Abstracts of KAM-DIMATIA Series Year 2004

Dear colleagues,

in our experience as editors of KAM-DIMATIA Series we noticed, how many interesting submissions are going through our hands, much more than is possible to read by a mere human. To help people overview what is going on at KAM and DIMATIA in general, we prepared a list of abstracts of all papers submitted each year. We hope you will enjoy reading it.

Martin Bálek & Robert Šámal
editors of KAM-DIMATIA Series

2004-654 D. Král' and R. Škrekovski

The Last Excluded Case of Dirac's Map-Color Theorem for Choosability

In 1890, Heawood established the upper bound $H(\varepsilon) = \left\lfloor \frac{7+\sqrt{24\varepsilon+1}}{2} \right\rfloor$ on the chromatic number of every graph embedded on a surface of Euler genus $\varepsilon \geq 1$. Almost 80 years later, the bound was shown to be tight by Ringel and Youngs. These two results has became known under the name of the Map-Color Theorem. In 1956, Dirac refined this by showing that the upper bound $H(\varepsilon)$ is obtained only if a graph G contains $K_{H(\varepsilon)}$ as a subgraph with except of three surfaces. Albertson and Hutchinson settled these excluded cases in 1979. This result is nowadays known as Dirac's Map-Color Theorem.

Böhme, Mohar and Stiebitz extended Dirac's Map-Color Theorem to the case of choosability by showing that G is $(H(\varepsilon) - 1)$-choosable unless G contains $K_{H(\varepsilon)}$ as a subgraph for $\varepsilon \geq 1$ and $\varepsilon \neq 3$. In the present paper, we settle the excluded case of $\varepsilon = 3$.

2004-655 J. Fiala and V. B. Le

The Subchromatic Index of Graphs

In an edge coloring of a graph, each color class forms a subgraph without path of length two (a matching). An edge subcoloring generalizes this concept: Each color class in an edge subcoloring forms a subgraph without path of length three. While every graph with maximum degree at most two is edge 2-subcolorable, we point out in this paper that recognizing edge 2-subcolorable graphs with maximum degree three is NP-complete, even when restricted to triangle-free graphs. As by-products, we obtain NP-completeness results for the star index and the subchromatic number for several classes of graphs. It is also proved that recognizing edge 3-subcolorable graphs is NP-complete.

Moreover, edge subcolorings and subchromatic index of various basic graph classes are studied. In particular, we show that every unicyclic graph is edge 3-subcolorable and edge 2-subcolorable unicyclic graphs have a simple structure, allowing an easy linear time recognition. We also present an algorithm for testing edge k-subcolorability for graphs of bounded treewidth.

2004-656 J. Nešetřil and P. Ossona de Mendez
Tree depth, subgraph coloring and homomorphism bounds

We define the notions tree depth and upper chromatic number of a graph and show their relevance to local - global problems for graphs partitions. Particularly we show that the upper chromatic number coincides with the maximal function which can be locally demanded in a bounded coloring of any proper minor closed class of graphs. The rich interplay of these notions is applied to a solution of bounds of minor closed classes satisfying local conditions. This solves an open problem and as an application it yields the bounded chromatic number of exact odd powers of any graph in an arbitrary proper minor closed class.

2004-657 M. Bläser, B. Manthey and J. Sgall
An Improved Approximation Algorithm for the Asymmetric TSP with Strengthened Triangle Inequality

We consider the asymmetric traveling salesperson problem with γ-parameterized triangle inequality for $\gamma \in [\frac{1}{2}, 1)$. That means, the edge weights fulfill $w(u,v) \leq \gamma \cdot (w(u,x) + w(x,v))$ for all nodes u, v, x. Chandran and Ram 2002 recently gave the first constant factor approximation algorithm with polynomial running time for this problem. They achieve performance ratio $\frac{\gamma}{1-\gamma}$. We devise an approximation algorithm with performance ratio $\frac{1+\gamma}{2-\gamma-\gamma^3}$, which is better than the one of Chandran and Ram for $\gamma \in [0.5437, 1)$, that is, for the particularly interesting large values of γ.

