Igor Fabrici, Mirko Horňák, Stanislav Jendrol' ed.

Workshop

Cycles and Colourings 2005

dedicated to the memory of Hanjo Walther

September 04–09, 2005 Tatranská Štrba

http://umv.science.upjs.sk/c&c

Dear Participant,

welcome to the Fouteenth Workshop Cycles and Colourings. It is dedicated to the memory of Hanjo Walther, one of the founders of C&C workshops.

The workshop idea was born during the Czechoslovak Graph Theory Conference (Zemplínska Šírava 1991) organised by Košice combinatorial group and visited by Ilmenau group with similar scientific interests. The workshop took place first in Slovak Paradise in 1992 and then it moved to High Tatras and continued there successfully each year (Nový Smokovec, ten times Stará Lesná, Tatranská Štrba). The High Tatras were devastated in November 2004 by an enormously strong wind, and so they are thankful to you for coming as for the best help for their recovery.

The scientific programme consists of 50 minute lectures of invited speakers and of 20 minute contributed talks. This booklet contains abstracts as were sent to us by the authors.

Invited speakers:

Vašek Chvátal,	Concordia University, Montreal, Canada
Ralph J. Faudree,	University of Memphis, TN, USA
Jochen Harant,	Technical University, Ilmenau, Germany
Mikio Kano,	Ibaraki University, Ibaraki, Japan
Michał Karoński,	Adam Mickiewicz University, Poznań, Poland
Arnfried Kemnitz,	Technical University, Braunschweig, Germany
Miklós Simonovits,	Hungarian Academy of Sciences, Budapest, Hungary
Ladislav Stacho,	Simon Fraser University, Burnaby, Canada

(Jochen Harant's lecture will be devoted to the memory of Hanjo Walther.)

Have a pleasant and successful stay in Tatranská Štrba.

Organising committee:

Igor Fabrici
Jochen Harant
Erhard Hexel
Mirko Horňák
Stanislav Jendroľ (chair)
Štefan Schrötter

Contents

Hanjo Walther (1939–2005)

On January 17, 2005, just a few weeks after his 65th birthday our dear friend and colleague Hanjo Walther passed away. Hansjoachim Walther was born on December 16, 1939, in Bütow (now Bytów, Poland). In 1945 his family fled and found a new home in Zeitz. After finishing the school Hanjo made an apprenticeship as a lathe operator and later on he studied mathematics in Dresden. In 1964 he applied for an assistant position in Ilmenau. There he began to work in the field of graph theory. He finished his PhD thesis in 1969 under the supervision of Professor Horst Sachs and three years later he habilitated in the field of graph theory. In 1968 Hanjo became chief assistant and in 1970 he got a lecturer position in Ilmenau. In 1986 he was promoted to an associate professor and in 1992 after the reunion of the two German states he finally became university professor. The P. J. Šafárik University Košice conferred the honorary doctorate on Hanjo in 2000.

During his work at the University Hanjo instructed many graduates and PhD students. He is the author and co-author of several books, e.g. *Über Kreise in Graphen* (with H.-J. Voß), VEB Deutscher Verlag der Wissenschaften, Berlin, 1974, *Anwendungen der Graphentheorie*, VEB Deutscher Verlag der Wissenschaften, Berlin, 1979, *Ten Applications of Graph Theory*, D. Reidel Publishing Company, Dordrecht, Boston, Lancaster, 1984, *Graphen, Algorithmen, Programme* (with G. Nägler) VEB Fachbuchverlag, Leipzig, 1987 and Springer Verlag, Wien, 1987. In his work with students his love for mathematics was always visible and he had a talent to encourage and inspire his students. Hanjo very much liked to work with young people.

In the times of change in the GDR in 1989 he was one of the founders of two parties, the Forumspartei Thüringens and the DSU. He led the DSU faction in the only freely elected Volkskammer (the parliament) in the GDR and became a minister in the Kohl's government after the reunion in October 1990. In 1993 he joined the CDU party and worked in the Ilm County. There he led the CDU faction in the local parliament and was especially engaged in the school committee.

But Hanjo was not only known for his mathematical and political achievements. He was a passionate sportsman playing soccer and handball almost all his life. He had many friends and wherever he appeared, it didn't take him long to find new ones, people of very different characters and heritage. In his open and cheerful way he lifted the spirits of many people on a lot of occations.

We believe Hanjo died in a way he would have liked - on the soccer field. We shall greatly miss him.

Vertex-antimagic total labelings

Martin Bača
(joint work with Y. Lin, M. Miller and K. A. Sugeng)

An (a, d)-vertex-antimagic total labeling of G is a one-to-one mapping λ taking the vertices and edges onto $1, 2, \ldots, |V(G)| + |E(G)|$ so that the vertex-weights

$$wt(x) = \lambda(x) + \sum \lambda(xy)$$

where the sum is over all vertices y adjacent to x, form an arithmetic progression with initial term a and common difference d. Such a labeling is called super if the smallest possible labels appear on the vertices.

We study properties of such labelings and show how to construct such labelings for some families of graphs. We also show that such labeling do not exist for certain families of graphs, such as cycles with at least one tail, trees with even number of vertices and all stars.

Infinite graph domination

Gábor Bacsó
(joint work with Zsolt Tuza)

The following general frame can be given for the problems which we deal with:

Given a set of sample graphs, is it true that all those graphs who do not contain any sample graph as an induced subgraph, have some special type of dominating subgraph?

Here the expression 'special type of graphs' often means 'a graph from a given class' but not always. Sometimes it means a subgraph which is in some given relationship with the whole graph.

The main point of view of our investigations will be, whether the results are also valid for infinite graphs or there are infinite counterexamples. Both cases occur.

