C-S'01 Sedmihorky

Dear colleagues and friends,

welcome to the first Czech and Slovak Graph Theory and Combinatorics Conference in the Third Millenium. We are happy to keep alive the tradition of these late spring meetings where Czech and Slovak are the official conference languages. Despite deciding and announcing the dates of the conference almost a year in advance, our meeting has a tough competition of Twente Graph Theory workshop (this year in Köln) and Katona's Hypergraphs (in Budapest). The more were are pleased by the number of registered participants. And in particular we thank those invited speakers who made the effort to come to our conference at least for a day or two and support it by delivering one of the main lectures.

Two of the regular participants could not come because of health problems in their families. We all hope and keep fingers crossed for them, so that we can all meet next year at CS02.

Our conference was not promoted internationally. Nevertheless, we welcome several foreign participants. These are the current visitors of DIMATIA and some friends who have learned about the conference and expressed their wish to take part in it.

The conference is organized by Institute for Theoretical Computer Science of Charles University in Prague (Founded in 2000 and supported by Ministry of Education of Czech Republic as project LN00A056). We thank it for financial help which made participation in the conference possible for most of the Czech and Slovak participants. DIMATIA visitors are supported by Czech Grant GAČR 201/99/0242.

I wish to express many thanks to the members of the organizing committee, my PhD. student Jakub Šimek and the KAM secretary Mrs. Hana Časenská. We all hope that we will spend a pleasant and scientifically valuable week in Lázně Sedmihorky.

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List of Contributions

Programme

Monday 4.6.2001

13:00 Lunch
16:00 **J. Nešetřil** TBA
17:00 **Z. Ryjáček:** Contractibility Techniques as a Closure Concept
17:30 **R. Čada:** Closure Concepts for Hamiltonian-Connectivity
18:00 Dinner
19:00 **Problem session**

Tuesday 5.6.2001

8:00 Breakfast
9:00 **M. Horňák:** On the Achromatic Index of Complete Graphs
10:00 Coffee break
10:30 **E. Bruoth:** On-line Ranking Number for Cycles and Paths
11:00 **J. Fiala:** On the On-line Coloring and Labeling of Intersection Graphs of Disks and Squares
11:30 **A. Lozano:** On the Complexity of Counting the Number of Vertices Moved by Graph Automorphisms
12:15 Lunch
16:00 **R. Babilon:** Small Aperiodic Sets of Tiles
16:30 **T. Kaiser:** k-flat Transversals to Unit Balls
17:00 **O. Pangrác:** On Intersection Graphs of Segments with Prescribed Slopes
17:30 **V. Jungic:** On Monochromatic Arithmetic Progressions Having Odd Common Difference
18:00 Dinner

Wednesday 6.6.2001

8:00 Breakfast
9:00 **R. Škrekovský:** Colorings of Planar Graphs
10:00 Coffee break
10:30 **R. Nedela:** Regular Embeddings of Complete Multipartite Graphs
11:00 **M. Ipolyiová, J. Šiagiová:** Regular Maps, Chebychev Polynomials, and Minimal Polynomials of $2\cos(\pi/n)$
11:30 **M. Knor:** Connectivity of Iterated Path Graphs
12:00 **G. Hahn:** Barveni turnamentu
12:45 Lunch
13:30 Excursion (for those, who are interested)
19:30 Conference banquet

Thursday 7.6.2001

8:00 Breakfast
9:00 **P. Valtr** TBA
10:00 Coffee break
10:30 **J. Maxová:** On Faithful Cycle Covers of Graphs
11:00 **P. Smolíková:** Simple Homomorphisms and Simple Chromatic Numbers
11:30 **T. Marshall:** Universal Graphs and Vertex Colourings
12:15 Lunch
16:00 **F. Franěk:** Erdös' Conjecture on Multiplicities of Complete Subgraphs Revisited, Lower Upper Bounds for Cliques of Size 5 and 6
16:30 **M. Kubesa:** Note on a Multiple-Key Multiple-Lock Security Problem
17:00 **T. Madaras:** On the Structure of Plane Graphs of Restricted Face Size
17:30 **P. Kolman:** Simple On-line Algorithms for the Maximum Disjoint Paths Problem
18:00 Dinner