2004-658 M. Chrobak, W. Jawor, J. Sgall and T. Tichý
Improved Online Algorithms for Buffer Management in QoS Switches

We consider the following buffer management problem arising in QoS networks: packets with specified weights and deadlines arrive at a network switch and need to be forwarded so that the total value of forwarded packets is maximized. If a packet is not forwarded before its deadline, it is lost and brings no profit. The main result of the paper is an online $\frac{64}{33} \approx 1.939$-competitive algorithm – the first deterministic algorithm for this problem with competitive ratio below 2. We also study the *s-uniform* case, in which all packets have the same span s (the difference between the deadline and the arrival time), for which we give an algorithm with ratio $5 - \sqrt{10} \approx 1.838$. Our algorithm achieves the same ratio in a more general scenario when all packets are similarly ordered. Our last two results concern the 2-uniform case, for which we give an algorithm with ratio ≈ 1.377 and a matching lower bound.

2004-659 M. Chrobak, W. Jawor, J. Sgall and T. Tichý
Online Scheduling of Equal-Length Jobs: Randomization and Restarts Help

We consider the following scheduling problem. The input is a set of jobs with equal processing times, where each job is specified by its release time and deadline. The goal is to determine a single-processor, non-preemptive schedule of these jobs that maximizes the number of completed jobs. In the online version, each job arrives at its release time. We give two online algorithms with competitive ratios below 2 and show several lower bounds on the competitive ratios. First, we give a $\frac{5}{3}$-competitive randomized algorithm. Our algorithm needs only one fair random bit, as it chooses one of two (nearly identical) deterministic algorithms, each with probability $\frac{1}{2}$. We also show a lower bound of $\frac{3}{2}$ for barely random algorithms, that (with arbitrary probability) choose one of two deterministic algorithms. Next, we give a deterministic $\frac{3}{2}$-competitive algorithm in the model that allows restarts, and we show that in this model the ratio $\frac{3}{2}$ is optimal. For randomized algorithms with restarts we show a lower bound of $\frac{6}{5}$.

2004-660 Z. Dvořák and V. Jelínek
On the Complexity of the G-Reconstruction Problem

Let G be a fixed unoriented graph. A G-structure of a graph F is a hypergraph H with the same set of vertices as F and with the property that a set h is a hyperedge of H iff the subgraph of F induced on h is isomorphic to G. We consider a G-reconstruction problem – given a hypergraph H, decide whether there exists a graph F such that H is a G-structure of F. It has been proved that this problem is polynomial if $|V(G)| \leq 4$. We investigate the complexity of the problem for larger graphs G and prove that there are cases where this problem is NP-complete – in fact we prove that it is NP-complete for almost all graphs G.

2004-661 Z. Dvořák, D. Král' and O. Pangrác
Locally consistent constraint satisfaction problems

An instance of a constraint satisfaction problem is l-consistent if any l constraints of it can be simultaneously satisfied. For a fixed constraint type

P, $\rho_l(P)$ denotes the largest ratio of constraints which can be satisfied in any l-consistent instance. In this paper, we study locally consistent constraint satisfaction problems for constraints which are Boolean predicates. We determine the values of $\rho_l(P)$ for all l and all Boolean predicates which have a certain natural property which we call 1-extendibility as well as for all Boolean predicates of arity at most three. All our results hold for both the unweighted and weighted versions of the problem.

2004-662 A. Bagchi, A. Chaudhary, P. Kolman and J. Sgall

A Simple Combinatorial Proof of Duality of Multiroute Flows and Cuts

A classical flow is a nonnegative linear combination of unit flows along simple paths. A multiroute flow, first considered by Kishimoto and Takeuchi, generalizes this concept. The basic building blocks are not single paths with unit flows but rather tuples consisting of k edge disjoint paths, each path with a unit flow. A multiroute flow is a nonnegative linear combination of such tuples.

We present a simple combinatorial proof of the duality theorem for multiroute flows and cuts and its corollary which characterizes multiroute flows in terms of classical flows. Specifically, we show that a (classical) flow of size F is a k-flow if and only if the flow through every edge is at most F/k. This duality then immediately yields an efficient algorithm.