Coloring of graphs without short odd paths between vertices of the same color class

Stephan Baum

By an odd (k, ℓ)-coloring of a graph G we mean a vertex coloring of G with k colors such that the pth distance class of each color class form an independent set in G for each $p \in \{0, \ldots, \ell\}$. We denote by $\mathcal{OC}(k, \ell)$ the class of all graphs that have an odd (k, ℓ)-coloring.

A. Gyárfás, T. Jensen and M. Stiebitz proved in 2004 that, for every integers $k \geq 1$ and $\ell \geq 0$, the class $\mathcal{OC}(k, \ell)$ contains a k-chromatic graph. The smallest k-chromatic graph G_k that belongs to $\mathcal{OC}(k, 1)$ was also constructed for all integers $k \geq 1$.

In the lecture, we construct the smallest k-chromatic graph $G(k, \ell)$ that belongs to $\mathcal{OC}(k, \ell)$ for all integers $k \geq 1$ and $\ell \geq 0$. We show that the graph $G(k, \ell)$ is homomorphism universal in $\mathcal{OC}(k, \ell)$ and that $G(k, \ell)$ is uniquely odd (k, ℓ)-colorable provided that $k \neq 3$.

Eventually, we introduce the odd chromatic number $\chi_o(G)$ of a graph G as $\chi_o(G) = \inf\{k/(2\ell + 1) \,|\, G \in \mathcal{OC}(k, \ell)\}$ and establish some basic properties for this parameter.

Acyclic colourings of graphs

Mieczysław Borowiecki

(joint work with Anna Fiedorowicz)

Following [4], let $\mathcal{P}_1, \mathcal{P}_2, \ldots, \mathcal{P}_k$ be hereditary properties of graphs. A $(\mathcal{P}_1, \mathcal{P}_2, \ldots, \mathcal{P}_k)$-*colouring* of a graph G is a mapping f from the set of vertices of G to a set of k colours such that for every colour i, the subgraph induced by the i-coloured vertices has property $\mathcal{P}_i$. Such a colouring is called *acyclic*, if for every two distinct colours i and j, the subgraph induced by all the edges linking an i-coloured vertex and a j-coloured vertex is acyclic.

The notion of acyclic colourings was introduced by Grűnbaum [5], who asked about planar graphs. In [3] Borodin solved this problem showing that every planar graph can be acyclically 5-coloured. Sopena, Boiron and Vignal studied acyclic $(\mathcal{P}_1, \mathcal{P}_2, \ldots, \mathcal{P}_k)$-colourings (also called acyclic improper colourings) of planar and outerplanar graphs, see [1], and graphs with bounded degree, see [2].

In our talk we consider acyclic $(\mathcal{P}_1, \mathcal{P}_2, \ldots, \mathcal{P}_k)$-colourings of some classes of graphs. Among others, we prove some results for outerplanar graphs.

References

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[3] O. V. Borodin, *On acyclic colorings of planar graphs*, Discrete Math. **25** (1979), 211–236.

[4] M. Borowiecki, P. Mihók, *Hereditary properties of graphs*, In: V. R. Kulli (ed.), *Advances in Graph Theory*, Vishwa International Publications, 1991, 41–68.
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Dense triangle-free graphs are four-colourable: A solution to the Erdős-Simonovits problem

Stephan Brandt
(joint work with Stéphan Thomassé)

In 1972, Erdős and Simonovits conjectured that triangle-free graphs with n vertices and minimum degree $\delta > n/3$ are 3-colourable, and Hajnal gave a construction based on Kneser graphs, showing that for any $c < 1/3$ the chromatic number can be arbitrarily large among the triangle-free graphs with $\delta > cn$. In 1982 Häggkvist found a counterexample based on the 4-chromatic Grötzsch graph. Jin proved in 1993, that the original statement is true if $n/3$ is replaced by $10n/29$ which is sharp. Moreover he conjectured that the chromatic number can be arbitrarily large for triangle-free graphs with $\delta > n/3$. Recently, Brandt showed that 4 is an upper bound for the chromatic number of maximal triangle-free r-regular graphs with $r > n/3$, Thomassen proved that for any $c > 1/3$ the chromatic number of every triangle-free graphs with $\delta > cn$ is bounded by a constant depending on c, and Łuczak improved this statement, showing that every such graph is homomorphic with a triangle-free graph on constantly many vertices.

We prove the original problem with 4 in place of 3 by determining the homomorphically minimal subgraphs of the maximal triangle-free graphs with $\delta > n/3$. This turns out to be a minor extension of a class described by Brandt and Pisanski in 1997.

Coloring prime graphs

Roman Čada
(joint work with Francois Genest and Tomáš Kaiser)

A. Bouchet obtained in 1987 a polynomial algorithm for recognizing circle graphs. The algorithm is based on reduction theorem for prime graphs. We present an extension of this theorem for bicolored prime graphs.

Related techniques of local complementations (first introduced as a way to establish relationships between euler tours in an eulerian graph) for both uncolored and colored graphs will be presented. These techniques are also closely related e.g. to the Cycle Double Cover Conjecture.

The Sylvester-Gallai Theorem and metric betweenness

Vašek Chvátal

Sylvester conjectured in 1893 and Gallai proved some forty years later that every finite set S of points in the plane includes two points such that the line passing through them includes either no other point of S or all other points of S. I conjectured in 1998 and Xiaomin Chen proved in 2003 that, when the notion of lines is appropriately extended from Euclidean spaces to arbitrary metric spaces, the Sylvester-Gallai theorem generalizes as follows: in every finite metric space, there is a line consisting of either two points or all the points of the space. I will present first the appropriate definition of lines in metric spaces and then Xiaomin Chen's beautiful proof. Finally, I will discuss the underlying ternary relation of metric betweenness and its algebraic counterparts that flourish in Slovakia (Bálint, Hedlíková, Katriňák, Lihová, Mendris, Ploščica, Šimko, Zlatoš).

