq \frac{3}{4}\Delta^2 + 3\Delta - 3$. Moreover, from work of Fiala, Fishkin and Fomin [1], we derive a bound $\lambda \leq 18\Delta + 18$, which is significantly better for large Δ.

Joint work with Paweł Rzążewski, Joanna Sokół and Krzysztof Węsek.

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Alexandre Talon
University of Lyon

Decomposing 8-regular graphs into paths of length 4

A T-decomposition of a graph G is a set of edge-disjoint copies of T in G that covers the edge set of G. Graham and Häggkvist (1989) conjectured that any 2ℓ-regular graph G admits a T-decomposition if T is a tree with ℓ edges. Kouider and Lonc (1999) conjectured that, in the special case where T is the path with ℓ edges, G admits a T-decomposition D where every vertex of G is the end-vertex of exactly two paths of D, and proved that this statement holds when G has girth at least $(\ell + 3)/2$. In this paper we verify Kouider and Lonc's Conjecture (and, consequently, Graham–Häggkvist's Conjecture) for paths of length 4.

Erik Thornblad

Uppsala University

Degree distributions and score functions of tournament limits

Motivated by known results for finite tournaments, we define and study the score functions of tournament kernels (functions $W : [0,1]^2 \to [0,1]$ satisfying $W(x,y) + W(y,x) = 1$) and the degree distributions of tournament limits (in the Lovász/Szegedy-sense). Our main theorem fully characterizes those distributions which appear as the degree distribution of some tournament limit, and those functions which appear as the score function of some tournament kernel. We also show that there is only one valid degree distribution that is realized by a unique tournament limit, implying that the degree distribution does not (in general) distinguish between distinct tournament limits.

Tom Trotter

Georgia Institute of Technology

An update on the dimension of random partially ordered sets

In 1991, Erdős, Kierstead and Trotter investigated the dimension of random height 2 partially ordered sets (posets). Their research was motivated primarily by two goals. One was to analyze the accuracy of the Füredi-Kahn upper bounds on dimension in terms of maximum degree. The second was to develop the machinery for estimating the expected dimension of a random labelled poset on n points. For these reasons, most of their efforts were focused on the case $0 < p \leq 1/2$.

Motivated by extremal problems involving conditions which force a poset to contain a large standard example, we were compelled to revisit this subject, but now with particular emphasis on the range $1/2 \leq p < 1$, where can make substantive improvements in both upper and lower bounds. Our sharpened analysis allows us to conclude that as p approaches 1, the expected value of dimension increases and then decreases, a subtlety not previously identified. Along the way, we establish connections with classical topics in analysis as well as with latin rectangles. Also, using structural insights drawn from this research, we are able to make progress on the motivating extremal problem with an application of the asymmetric form of the Lovász Local Lemma.

Joint work with Csaba Biró, Peter Hamburger, Hal A. Kierstead, Attila Pór and Ruidong Wang.

Maciej Ulas
Jagiellonian University

Arithmetic properties of a sequence related to the Rudin-Shapiro sequence

We present an exact computation of a 2-adic valuation of certain integer sequences related to the powers of generating function of the Rudin-Shapiro sequence.

Dorota Urbańska
Gdańsk University of Technology

Distributed searching of arbitrary graphs by mobile agents

A team of mobile agents starting from a home base need to visit and clean all nodes of the network. The goal is to find a strategy which would be optimal in sense of number of needed entities, moves performed by them or a total time of an algorithm. Currently, the field of distributed graph searching by a team of mobile agents is rapidly expanding and many new approaches and models are being presented in order to better describe real life problems like decontaminating danger areas by a group of robots or cleaning networks from viruses. An offline case, when a topology of a graph is known in advance is well studied, especially for one searcher. This survey presents recent results focusing mainly on an issue of decontaminating an arbitrary graph with none or some a priori knowledge about its topology, but also some background of an offline case is given. We introduce a bibliography for various models, which differ on i.e. knowledge about a graph, properties of agents, time clock or size of available memory.

Bartosz Walczak

Jagiellonian University

Common tangents of two disjoint polygons in linear time and constant workspace

A tangent of a polygon is a line touching but not crossing the polygon. Two disjoint polygons can have four, two, or no common tangents, depending on whether the convex hulls of the polygons are disjoint, overlapping, or nested. We describe a very simple linear-time constant-workspace algorithm to compute all common tangents of two disjoint simple polygons, each given by a read-only array of its corners in a cyclic order.

Joint work with Mikkel Abrahamsen.

Lutz Warnke
University of Cambridge

The phase transition in the random d-process

One of the most interesting features of Erdős-Rényi random graphs is the 'percolation phase transition', where the global structure intuitively changes from only small components to a single giant component plus small ones.

In this talk we discuss the percolation phase transition in the random d-process, which corresponds to a natural algorithmic model for generating random regular graphs that differs from the usual configuration model (starting with an empty graph on n vertices, the random d-process evolves by sequentially adding new random edges so that the maximum degree remains at most d).

Our results on the phase transition solve a problem of Wormald from 1997, and verify a conjecture of Balińska and Quintas from 1990.

Joint work with Nick Wormald.