2004-663 Z. Dvořák

Two-factors in Oriented Graphs with Forbidden Transitions

The instance of the problem of finding 2-factors in an oriented graph with forbidden transitions consists of an oriented graph G and for each vertex v of G a graph H_v of forbidden transitions assigned to it. Vertices of H_v are the edges incident to v. An oriented 2-factor F of G is called *legal* if there is not a vertex v such that the two edges of F adjacent to it form an edge in H_v. Deciding whether a legal 2-factor exists in G is NP-complete in general. We investigate the case when the graphs of forbidden transitions are taken from some class C. We provide an exact characterization of classes C for that the problem is NP-complete. Specially we prove a dichotomy for this problem, i.e., that for any class C it is either polynomial or NP-complete.

2004-664 V. Jungić, J. Nešetřil and R. Radoičić
Rainbow Ramsey Theory

This paper presents an overview of the current state in research directions in the rainbow Ramsey theory. We list results, problems, and conjectures related to existence of rainbow arithmetic progressions in $[n]$ and $\mathbb{N}$. A general perspective on other rainbow Ramsey type problems is given.

2004-665 A. Bagchi, A. Chaudhary and P. Kolman
Short Length Menger's Theorem and Reliable Optical Routing

In the minimum path coloring problem, we are given a graph and a set of pairs of vertices of the graph and we are asked to connect the pairs by colored paths in such a way that paths of the same color are edge disjoint. In this paper we deal with a generalization of this problem where we are asked to connect each pair by a k edge disjoint paths of the same color. The objective is to minimize the number of colors. The reason for multiple paths between the same pair of vertices is to ensure fault tolerance of the connections. We propose an $O(k^2F) = O(k^2\Delta\alpha^{-1}\log n)$ approximation algorithm for this problem where F is the flow number of the graph, Δ is the maximum degree and α is the expansion. This is an improvement even for the special case $k = 1$ where, to our knowledge, the best bound known previously is weaker by a factor of $\log n$.

The underlying problem is that of finding several disjoint path between a given pair of vertices. Menger's theorem provides necessary and sufficient condition for existence of k such paths. However, it does not say anything about the length of the paths whereas in communication problems the number of links used is an issue. We show that any two k-connected vertices are connected by k edge disjoint paths of average length $O(kF)$ which improves an earlier result of Galil and Yu 1995 for several classes of graphs. In fact, this is only a corollary of a stronger result for multicommodity flow on networks with unit edge capacities: any multicommodity flow with k units for each commodity can be rerouted such that the flow for each commodity is shipped through k-tuples of edge disjoint paths of average length $O(kF)$ without exceeding the capacity constraints significantly.

2004-666 J. Nešetřil and Y. Nigussie
Minimal Universal and Dense Minor Closed Classes

We study the homomorphism (coloring) order induced on minor-closed classes. In Hubička and Nešetřil (2003), the minor-closed class $\mathcal{P}$ of directed paths is shown to be universal and in Nešetřil and Zhu (1996), $\mathcal{P}$ is shown to contain a dense subset. In this note we prove $\mathcal{P}$ is a unique minimal class of oriented graphs which is both universal and dense. Moreover, we show a dichotomy result for any minor-closed class $\mathcal{K}$ of directed trees: $\mathcal{K}$ is either universal or it is wqo. We also prove structure theorems about K_4-minor-free undirected graphs, in an attempt to determine the minimal universal and dense minor-closed classes of undirected graphs.

2004-667 R. Naserasr and Y. Nigussie
On the new reformulation of Hadwiger's conjecture

Assuming that every minor closed class of graphs contains a maximum with respect to the homomorphism order, we prove that such a maximum must be homomorphically equivalent to a complete graph. This proves that Hadwiger's conjecture is equivalent to say that every minor closed class of graphs contains a maximum with respect to homomorphism order. This later conjecture one is one of two conjectures introduced by J. Nešetřil and P. O. De Mendez in an effort to refine Hadwiger's conjecture. Let $\mathcal{F}$ be a finite set of 2-connected graphs, and let $\mathcal{C}$ be the class of graph with no minor from $\mathcal{F}$. We prove that if $\mathcal{C}$ has a maximum, then any maximum of $\mathcal{C}$ must be homomorphically equivalent to a complete graph. Finally we introduce yet another reformulation of the Hadwiger's conjecture.