The crossing numbers of products

Emília Draženská

The *crossing number* $cr(G)$ of a graph G is the smallest number of pairs of non-adjacent edges that intersect in any drawing of G in the plane. Computing the crossing number of a given graph is in general an elusive problem.

The crossing numbers of the Cartesian products of all four-vertex graphs with cycles and with paths are determined. There are known crossing numbers of the Cartesian products of all graphs of order five with paths and several graphs of order five with cycles. About crossing numbers of the Cartesian products of graphs of order at least six with cycles or with paths we have not a lot of information. We know the crossing numbers of the Cartesian products of all but one trees on six vertices with cycles.

In this talk we give a new results or limits for crossing numbers of the Cartesian products of cycles or paths with some graphs on six vertices.

Planar graphs of odd-girth at least 9 are homomorphic to Petersen graph

Zdeněk Dvořák
(joint work with R. Škrekovski and T. Valla)

Let G be a graph and let $c : V(G) \to \binom{\{1,\ldots,5\}}{2}$ be an assignment of 2-element subsets of the set $\{1, \ldots, 5\}$ to the vertices of G such that for every edge vw

the sets $c(v)$ and $c(w)$ are disjoint. We call such an assignment a $(5, 2)$-*coloring*. Observe that a graph is (5,2)-colorable if and only if it has a homomorphism to the Petersen graph. The *odd-girth* of a graph G is the length of the shortest odd cycle in G (∞ if G is bipartite). We prove that every planar graph of odd-girth at least 9 is $(5, 2)$-colorable, and thus it is homomorphic to the Petersen graph. Also, this implies that such graphs have the fractional chromatic number at most $\frac{5}{2}$. As a special case, these results apply for planar graphs of girth at least 8.

Linear forests, k-ordered, and pancyclic graphs

Ralph J. Faudree

Given integers k, s, t with $0 \leq s \leq t$ and $k \geq 0$, a (k, t, s)-linear forest F is a graph that is the vertex disjoint union of t paths with a total of k edges and with s of the paths being single vertices. Given integers m and n with $k + t \leq m \leq n$, a graph G of order n is (k, t, s, m)-pancyclic if for any (k, t, s)-linear forest F and for each integer r with $m \leq r \leq n$, there is a cycle of length r containing the linear forest F. If the paths of the forest F are required to appear on the cycle in a specified order, then the graph is said to be (k, t, s, m)-pancyclic ordered. If, in addition, each path in the system is oriented and must be traversed in the order of the orientation, then the graph is said to be strongly (k, t, s, m)-pancyclic ordered. Minimum degree conditions and minimum sum of degree conditions of nonadjacent vertices that imply a graph is (k, t, s, m)-pancylic, as well as degree conditions that imply a graph is (strongly) (k, t, s, m)-pancylic ordered will be given. Examples showing the sharpness of the conditions will be described. Problems and open questions related to these conditions will be presented.

Ramsey numbers for certain hypergraphs

Izolda Gorgol
(joint work with Ewa Łazuka)

For graphs G, H the *Ramsey number* $R(G, H)$ is defined as the smallest integer n for which any 2-colouring of edges of K_n with red and blue leads to either a red copy of G or a blue copy of H.

Analogously for hypergraphs $\mathcal{G}$, $\mathcal{H}$ the *Ramsey number* $R(\mathcal{G}, \mathcal{H})$ is defined as the smallest integer n for which any 2-colouring of edges of complete hypergraph on n vertices with red and blue leads to either a red copy of $\mathcal{G}$ or a blue copy of $\mathcal{H}$.

A hypergraph $\mathcal{H} = (X, \mathcal{E})$ is *h-uniform* if $|E| = h$ for each edge $E \in \mathcal{E}$. Let $\mathcal{SH}(k, p, r)$ denote a $(k + p)$-uniform hypergraph with $n = k + pr$ vertices in which any two of its edges overlap in a fixed k-subset of vertices. $\mathcal{SH}(k,p,r)$ is called a *sunflower hypergraph.*

We study diagonal Ramsey numbers for certain sunflower hypergraphs.

Packing cycles and unicyclic graphs into planar graphs

Agnieszka Görlich

In [1] A. Garcia, C. Hernando, F. Hurtado, M. Noy and J. Tehel obtained planar packing of two specific trees, e.g. they have established the existence of planar packing of two copies of trees. We show the existence of planar packing of two copies of cycles, of any order with the exceptions of C_5 and C_7. We also provide methods for obtaining planar packings of two copies of unicyclic graphs in some specific cases.

References

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Ring's maps M_n(7,5)

Róbert Hajduk
(joint work with Roman Soták)

We study existence of maps $M_n(p,q)$ (maps with ring of n q-gons whose inner and outer domain are filled by p-gons). In succesion on [1] we study existence of maps $M_n(7,5)$. We find some next values of n for which no maps $M_n(7,5)$ exists. Namely for $n = 29, 31, 33, 34, 35, 37$. We are focused on maps $M_n(7,5)$ with inner domain filled by the chain of pentagons too.

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Hanjo Walther and his scientific life

Jochen Harant
(with help of Erhard Hexel)

In the early sixties Hanjo Walther came to Ilmenau and started to work in graph theory under the supervision of Horst Sachs. I met Hanjo the first time in 1976 and worked with him almost 30 years together. This period, Hanjo's life, and his mathematical results form the contents of my lecture.