Friday 8.6.2001

8:00 Breakfast
9:00 **M. Škoviera:** Regular Embeddings of Complete Bipartite Graphs
10:00 Coffee break
10:30 **L. Nebeský:** A Ternary Relation Defined by a Connected Graph
11:00 **R. Caha:** Paths, Cycles, Multipaths and Multicycles in Dense Subsets of Hypercubes
11:30 **H. J. Voss:** Light Subgraphs in Maps of Minimum Degree 5 on Compact 2-Manifolds
12:15 Lunch

Small Aperiodic Sets of Tiles

Robert Babilon

A tiling of the plane is called *non-periodic* if there is no translation vector leaves the tiling invariant. A set of tiles is called *aperiodic* if it is possible to completely tile the plane (i.e. without holes and overlaps) with copies of the tiles, but *only* non-periodically. There are known about 12 "small" aperiodic sets. We give some such examples, methods for proving non-periodicity and some graph properties.

On-line Ranking Number for Cycles and Paths

Erik Bruoth

A k - ranking of a graph G is a coloring φ: $V(G) \to \{1, \ldots, k\}$ such that any path in G with endvertices x, y fulfilling $\varphi(x) = \varphi(y)$ contains an internal vertex z with $\varphi(z) > \varphi(x)$. On-line ranking number $\chi_r^*(G)$ of a graph G is minimum k such that G has a k - ranking constructed step by step if vertices of G are coming and coloured one by one in an arbitrary order; when coloring vertex, only edges between already present vertices are known. Horňák and Bruoth proved that $\chi_r^*(P_n) \leq 2\lfloor \log_2(n) \rfloor + 1$. We show that $\chi_r^*(P_n) \geq 1.61 \log_2(n) - 1$.

Paths, Cycles, Multipaths and Multicycles in Dense Subsets of Hypercubes

Rostislav Caha, Václav Koubek

Dense subsets of a hypercube are graphs which are easily growable and are usefull for inductive construction of subgraphs of a hypercube. We show construction of paths, cycles, multipaths and multicycles in a hypercube which span a dense subset and can be interconnected or can be extended to span a bigger dense set.

Closure Concepts for Hamiltonian-Connectivity

Roman Čada

An overview will be given about closure concepts for hamiltonian properties of graphs. The talk will deal with closure concepts based on local structure of a graph. Main attention will be paid to strong hamiltonian properties – hamiltonian-connectivity and homogeneous traceability. Most of the results are taken from the author's thesis.

On the On-line Coloring and Labeling of Intersection Graphs of Disks and Squares

Jiří Fiala

We present a study on graph coloring and so called distance labeling problems. These notions are stemming from channel assignment industry, and are hard in general. However, for restricted classes of graphs, - namely for intersection graphs of disks and squares - there exists exact or approximate algorithm. Several of them are based on an extension of First-fit method. We give overview of these algorithms, exhibit lower bound and present some open problems.

Erdös' Conjecture on Multiplicities of Complete Subgraphs Revisited Lower Upper Bounds for Cliques of Size 5 and 6

Fráňa Franěk

Denote by $k_t(G)$ the number of cliques of order t in the graph G. Let $k_t(n) = min\{k_t(G) + k_t(\overline{G}) : |G| = n\}$, where $\overline{G}$ denotes the complement of G, and $|G|$ denotes the order of G. Let $e_t(n) = k_t(n)/\binom{n}{t}$, and let $e_t = \lim_{n\to\infty} e_t(n)$. An old conjecture of Erdös, related to Ramsey's theorem, states that $e_t = 2^\alpha$, where $\alpha = 1 - \binom{t}{2}$. It was proved tru for $t = 3$, while shown false by Thomason for all $t \geq 4$. Franek and Rödl presented a sequence of graphs derived from a simple Cayley graph that disaproves the conjecture for $t = 4$ obtaining basically the same upper bound as Thomason did. In this paper we present similar sequences of graphs derived from that same Cayley graph that disaprove the conjecture for $t = 5, 6$ giving significantly lower upper bounds than those of Thomason.