2004-668 B. Banaschewski, E. Giuli and A. Pultr
Epimorphisms of Uniform Frames

It is shown that some familiar properties of epimorphisms in the category of frames cary over to the category of uniform frames. This is achieved by suitably enriching certain frame homomorphisms to uniform frame homomorphisms.

2004-669 Z. Dvořák
Eulerian tours in graphs with forbidden transitions and bounded degree

We study a problem of finding an Eulerian tour in a graph with forbidden transitions. This problem was proved to be NP-complete by Maxová, Nešetřil 2002, but their construction requires the degrees of the graph to be unbounded. We prove that the problem is NP-complete even for graphs with degree at most four. We also investigate some cases in that the problem can be solved in a polynomial time.

2004-670 G. Tóth and P. Valtr
The Erdos-Szekeres theorem: upper bounds and related results

Let $ES(n)$ denote the least integer such that among any $ES(n)$ points in general position in the plane there are always n in convex position. In 1935, P. Erdős and G. Szekeres showed that $ES(n)$ exists and $ES(n) \leq \binom{2n-4}{n-2}+1$. About 62 years later, the upper bound has been slightly improved by Chung and Graham, a few months later it was further improved by Kleitman and Pachter, and another few months later it was further improved by the present authors. Here we review the original proof of Erdős and Szekeres, the improvements, and finally we combine the methods of the first and third improvements to obtain yet another tiny improvement.

We also briefly review some of the numerous results and problems related to the Erdős–Szekeres theorem.

2004-671 P. Valtr
Open caps and cups in planar point sets

A *configuration* is a finite set of points in the plane such that no 3 points lie on a line and no 2 points have the same x-coordinate. Let X be a configuration and let $p_1, \ldots, p_k$ be k points of X ordered according to the increasing x-coordinate. For $i = 1, \ldots, k-1$, let s_i be the slope of the line $p_i p_{i+1}$. The set $P = \{p_1, \ldots, p_k\}$ is a *k-cap* or a *k-cup*, if the sequence $s_1, s_2, \ldots, s_{k-1}$ is decreasing or increasing, respectively. The set $P = \{p_1, \ldots, p_k\}$ is *open (in X)*, if no point $p \in X$ with $x(p_1) < x(p) < x(p_k)$ lies above the polygonal line $p_1 p_2 \ldots p_k$. We prove that for every $k, l \geq 2$ there is an integer $f(k,l)$ such that any configuration of size $\geq f(k,l)$ contains an open k-cap or an open l-cup. This can be seen as a generalization of the Erdős-Szekeres theorem. It implies results on empty polygons in k-convex configurations proved by Károlyi *et al.* 2001, Kun and Lippner 2003, and Valtr 2002 (a configuration is *k-convex*, if it determines no triangle with more than k points in the interior). Another immediate corollary is that for any $k, l \geq 2$ any sufficiently large configuration with no (open) k-cap contains an empty l-gon. We give double–exponential lower and upper bounds on $f(k,l)$.

2004-672 J. Nešetřil, J. Solymosi and P. Valtr
A Ramsey property of planar graphs

We prove the following colored version of the well-known result of Wagner and Fáry. Suppose that the line segments of the plane are partitioned into finitely many classes $C_1, \dots, C_k$. Then for some C_i, every planar graph G has a crossing-free drawing in the plane such that all its edges are drawn by segments belonging to C_i. If there is only one C_i with this property, then in fact this C_i contains a drawing of any graph (with possible crossings). Furthermore, all this is true also if we distinguish topologically non-isomorphic drawings of a graph. We also give a generalization of these results to so-called pseudoplanar graphs.

2004-673 K. J. Swanepoel and P. Valtr
The unit distance problem on spheres

For any $D > 1$ and for any $n \geq 2$ we construct a set of n points on a sphere in $\mathbb{R}^3$ of diameter D determining at least $cn\sqrt{\log n}$ unit distances. This improves a previous lower bound of Erdős, Hickerson and Pach (1989). We also construct a set of n points in the plane not containing collinear triples or the vertices of a parallelogram and determining at least $cn\sqrt{\log n}$ unit distances.