Edge-closure concept in claw-free graphs and stability of forbidden subgraphs

Přemysl Holub
(joint work with Jan Brousek)

Ryjáček introduced a closure concept in claw-free graphs based on local completion of a locally connected vertex. Connected graphs A, for which the (C, A)-free class is stable under the closure were completely characterized. In this paper, we give a variation of the closure concept based on local completion of a locally connected edge of a claw-free graph. The closure is uniquely determined and preserves the value of the circumference of a graph. We show that the (C, A)-free class is stable under the edge-closure if $A \in \{P_i, Z_i, N_{i,j,k}\}$.

Graphs close to being hamiltonian

Peter Horák

If we are not able to prove that a graph is hamiltonian, sometimes we at least try to show that the graph is "close" to being hamiltonian. Of course, the word close can be interpreted in different manners. In this talk several ways how to relax the property that a graph posesses a hamiltonian cycle/path will be discussed, and some related results and problems will be presented.

Monochromatic and heterochromatic subgraphs in colored graphs – A survey

Mikio Kano

We give some current results on monochromatic and heterochromatic trees in colored graphs. In particular, we determine the tree partition number of the complete multipartite graphs colored with two colors. Moreover, we propose some problems on these topics, and introduce a new subgraph called an alternating spanning tree and give some results.

Path factors and cycle factors of cubic bipartite graphs

Mikio Kano

(joint work with Changwoo Lee and Kazuhiro Suzuki)

For a set $\mathcal{S}$ of connected graphs, a spanning subgraph F of a graph is called an $\mathcal{S}$-factor if every component of F is isomorphic to one of S. It was shown by Kawarabayashi et al. (J. Graph Theory, Vol. 39 (2002) 188–193) that every 2-connected cubic graph has a $\{C_n|n \geq 4\}$-factor and a $\{P_n|n \geq 6\}$-factor, where C_n and P_n denote the cycle and the path of order n, respectively. In this paper, we show that every connected cubic bipartite graph has a $\{C_n|n \geq 6\}$-factor and a $\{P_n|n \geq 8\}$-factor.

Upper bound for maximal degree of oblique triangulations

František Kardoš

(joint work with Stanislav Jendroľ)

A polyhedral graph G is *oblique* if it has no two faces of the same type. Here, a k-gonal face α is of type $\langle b_1, b_2, \ldots, b_k \rangle$, if the vertices incident with α in cyclic order have degrees $b_1, b_2, \ldots, b_k$ and this is the lexicographic minimum of all such sequences available for α. The set of all oblique triangulations was proved to be non-empty and finite by Walther. He also proved that the degree set of oblique triangulation contains at most 90 elements. Examples of oblique triangulations with large maximal degree and an upper bound for maximal degree are presented.

Irregular assignments

Michał Karoński

A weighting of the edges of a graph with integer weights gives rise to a weighting of the vertices, the weight of a vertex being the sum of the weights of its incident edges.

An assignment of positive integer weights to the edges of a simple graph G is called *irregular* if the weighted degrees of the vertices are all different. The *irregularity strength*, $s(G)$, is the maximal weight, minimized over all irregular assignments, and is set to ∞ if no such assignment is possible. In the first part of my talk I shall discuss some recent results on irregularity strength of graphs, in particular on irregularity strength of trees.

An assignment of positive integer weights to the edges of a simple graph G is called *locally irregular* if the weighted degrees of adjacent vertices are different. Obviously, such vertex weighting induce a proper coloring of the graph. In this context, the following question has been raised: Is it possible to weight the edges of any connected graph with at least three vertices, with the integers $\{1, 2, 3\}$ such that the resultant vertex weighting is aproper coloring? In the second part of my talk I will overview some recent attempts to prove this conjecture.

The talk is based on joint work with Alan Frieze, Mike Ferrara, Ron Gould, Tomasz Łuczak, Florian Pfender and Andrew Thomason.

Partition problems and kernels of graphs

Peter Katrenič

Let $\tau(G)$ denote the number of vertices in a longest path of a graph $G = (V, E)$. A subset K of V is called a *P_n-kernel* of G if $\tau(G[K]) \leq n - 1$ and every vertex $v \in V(G - K)$ is adjacent to an end-vertex of a path of order $n - 1$ in $G[K]$. A partition A, B of V is called an (a, b) partition if $\tau(G[A]) \leq a$ and $\tau(G[B]) \leq b$. We show that every graph has a P_9-kernel and for every $n \geq 364$ there exists a graph G that does not contain any P_n-kernel.

Colorings of distance graphs

Arnfried Kemnitz

If S is a subset of the n-dimensional Euclidean space, $S \subseteq \mathbb{R}^n$, and D a set of positive real numbers, $D \subseteq \mathbb{R}_+$, then the distance graph $G(S, D)$ is defined to be the graph G with vertex set $V(G) = S$ and two vertices u and v are adjacent if and only if their distance $d(u, v)$ is an element of the so-called distance set D.

In the talk we will survey results to vertex colorings, edge colorings and total colorings of distance graphs as well as to the appropriate list colorings.

Domaticity of special graphs

Monika Kijewska

The domatic number of a graph was introduced E. J. Cockayne and S. T. Hedetniemi in [1]. More interesting results on domaticity can be found in papers of B. Zelinka, see [2], [3].

A partition of $V(G)$ into dominating sets D_i is called a *domatic partition* of G and it is denoted by $W = \{D_1, ..., D_k\}$. The maximal number of classes of a domatic partition of a graph G is called the *domatic number* of G and is denoted by $d(G)$. Clearly, $d(G) \geq k$.

We discusses reccurence relations for the numbers $i(P_n)$ and $i(C_n)$ of all domatic partitions of the path P_n and the cycle C_n, respectively. The number $i(G)$ is the sum of all possible domatic partitions of G with cardinalities $k \in \{1, 2, \ldots, d(G)\}$. We give also the relationship between numbers $i(P_n)$, $i(C_n)$ and F_n, where F_n is the Fibonacci numbers.