Note on a Multiple-Key Multiple-Lock Security Problem

Dalibor Fronček, Michael Kubesa

We have electronical system of n keys and m locks such that each lock can be opened by at least one key.

Problem 1: We look for system of n keys and m locks, where all locks can be opened by any set of q keys ($q \leq n$), but not by less than that.

Problem 2: For a given number keys and locks, n, and a given number ($q \leq n$) such that each set of q keys opens all locks, determine the largest possible number p with property that no set of less than p keys opens all locks.

Barveni turnamentu

Gena Hahn

Novy pohled na stary problem. V kazdem (konecnem) turnamnentu T, jehoz hrany jsou obarvene k barvami, existuje mnozina S(T) takova, ze od kazdeho vrcholu v $T - S(T)$ existuje monochromaticka (orientovana) cesta do nejakeho vrcholu v $S(T)$. Zavisi velikost $S(T)$ jenom na k? Jinymi slovy, existuje funkce abs(k), ktera kazdemu prirozenemu k priradi maximalni velikost mnoziny $S(T)$?

On the Achromatic Index of Complete Graphs

Mirko Horňák and Štefan Pčola

The *achromatic index* of a graph G, in symbol achri(G), is a maximum number of colours in a proper edge colouring of G that is *complete*; this means that, for any two distinct colours c_1, c_2, there are adjacent edges receiving colours c_1 and c_2. It is known that $\mathrm{achri}(K_{q^2+q+1}) = q(q^2+q+1)$ for an odd integer $q \geq 3$ if and only if there exists a projective plane of order q (Bouchet [1]). The achromatic index of K_n is known only for $n \leq 14$ and the above orders. The value $\mathrm{achri}(K_{12}) = \mathrm{achri}(K_{3^2+3}) = 32$ has been determined by Jamison [3] (the lower bound) and by Horňák [2] (the upper bound).

Theorem 1 *If q is a prime, $q \geq 5$, then* $\mathrm{achri}(K_{q^2+q}) \geq q^3 + q2 + \lfloor \frac{q-2}{3} \rfloor$.

References:

1 A. Bouchet : Indice achromatique des graphes multiparti complets et réguliers *(Cahiers Centre Études Rech. Opér. vol 20 year 1978 pages 331–340)*

2 M. Horňák : Achromatic index of K_{12} *(Ars Combin. vol 20 year 1997 pages 271–275)*

3 R. E. Jamison : On the achromatic index of K_{12} *(Congr. Numer. vol 81 year 1991 pages 143–148)*

Regular Maps, Chebychev Polynomials, and Minimal Polynomials of $2\cos(\pi/n)$

Mária Ipolyiová and Jana Šiagiová

It is well known that regular maps of type $\{m, n\}$ are in one-to-one correspondence with normal subgroups (torsion-free) of the triangle group $T(2, m, n) = \langle y, z|\, y^m = z^n = (yz)^2 = 1\rangle$. In a hyperbolic case (if $1/m+1/n < 1/2$) the group $T(2, m, n)$ can be represented in the group $SL_3(\mathcal{Z}[\xi, \eta])$, where $\xi = 2\cos(\pi/m)$ and $\eta = 2\cos(\pi/n)$. This representation can be successfully used for construction of regular maps. In our presentation we will show some of the connections of this representation with Chebychev polynomials and minimal polynomials for ξ and η.

On Monochromatic Arithmetic Progressions Having Odd Common Difference

Veselin Jungic

In this talk we will address the question of the following type: ¡par¿ Is it possible to state a density characterization of a certain set of finite colorings. Particularly, we are interested to give a density characterization of the set of 2-colorings that allow long monochromatic arithmetic progressions having odd common difference. An experiment and its results will be described. Also, a related conjecture given by Brown, Graham, and Landman in 1999 will be mentioned.

k-flat Transversals to Unit Balls

Tomáš Kaiser

We discuss Helly-type results and conjectures related to k-flattransversals to families of unit balls in $\mathbf{R}^d$. A prototype ofthese statements is a theorem due to Danzer, saying that if any fivemembers of a family F of pairwise disjoint unit disks in the plane have aline transversal, then there is a line meeting all of F. We present aconjecture on the existence of k-flat transversals to unit d-balls in$\mathbf{R}^d$.