2004-674 I. Bárány and P. Valtr
Planar point sets with a small number of empty convex polygons

A subset A of a finite set P of points in the plane is called an *empty polygon*, if each point of A is a vertex of the convex hull of A and the convex hull of A contains no other points of P. We construct a set of n points in general position in the plane with only $\approx 1.62n^2$ empty triangles, $\approx 1.94n^2$ empty quadrilaterals, $\approx 1.02n^2$ empty pentagons, and $\approx 0.2n^2$ empty hexagons.

2004-675 J. Hubička and J. Nešetřil
Finite Presentation of Homogeneous Graphs, Posets and Ramsey Classes

It is commonly believed that one can prove Ramsey properties only for simple and "well behaved" structures. This is supported by the link of Ramsey classes of structures with homogeneous structures. We outline this correspondence in the context of the Classification Programme for Ramsey classes. As particular instances of this approach one can characterize all Ramsey classes of graphs, tournaments and partial ordered sets and also fully characterize all monotone Ramsey classes of relational systems (of any type). On the other side of this spectrum many homogeneous structures allow a concise description (called here a finitary presentation) by means of all finite models of a suitable theory. Extending classical work of Rado (for the random graph) we find a finitary presentation for each of the above classes where the classification problem is solved: (undirected) graphs, tournaments and partially ordered sets. The main result of the paper is a construction of classes $\mathcal{P}_{\in}$ and $\mathcal{P}_f$ of finite structures which are isomorphic to the generic (i.e. homogeneous and universal) partially ordered set. Somehow surprisingly, the structure $\mathcal{P}_{\in}$ extends Conway's surreal numbers and their linear ordering.

2004-676 D. Král' and O. Pangrác

An Asymptotically Optimal Linear-Time Algorithm for Locally Consistent Constraint Satisfaction Problems

An instance of a constraint satisfaction problem is l-consistent if any l constraints of it can be simultaneously satisfied. For a set Π of constraint types, $\rho_l(\Pi)$ denotes the largest ratio of constraints which can be satisfied in any l-consistent instance composed by constraints from the set Π. We study the asymptotic behavior of $\rho_l(\Pi)$ for sets Π consisting of Boolean predicates. The value $\rho_\infty(\Pi) := \lim\limits_{l\to\infty} \rho_l(\Pi)$ is determined for all such sets Π. Moreover, we design a robust deterministic algorithm (for a fixed set Π of predicates) running in time linear in the size of the input and $1/\varepsilon$ which finds either an inconsistent set of constraints (of size bounded by the function of ε) or a truth assignment which satisfies the fraction of at least $\rho_\infty(\Pi) - \varepsilon$ of the given constraints. Most of our results hold for both the unweighted and weighted versions of the problem.

2004-677 J. Nešetřil

Metric Spaces are Ramsey

We prove that the class of all finite ordered metric spaces is a Ramsey class. This solves a problem of Kechris, Pestov and Todorćevic.

2004-678 R. N. Ball, A. Pultr and J. Sichler
Combinatorial trees in Priestley spaces

We show that prohibiting a combinatorial tree in the Priestley duals determines an axomatizable class of distributive lattices. On the other hand, prohibiting n-crowns with $n \geq 3$ does not. Given what is known about the diamond, this is another strong indication that this fact characterizes combinatorial trees. We also discuss varieties of 2-Heyting algebras in this context.

2004-679 D. Král'
Polynomial-size binary decision diagrams for the Exactly half-d-hyperclique problem reading each input bit twice

Binary decision diagrams (BDDs) are graph-based data structures representing Boolean functions; ℓ-BDDs are BDDs with an additional restriction that each input bit can be tested at most ℓ times. A d-uniform hypergraph H on N vertices is an exactly half-d-hyperclique if $N/2$ of its vertices form a hyperclique and the remaining vertices are isolated. Wegener [J. ACM 35(2) (1988), 461–471] conjectured that there is no polynomial-size $(d-1)$-BDD for the Exactly half-d-hyperclique problem. We disprove this conjecture by constructing polynomial-size 2-BDDs for the Exactly half-d-hyperclique problem for every $d \geq 2$. Our construction is based on a new idea involving log-space algorithms with faulty inputs.