References

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[3] B. Zelinka, *Induced-paired domatic numbers of graphs*, Math. Bohem. 127 (2002), 591–596.

On the crossing number problems

Marián Klešč

The *crossing number* $cr(G)$ of a graph G is the minimum number of pairwise intersections of edges (at a point other than a vertex) in a drawing of G in the plane. Computing the crossing number of a given graph is in general an elusive problem, and the crossing numbers of very few infinite families of graphs are known. In 1973, Harary, Kainen and Schwenk proved that toroidal graphs can have arbitrarily large crossing number. For the Cartesian product $C_m \times C_n$ of the cycles of sizes m and n they conjectured that its crossing number is $(m-2)n$, for all $3 \leq m \leq n$, but only for m, n satisfying $n \geq m$, $m \leq 6$, this equality was shown. It was recently proved by L. Glebsky and G. Salazar (2004) that the crossing number of $C_m \times C_n$ equals its long-conjectured value at least for $n \geq m(m+1)$.

There are known exact crossing numbers of Cartesian products of paths, cycles or stars with all graphs of order four and with several graphs of order five. It thus seems natural to inquire about the crossing numbers for some other infinite families of graphs. The purpose of this talk is to summarize known results concerning crossing numbers of interesting graphs. Moreover, we give some new results for crossing numbers obtained in the last time.

Iterated line graphs are maximally ordered

Martin Knor

(joint work with Ľudovít Niepel)

A graph G is k-ordered if for every ordered sequence of k vertices, there is a cycle in G that encounters the vertices of the sequence in the given order. We prove that if G is a connected graph distinct from a path, then there is a number t_G such that for every $t \geq t_G$ the t-iterated line graph of G, $L^t(G)$, is $(\delta(L^t(G))+1)$-ordered. Since there is no graph H which is $(\delta(H)+2)$-ordered, the result is best possible.

Decomposition of circulant graphs into closed trails

Kocková Zuzana

Let G be a simple connected even graph (all its vertices are of even degrees) and let $\mathrm{Lct}(G)$ denote the set of all integers $l \geq 3$ such that G contains a closed trail of length l. A graph G is said to be *arbitrarily decomposable into closed trails* (ADCT for short) if any sequence $(l_1, \ldots, l_p)$ whose terms belong to $\mathrm{Lct}(G)$ and sum up to $|E(G)|$, has a G-realisation, a sequence $(T_1, \ldots, T_p)$ of edge-disjoint closed trails in G such that T_i is of length l_i, $i = 1, \ldots, p$. We present some special classes of circulant graphs that are ADTC.

On the structure of plane graphs extremal according to Kotzig theorem

Tomáš Madaras

A plane graph is said to be extremal according to Kotzig theorem if either it is of minimum degree 3 and each its edge has the weight (that is, the sum of degrees of its endvertices) at least 13, or it is of minimum degree at least 4 and each its edge has the weight at least 11. We explore the local structure of such plane graphs showing that they contain a variety of short cycles and stars with the vertices of small degrees.

Lattice of additive hereditary properties and formal concept analysis

Peter Mihók

A graph property $\mathcal{P}$ is any nonempty proper isomorphism closed class of finite simple graphs. A graph property is said to be hereditary if it is closed under taking subgraphs and additive if it is closed under disjoint union of graphs. The lattice $\mathbb{L}^a$ of additive hereditary graph properties have been introduced and investigated in connection with generalized colourings of graphs. Some results on the structure of the lattice $\mathbb{L}^a$ can be easily generalized and proved for digraphs, hypergraphs, posets and other structures. The aim of our talk is to introduce additive hereditary properties as concepts of an appropriate context in the *Formal Concept Analysis* (FCA). FCA is based on a notion of a formal context, which is defined as a triple $(O, A, \in)$, where O and A are non-empty sets and $\in$ is a binary relation between O and A. The elements of O are called objects and the elements of A are the attributes of the context. The *concepts* of a context $(O, A, \models)$ are ordered pairs (X, Y), where $X \subset O$ and $Y \subset A$ are closed sets of some related closure operators on O and A, respectively. We will show that the lattice $\mathbb{L}^a$ of additive hereditary properties of finite graphs is a complete algebraic lattice of the formal concepts of the the context $(\mathcal{I}, -\mathcal{C}, \in)$ where the objects are finite graphs, the attributes are the properties $-F$ - "do not contain a given finite connected graph F" and the incidence relation is simply $G \in -F$. Thus each graph property $\mathcal{P}$ has its *extent* $X = \mathcal{P} \subset \mathcal{I}$ and its *intent* $Y = \mathcal{F}$, the class of forbidden graphs for $\mathcal{P}$.

Hence, FCA is used to obtain deeper view to additive hereditary graph properties. For example, if we enlarge the given context to the class of all simple infinite graphs, we obtain an isomorphic lattice of additive graph properties of finite character. Our approach can be used analogousely to *object-system* and we will describe the ideas and reasons, which allows us to prove different types of general statements, e.g. Unique Factorization Theorem.

Total edge irregularity strength of complete graphs

Jozef Miškuf
(joint work with Stanislav Jendroľ and Roman Soták)

A total edge-irregular k-labelling $\varphi : V \cup E \to \{1, ..., k\}$ of a graph $G = (V, E)$ is a labelling of the vertices and the edges of G in such a way that for any two different edges e, f their weights $w(e)$ and $w(f)$ are distinct. The weight of an edge $e = uv$ is the sum of the labels of vertices u and v and the edge e. The minimum k for which there exists a total edge-irregular k-labelling of the graph

G is called total irregularity strength of G, $tes(G)$. We focus on complete graphs, complete bipartite graphs and complete multipartite graphs. Exact value of tes number for the mentioned graphs is shown.