Connectivity of Iterated Path Graphs

Martin Knor

Let $P_2(G)$ denote the path graph (formed by paths of length 2) of G. We proved that, if G is a regular graph then $P_2^i(G)$ (i.e., the i-iterated P_2-path graph of G) has connectivity equal to its degree. Hence, iterated P_2-path graphs are maximally connected, as well as iterated line graph.

Simple On-line Algorithms for the Maximum Disjoint Paths Problem

Petr Kolman and Christian Scheideler

We consider the classical problem of finding disjoint paths in graphs between given set of pairs of terminal vertices. We study a class of simple deterministic on-line algorithms, called bounded greedy algorithms, and show that they achieve a competitive ratio that is asymptotically equal to the best possible competitive ratio that can be achieved by any deterministic on-line algorithm.

On the Complexity of Counting the Number of Vertices Moved by Graph Automorphisms

Antoni Lozano, V. Raghavan

We consider the problem of deciding whether a given graph has an automorphism which moves at least k vertices (where k is a function in the order of the graph), a question originally posed by Lubiw (1981). Here we show that this problem is equivalent to the one of deciding whether a graph has a nontrivial automorphism, for $k \in O(\log n / \log \log n)$. Taking now $k \in O(\log n)$, we show that the above problem is still easier (by means of a Turing reduction) than deciding whether two graphs are isomorphic. If P$\neq$NP and Graph Isomorphism is not NP-complete, the above results are fairly tight, since it is known that deciding if there is an automorphism which moves at least n^ϵ vertices, for any fixed $\epsilon \in (0, 1)$, is NP-complete.

On the Structure of Plane Graphs of Restricted Face Size

Tomáš Madaras

A subgraph of a plane graph is light if each of its vertices has a small degree in entire graph. Consider the class $\mathcal{G}$ of all plane graphs of minimum face size 5. From the classical result of Lebesgue (1940) it follows that each $G \in \mathcal{G}$ contains a light pentagon. We supplement this result by proving that each $G \in \mathcal{G}$ contains a 3-star $K_{1,3}$ with 3-valent central vertex such that the sum of degrees of its vertices (in G) is at most 13; further, we prove that each $G \in \mathcal{G}$ contains a light pentagon with two added edges. For the class $\mathcal{G}'$ of all plane graphs of minimum face size 4, no graphs other than paths are light; but, considering that the sum of sizes of two adjacent faces is at least 9, we can prove that $K_{1,3}$ is light.

Universal Graphs and Vertex Colourings

Timothy Marshall

If $\mathcal{C}$ is a class of graphs, then a graph U is said to be $\mathcal{C}$-universal if every graph from $\mathcal{C}$ admits a homo morphism into U. We characterize classes $\mathcal{C}$ for which there exists a $\mathcal{C}$-universal of specified odd girth g (ie containing no odd cycle of length $< g$), and of specified clique number, in terms of the existence of special vertex colourings on the graphs of $\mathcal{C}$. These are analogues of acyclic colourings. We prove, in particular, the existence of a K_i-free graph which is universal for K_i-free planar graphs, for $i = 4, 5$ and conjecture the same result for $i = 3$. [Joint work with Reza Nasraser and Jarik Nešetřil]

On Faithful Cycle Covers of Graphs

Jana Maxová

We consider a problem related to the Cycle Double Cover (CDC) conjecture for graphs, the Oriented Faithful Cycle Cover: For a given graph G and a weight function p on the arcs of its symmetric orientation $S(G)$ we wish to find a collection of cycles in $S(G)$ (of length ≥ 3) such that each arc $e \in E(S(G))$ is contained in exactly $p(e)$ cycles of the collection. Such a collection we call an oriented faithful cycle cover of (G, p).

The unoriented version of this problem was posed by P. D. Seymour who gave two necessary conditions (so called admissibility conditions) on (G, p) to have a faithful cycle cover and proved that for planar graphs these conditions are also sufficient. B. Alspach, L. Goddyn and C. Q. Zhang proved later that a graph G has a faithful cycle cover for every admissible weight vector p if and only if G has no Petersen minor.