Krzysztof Węsek

Warsaw University of Technology

Nested knapsack and bin packing problems

In this talk we introduce nested versions of knapsack and bin packing type of problems. The word 'nested' means that items can be packed into each other according to some natural constraint. In the classic knapsack problem, we are given a set of items with two positive values representing its size and value. The goal is to choose a subset of those items with the total size not exceeding a given limit, such that the total value is as large as possible. In the proposed nested version, each item additionally offers a certain non-negative amount of its capacity to other items. Hence each item can be considered as a potential knapsack for other, smaller items. Therefore, we seek for a subset of items that can be packed into the given base capacity or into other chosen items, such that the sum of item values is maximized. Similarly, one can define the nested versions of bin packing problem and also a related variable-sized variant. We make the first steps to investigate these problems. In particular, we obtain an algorithm with logarithmic approximation ratio for nested knapsack problem and an algorithm with constant approximation ratio for nested bin packing problem.

Joint work with György Dosa, Armin Fügenschuh, Fabian Gnegel, Qie He, Shi Li and Zsolt Tuza.

The author's work was partially conducted as a guest researcher at the Helmut Schmidt University / University of the Federal Armed Forces Hamburg.

Marcin Witkowski
Adam Mickiewicz University

Cops and Robber games on G^{Ξ}

Cop Robber game is a two player game played on an undirected graph. In this game cops try to capture a robber moving on the vertices of the graph. The cop number of a graph is the least number of cops needed to guarantee that the robber will be caught.

In the talk we present results concerning games on G^{Ξ}. Graph G^{Ξ} is defined as a graph on vertex set $V(G \cup \overline{G})$ with edges as in G and $\overline{G}$ and additional edges between corresponding vertices of G and $\overline{G}$ (we connect every vertex v with its copy v' in the complement graph). For example Petersen graph is C_5^{Ξ}. In particular we show that for planar graphs $c(G^{\Xi}) \leq 3$. Furthermore we investigate the cop-edge critical graphs, i.e. graphs that for any edge e in G we have either $c(G-e) < c(G)$ or $c(G-e) > c(G)$. We show couple examples of cop-edge critical graphs having cop number equal to 3.

Joint work with D. Cardoso, C. Dominic and Ł. Witkowski.

Rafał Witkowski
Adam Mickiewicz University

Rotate-resistant de Bruijn sequence

De Bruijn objects are significant combinatorial problems. I would like to present the properties and applications of the standard de Bruijn objects. Afterwards, there will be shown the purpose of thesis which is to describe a specific type of de Bruijn objects – rotate resistant objects. A few different types of these objects, ways to generate them and unique applications will also be presented. In the third part I attempt to verify hypothesis that comes to mind after discussion of length of de Bruijn sequences and rotate resistant de Bruijn sequences.

Andrzej Żak

AGH University of Science and Technology

On packing large trees

A set of (simple) graphs $G_1, G_2, \ldots, G_k$ are said to *pack into a complete graph* K_n (in short pack) if $G_1, G_2, \ldots, G_k$ can be found as pairwise edge-disjoint subgraphs in K_n. Much attention has been given to packing trees. One example is a conjecture by Bollobás from 1995 (which is a weakening of the famous Tree Packing Conjecture by Gyárfás from 1976) which states that any set of k trees $T_n, T_{n-1}, \ldots, T_{n-k+1}$, such that T_{n-i} has $n-i$ vertices, pack into K_n, provided n is sufficiently large. In 2013 Balogh and Palmer confirmed Bollobás conjecture in the case when no tree is a star. We confirm Bollobás conjecture for trees $T_n, T_{n-1}, \ldots, T_{n-k+1}$, such that T_{n-i} has $k-1-i$ leaves or a pending path of order $k-1-i$. As a consequence we obtain that the conjecture is true for $k \leq 5$. Another famous problem is the Erdős-Sós conjecture from 1963, which states that every graph G of average degree greater than $k-1$ contains every tree with k edges. In the early 1990's, Ajtai, Komlós, Simonovits and Szemerédi announced a proof of this result for sufficiently large k. On the other hand, many partial results are known. In particular, the conjecture is true in the special cases where G has exactly $k+1$ vertices (Zhou, 1984), $k+2$ vertices (Slater, Teo, and Yap, 1985), $k+3$ vertices (Woźniak, 1996) and $k+4$ vertices (Tiner, 2010). We further explore this direction. Given an arbitrary integer $c \geq 1$, we prove Erdős-Sós conjecture in the case when G has $k+c$ vertices provided that $k \geq k_0(c)$ (here $k_0(c) = o(c^{13})$).

Joint work with A. Görlich.

Maksim Zhukovskii

Moscow Institute of Physics and Technology

Bounded quantifier depth monadic sentences of very sparse random graph

The random graph $G(n, n^{-a})$ obeys FO (MSO) zero-one k-law if for any first order (monadic second order) formulae it is true for the random graph with a probability tending to 0 or to 1. Zero-one k-laws are well studied only for the first order language and $a < 1$. We obtain new zero-one k-laws (both for first order and monadic second order languages) for $G(n, n^{-a})$ where $a > 1$. More specifically, we obtain a lower and an upper bounds on the maximal $a > 1$ such that FO (MSO) zero-one k-law hods. Proofs of these results are based on the existed study of first order equivalence classes (O. Pikhurko et al., 2006) and our study of monadic second order equivalence classes. In particular, we estimate the number of MSO equivalence classes.

Michał Zwierzyński

Warsaw University of Technology

Discrete affine λ-equidistants of polygons with parallel opposite sides

In this talk we consider planar polygons with parallel opposite sides, especially non-convex ones. These polygons are discretization of closed planar curves by taking tangent lines at points of a curve with parallel tangents. For these polygons we present a notion of discrete affine λ-equidistants, in particular a discrete version of the Wigner caustic, and study its geometry.

We will also talk about an algorithm of parallel walking in the mountains which is related to describing the geometry of branches of the affine equidistants.