Precoloring extension of outerplanar graphs

Anja Pruchnewski

(joint work with Margit Voigt)

Given an outerplanar graph G where every vertex has a list of 4 available colors. We assume that some bipartite components of the graph are precolored, each of them by two colors. Let d be the minimum distance between two vertices belonging to different precolored components. The problem is to determine the smallest d such that an arbitrary precoloring is extendable to a proper list coloring of the whole graph. Albertson, Hutchinson and Moore proved $d \leq 8$ whereas Kostochka gave an example showing $d > 6$.

In the talk we will give the proof for $d = 7$.

Decompositions of pseudographs into closed trials of even sizes

Jakub Przybyło

(joint work with Sylwia Cichacz and Mariusz Woźniak)

We consider a graph L_n, which is a complete graph with an additional loop at each vertex and minus 1-factor and we prove that it is decomposable into closed trials of even lengths greater than 4, whenever these lengths sum up to the size of the graph L_n. We also show that this statement remains true if we remove from L_n two loops attached to nonadjacent vertices. Consequently, we improve P. Wittmann's result on the upper boundary of the irregular number $c(G)$ of a 2-regular graph G of size n in the case when all components of G have even orders and we conclude that $c(G) = \lceil\sqrt{2n}\rceil$ in some cases and $\lceil\sqrt{2n}\rceil - 1 \leq c(G) \leq \lceil\sqrt{2n}\rceil$ or $\lceil\sqrt{2n}\rceil \leq c(G) \leq \lceil\sqrt{2n}\rceil + 1$ in the others.

Smallest non-rank 3 strongly regular graphs which satisfy the 4-vertex condition

Alexander Rosa
(joint work with Mikhail Klin, Mariusz Meszka and Sven Reichard)

The smallest non-rank 3 strongly regular graphs satisfying the 4-vertex condition have 36 vertices and paramaters $(v, k, \lambda, \mu) = (36, 14, 4, 6)$. Up to an isomorphism, there are exactly three such graphs. These graphs, together with the unique rank 3 graph having the same parameters, have interesting links to two-graphs, Steiner triple systems and other combinatorial structures.

Observability of some regular graphs

Janka Rudašová
(joint work with Roman Soták)

Observability of a graph G is the minimum k for which the edges of G can be properly coloured with k colours in such a way that colour sets of vertices of G (sets of colours of their incident edges) are pairwise distinct. We determine observability of arbitrary number of copies of some (regular) graphs. Moreover, we prove that for any graph, the request for equitable colouring has no impact on value of this invariant.

On Reed's conjecture about ω, Δ and χ

Ingo Schiermeyer

For a given graph G, the clique number $\omega(G)$, the chromatic number $\chi(G)$ and the maximum degree $\Delta(G)$ satisfy $\omega(G) \leq \chi(G) \leq \Delta(G) + 1$. In 1941 Brooks has shown that complete graphs and odd cycles are the only graphs attaining the upper bound $\Delta(G) + 1$.

In 1998 Reed posed the following conjecture:
Conjecture: For any graph G of maximum degree Δ,

$$\chi(G) \leq \lceil \frac{\Delta + 1 + \omega}{2} \rceil.$$

The Chvátal graph, the smallest 4-regular, triangle-free graph of order 12 with chromatic number 4, and some other graphs show that the rounding up in this conjecture is necessary. In this talk we will present some old and new partial solutions for this conjecture.

In particular we will show that the conjecture is true
(1) for all graphs of order $n \leq 12$,
(2) for all graphs with $\Delta(G) = n - k$ and $\alpha(G) \geq k$ for fixed k and
(3) for all graphs with $n - 5 \leq \Delta(G) \leq n - 1$.

References

[1] B. A. Reed, *ω, Δ and χ,* J. Graph Theory, 27 (4), (1998), 177–212.

On learning methods in games on graphs

Jens Schreyer
(joint work with Thomas Böhme)

The topic of the talk is automatic learning by following simple rules. Almost every learning problem can be considered as learning winning strategies in position games. We consider games, where a series of discrete decisions must be made by one or more players and the same game is repeated often. In the end of each game for every player there are only three possible outcomes: a win a loss or a drawn. These games can be represented as terminal games on a possibly unknown underlying directed graph, where each decision corresponds to the choice of one arc in a vertex of the graph. We will present some learning methods to find winning strategies, if the same game is repeated sufficiently often. We investigate deterministic and probabilistic learning algorithms and observe self-evolving cooperation between some of the players.

On magic and supermagic circulant graphs

Andrea Semaničová
(joint work with Jaroslav Ivančo)

A graph is called magic (supermagic) if it admits a labelling of the edges by pairwise different (and consecutive) integers such that the sum of the labels of the edges incident with a vertex is independent on the particular vertex. In the talk we characterize magic circulant graphs and 3-regular supermagic circulant graphs. We establish some conditions for supermagic circulant graphs. We also present some constructions of supermagic circulant graphs based on connection between supermagic labelling and other types of graphs labellings.

Minimal reducible bounds for induced-hereditary properties of graphs

Gabriel Semanišin
(joint work with Diana Čörgőová)

A *graph property* is an isomorphism closed subset of the set of all graphs. A property $\mathcal{P}$ is *induced-hereditary* if, whenever G belongs to $\mathcal{P}$ and $H \leq G$, then H belongs to $\mathcal{P}$ as well. A property that is closed under disjoint union of graphs is said to be *additive*. An additive induced-hereditary property is called *reducible* if it can be expressed as a "product" of two properties. A reducible additive induced-hereditary property $\mathcal{R}$ is called a *minimal reducible bound* for a property $\mathcal{P}$ if $\mathcal{P} \subseteq \mathcal{R}$ and there exists no reducible additive induced-hereditary property $\mathcal{Q}$ such that $\mathcal{P} \subseteq \mathcal{Q} \subset \mathcal{R}$.