Here we concentrate on the oriented version of this problem. We similarly define admissibility conditions in the oriented case and we give full characterization of graphs which admit an oriented faithful cycle cover for every admissible p: A simple graph G admits an oriented faithful cycle cover for each admissible weight vector p if and only if G has no K_4-minor.

A Ternary Relation Defined by a Connected Graph

Ladislav Nebeský

If U be a finite nonempty set and T is a ternary relation on U, then we say that (U, T) is a ternary system. Let X = (U, T) be a ternary system. We say that X is an IP-system if there exists a nontrivial connected graph G such that V(G) = U and T(x, y, z) if and only if y belongs to an induced x-z path in G for all x, y, z in U. In this contribution, IP-systems will be compared with another types of ternary systems defined by nontrivial connected graphs.

Regular Embeddings of Complete Multipartite Graphs

Roman Nedela

The problem to classify all regular embeddings of a given graph has been studied by many authors, in particular, for the complete graphs by Biggs, James, Jones, for the cocktail-party graphs by Nedela and Skoviera, or for the hypercubes and the complete bipartite graph $K_{n,n}$ Nedela, Skoviera and Zlatos, etc. In this paper, we describe the classification problem in terms of group theory and we classify all regular embeddings of the complete multipartite graphs $K_{p,\ldots,p}$ for a prime p. Besides, we also classify the regular embeddings of the lexicographic product of any connected arc-transitive graph of prime order with the complement of the complete graph of prime order p. A lot of these regular maps are isomorphic to some Cayley maps.

On Intersection Graphs of Segments with Prescribed Slopes

Ondřej Pangrác, Jakub Černý, Daniel Král', Helena Nyklová

We study intersection graphs of segments with prescribed slopes in the plane. A sufficient and necessary condition on tuples of slopes in order to define the same class of graphs is presented. Classes of intersection graphs of segments with four slopes are fully described; in particular, we find an infinite set of quadruples of slopes which define mutually distinct classes of intersection graphs of segments with those slopes.

Contractibility Techniques as a Closure Concept

Z. Ryjáček and R.H. Schelp.

We introduce a closure concept in the class of line graphs and claw-free graphs based on contractibility of certain subgraphs in the line graph preimage. The closure can be considered as a common generalization and strengthening of the reduction techniques of Catlin and Veldman and of the closure concept introduced by the first author. We show that the closure is uniquely determined and the closure operation preserves the circumference of the graph.

Simple Homomorphisms and Simple Chromatic Numbers

Petra Smolíková

We define a simple homomorphism from a digraph $G = (V(G), E(G))$ to a digraph $H = (V(H), E(H))$ as a mapping f of $V(G)$ to $V(H)$ such that for any $(u, v) \in E(G)$ either $(f(u), f(v)) \in E(H)$ or $f(u) = f(v)$. A digraph G is called simple core if it does not have any nontrivial (i.e. nonconstant and nonidentical) simple homomorphism from G to G. The set of all simple cores ordered by the existence of a nonconstant simple homomorphism is a poset. We show that this poset is dense and we compare it with the traditional coloring poset $\mathcal{C}$. We define the simple chromatic number of a digraph and consider some related problems.

Regular Embeddings of Complete Bipartite Graphs

Martin Škoviera

One of the main aims of topological graph theory is to determine all the regular embeddings (in orientable surfaces) of a given graph, or class of graphs. These embeddings enjoy the highest possible symmetry by having the automorphism group with size being the doubled number of edges. There are only a few classes of graphs for which this has been achieved, most notably the complete graphs K_n (James and Jones, 1985) and the cocktail-party graphs (Nedela and Skoviera, 1996). Surprisingly enough, for complete the bipartite graphs Kn, n and for the n-dimensional cubes Q_n the complete classification of regular embeddings is still missing.

In the talk we will first survey the known constructions and characterisation results. Then we will show that there is only one regular embedding of $K_{p,p}$ where p is a prime, and finally we will indicate a more general approach which can give results in many other cases.

Colorings of Planar Graphs

Riste Škrekovski

In the talk will be presented some results and problems on colorings of planar graphs with prescribed girth. Some (possible) extensions and generalizations of the Grötzsch Theorem for various colorings will be also considered.

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