We discuss the existence of minimal reducible bounds in the lattice of additive induced-hereditary properties. We extend some known results for the lattice of additive hereditary properties of graphs.

Asymptotic solution of the Erdős-T. Sós conjecture

Miklós Simonovits
(joint work with Miklós Ajtai, János Komlós and Endre Szemerédi)

We shall sketch a proof of a weakening of the famous Erdős-T. Sós conjecture on the extremal number of trees. The conjecture states that if T_k is a fixed tree of k vertices, then every graph G_n of n vertices and

$$e(G_n) > \frac{1}{2}(k-2)n$$

edges contains T_k. Our Main (approximation) Theorem asserts that for every $\eta > 0$ there exists an integer $n_0(\eta)$ such that if $n, k > n_0(\eta)$ and a graph G on n vertices contains no T_k then

$$e(G_n) \leq \frac{1}{2}(k-2)n + \eta n.$$

The proof is rather involved. Using an even more involved proof (but along the same lines) we can prove the sharp version ($\eta = 0$) as well, at least for k sufficiently large.

Decompositions into arbitrarily prescribed directed paths

Zdzisław Skupień
(joint work with Mariusz Meszka)

Two results which support the following conjecture will be presented.

Conjecture. *Each complete n-vertex digraph $\mathcal{D}K_n$ is decomposable into paths of arbitrarily prescribed lengths ($\leq n-1$) provided that the lengths sum up to the size $n\,(n-1)$ of $\mathcal{D}K_n$, unless $n = 3, 5$ and all paths are to be hamiltonian.*

Supporting cases:
(i) arbitrary nonhamiltonian paths,
(ii) any paths of which none avoids exactly one vertex.

Both Conjecture and supporting results are extended to complete multidigraphs.

References

[1] M. Meszka, Z. Skupień, Decompositions of a complete multidigraph into nonhamiltonian paths, J. Graph Theory, to appear.
[2] M. Meszka, Z. Skupień, Anti-1-defective path decompositions of a complete multidigraph, to appear.

Improving the connectedness of digraphs having a given competition hypergraph

Martin Sonntag
(joint work with Hanns-Martin Teichert)

If $D = (V, A)$ is a digraph, its *competition hypergraph* $C\mathcal{H}(D)$ has the vertex set V and $e \subseteq V$ is an edge of $C\mathcal{H}(D)$ iff $|e| \geq 2$ and there is a vertex $v \in V$, such that $e = \{w \in V | (w, v) \in A\}$. We tackle the problem to minimize the number of strong components in D without changing the competition hypergraph $C\mathcal{H}(D)$. The results are closely related to the corresponding investigations for competition graphs of K. F. Fraughnaugh, J. R. Lundgren, S. K. Merz, J. S. Maybee and N. J. Pullman.

Bounds for general neighbour-distinguishing index of a graph

Roman Soták

(joint work with Mirko Horňák)

It is proved that edges of a graph G with no component K_2 can be coloured using at most $\lceil \log_2 \chi(G) \rceil + 2$ colors so that any two adjacent vertices have distinct sets of colours of their incident edges. On the other hand, any colouring of edges of G having the above properties uses at least $\lceil \log_2 \chi(G) \rceil + 1$ colours. Moreover, if $\log_2 \chi(G)$ is not an integer, the determined colouring is optimal (it uses $\lceil \log_2 \chi(G) \rceil + 1$ colours).

Ordered 3-colorings

Ladislav Stacho

(joint work with A. Gupta, J. Manuch, and X. Zhao)

We introduce three variants of proper 3-colorings of graphs G with vertices uniquely labeled with integers from 1 to $|V(G)|$. These labels will impose some restrictions on the 3-colorings. We briefly discuss the motivation for these colorings that comes from the problem of reconstructing haplotype structure via genotype data in bioinformatics.

We show relationship of these coloring problems to other problems (directed graph homomorphism, list coloring) and study their computational complexities. One of the problems will be reduced to 2-SAT, hence having a polytime algorithm, while other problems will be shown to be NP-complete. For these intractable problems, we describe a random graph model for graphs that have such colorings and will describe an algorithm that colors almost all such graphs.

We conclude the talk with remarks for future work and some open problems.

A criterion for a colored graph to have a heterochromatic spanning tree

Kazuhiro Suzuki

We give a necessary and sufficient condition for the existence of a heterochromatic spanning tree in a connected edge-colored graph, and apply this criterion to some graphs. For example, we show that the edge-colored complete graph K_n has a heterochromatic spanning tree, if the number of edges colored with any fixed color is at most $n/2$. This was conjectured by J. Pach.

Results on some coloring parameters of a graph

Manouchehr Zaker

In this talk we discuss the b-chromatic, Grundy chromatic and ordinary chromatic number of graphs and give new bounds for these coloring parameters of a graph.

Suppose a proper vertex coloring of a graph G with t colors $1, 2, \ldots, t$ is such that each color class C_i contains a vertex v such that in the neighborhood of v all other $t-1$ colors are appeared. We call such a coloring a b-coloring with t colors. The largest number t such that there exists a b-coloring with t colors is called the b-chromatic number of G and denoted by $\varphi(G)$.

The Grundy chromatic number, denoted by $\Gamma(G)$, is the largest integer k, for which there exists a vertex coloring of G in such a way that for any two colors i and j where $1 \leq i < j \leq k$ any vertex colored j has a neighbor with color i.

We first report our bounds for the b-chromatic number of the following families of graphs: $K_{1,t}$-free graphs, bipartite graphs, complement of bipartite graphs, graphs with girth five and a general bound in terms of the clique partition number of a graph. We will show that all the bounds are tight. Next, a bound for the Grundy chromatic number of a graph in terms of its girth number is given. Finally we introduce a new upper bound for the chromatic number of a graph in terms of its degrees.

Some results of this talk on b-chromatic number have been obtained jointly with Mekkia Kouider.

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Programme of the Conference

Sunday	
14:00 - 22:00	Registration
18:00 - 21:00	Dinner

Monday		
07:30 - 08:30	Breakfast	
08:40 - 08:45	Opening	
08:45 - 09:35	Stacho L.	Ordered 3-colorings
09:40 - 10:00	Rosa A.	Smallest non-rank 3 strongly regular graphs which satisfy the 4-vertex condition
10:05 - 10:25	Schreyer J.	On learning methods in games on graphs
10:30 - 10:55	Coffee break	
10:55 - 11:15	Borowiecki M.	Acyclic colourings of graphs
11:20 - 11:40	Dvořák Z.	Planar graphs of odd-girth at least 9 are homomorphic to Petersen graph
11:45 - 12:05	Knor M.	Iterated line graphs are maximally ordered
12:10 - 12:30	Madaras T.	On the structure of plane graphs extremal according to Kotzig theorem
12:30 - 13:15	Lunch	
14:45 - 15:35	Kano M.	Monochromatic and heterochromatic subgraphs in colored graphs - A survey
15:40 - 16:00	Gorgol I.	Ramsey numbers for certain hypergraphs
16:05 - 16:25	Bacsó G.	Infinite graph domination
16:25 - 16:50	Coffee break	
16:50 - 17:10	Horák P.	Graphs close to being hamiltonian
17:15 - 17:35	Görlich A.	Packing cycles and unicyclic graphs into planar graphs
17:40 - 18:00	Kocková Z.	Decomposition of circulant graphs into closed trails
18:00 - 18:25	Draženská E.	The crossing numbers of products
18:30 - 19:15	Dinner	
20:00 -	Welcome party	

Tuesday		
07:30 - 08:30	Breakfast	
08:45 - 09:35	CHVÁTAL V.	The Sylvester-Gallai Theorem and metric betweenness
09:40 - 10:00	BRANDT S.	Dense triangle-free graphs are four-colourable: A solution to the Erdős-Simonovits problem
10:05 - 10:25	SKUPIEŃ Z.	Decompositions into arbitrarily prescribed directed paths
10:30 - 10:55	Coffee break	
10:55 - 11:45	HARANT J.	Hanjo Walther and his scientific life
11:50 - 12:30	Problem session	
12:30 - 13:15	Lunch	
14:45 - 15:35	KAROŃSKI M.	Irregular assignments
15:40 - 16:00	KIJEWSKA M.	Domaticity of special graphs
16:05 - 16:25	BAČA M.	Vertex-antimagic total labelings
16:25 - 16:50	Coffee break	
16:50 - 17:10	KLEŠČ M.	On the crossing number problems
17:15 - 17:35	ČADA R.	Coloring prime graphs
17:40 - 18:00	SUZUKI K.	A criterion for a colored graph to have a heterochromatic spanning tree
18:00 - 18:25	SEMANIČOVÁ A.	On magic and supermagic circulant graphs
18:30 - 19:15	Dinner	
20:00 - 21:20	Videopresentation C&C 2004	

Wednesday	
07:00 - 08:30	Breakfast
08:30 - 16:00	Trip
19:00 - 20:00	Dinner

Thursday		
07:30 - 08:30	Breakfast	
08:45 - 09:35	Faudree R. J.	Linear forests, k-ordered, and pancyclic graphs
09:40 - 10:00	Schiermeyer I.	On Reed's conjecture about ω, Δ and χ
10:05 - 10:25	Zaker M.	Results on some coloring parameters of a graph
10:30 - 10:55	Coffee break	
10:55 - 11:15	Mihók P.	Lattice of additive hereditary properties and formal concept analysis
11:20 - 11:40	Sonntag M.	Improving the connectedness of digraphs having a given competition hypergraph
11:45 - 12:05	Pruchnewski A.	Precoloring extension of outerplanar graphs
12:10 - 12:30	Baum S.	Coloring of graphs without short odd paths between vertices of the same color class
12:30 - 13:15	Lunch	
14:45 - 15:35	Simonovits M.	Asymptotic solution of the Erdős-T. Sós conjecture
15:40 - 16:00	Soták R.	Bounds for general neighbour-distinguishing index of a graph
16:05 - 16:25	Semanišin G.	Minimal reducible bounds for induced-hereditary properties of graphs
16:25 - 16:50	Coffee break	
16:50 - 17:10	Kano M.	Path factors and cycle factors of cubic bipartite graphs
17:15 - 17:35	Holub P.	Edge-closure concept in claw-free graphs and stability of forbidden subgraphs
17:40 - 18:00	Rudašová J.	Observability of some regular graphs
18:00 - 18:25	Miškuf J.	Total edge irregularity strength of complete graphs
19:00 -	Farewell party	

Friday		
07:30 - 08:30	Breakfast	
08:45 - 09:35	Kemnitz A.	Colorings of distance graphs
09:40 - 10:00	Przybyło J.	Decompositions of pseudographs into closed trails of even sizes
10:05 - 10:25	Katrenič P.	Partition problems and kernels of graphs
10:30 - 10:55	Coffee break	
10:55 - 11:15	Hajduk R.	Ring's maps $M_n(7,5)$
11:20 - 11:40	Kardoš F.	Upper bound for maximal degree of oblique triangulations
12:00 - 12:45	Lunch	