2004-680 B. Grünbaum, T. Kaiser, D. Král' and M. Rosenfeld
Equipartite polytopes and graphs

A graph G of even order is *weakly equipartite* if for any partition of its vertex set into subsets V_1 and V_2 of equal size the induced subgraphs $G[V_1]$ and $G[V_2]$ are isomorphic. A polytope P with $2n$ vertices is *equipartite* if for any partition of its vertex set into two equal-size sets V_1 and V_2, there is a symmetry of the polytope P that maps V_1 onto V_2.

A complete characterization of equipartite graphs is provided. This is then used to prove that an equipartite polytope in $\mathbb{R}^d$ can have at most $2d+2$ vertices. We prove that this bound is sharp.

2004-681 V. Jungić
On Brown's Conjecture on Accessible Sets

In this note we use a sequence constructed by H. Furtsenberg in 1981 to disprove the following conjecture posted by T. Brown: If a set of positive numbers L is such that for any finite coloring of $\mathbb{N}$ there are arbitrarily long monochromatic sequences with all gaps in L, then for any finite coloring of $\mathbb{N}$ there are arbitrarily long monochromatic arithmetic progressions whose common differences belong to L.

2004-682 M. Bálek, ed.
X. Midsummer Combinatorial Workshop

2004-683 Z. Dvořák, R. Škrekovski and T. Valla
Four Gravity Results

The gravity of a graph H in a given family of graphs $\mathcal{H}$ is the greatest integer n with the property that for every integer m, there exists a supergraph $G \in \mathcal{H}$ of H such that each subgraph of G, which is isomorphic to H, contains at least n vertices of degree $\geq m$ in G. Madaras and Škrekovski introduced this concept and showed that the gravity of the path P_k on $k \geq 2$ vertices is $k-2$ for each $k \neq 5, 7, 8, 9$. They conjectured that for each of the four excluded cases the gravity is $k-3$. In this paper we show that this holds.

2004-684 M. Janata and J. Szabó
Generalized star packing problems I.

Results of Las Vergnas, Hell and Kirkpatrick imply that packing an undirected graph by a set of stars is polynomial if and only if this set is $\{S_1, S_2, \ldots, S_k\}$. That is, if we forbide some stars from this 'sequential' set of stars then we get an NP-complete problem. This arises the question if it is possible to allow some other new graphs to be a component of the packing to maintain polynomiality. In this and in the sibling paper "... II." we show two types of graph sets which can be added to the packing to maintain polynomiality. These new graphs (called 'superstars') are trees such that some of the leaf vertices of a star are replaced by forbidden stars of the packing. These two papers show different methods for solving the two type of packing problems. The present paper introduces an Edmonds-type algorithm together with a Berge-type theorem.

2004-685 T. Feder, P. Hell, D. Král' and J. Sgall
Two Algorithms for General List Matrix Partitions

List matrix partitions are restricted binary list constraint satisfaction problems which generalize list homomorphisms and many graph partition problems arising, e.g., in the study of perfect graphs. Most of the existing algorithms apply to concrete small matrices, i.e., to partitions into a small number of parts. We focus on two general classes of partition problems, provide algorithms for their solution, and discuss their implications.

The first is an $O(n^{r+2})$-algorithm for the list M-partition problem where M is any r by r matrix over subsets of $\{0,1\}$, which has the "bisplit property". This algorithm can be applied to recognize so-called k-bisplit graphs in polynomial time, yielding a solution of an open problem.

The second is an algorithm running in time $(rn)^{O(\log r \log n/\log\log n)}$ for the list M-partition problem where M is any $r \times r$ matrix over subsets of $\{0,1,\ldots,q-1\}$, with the "incomplete property". This algorithm applies to all non-NP-complete list M-partition problems with $r=3$, and it improves the running time of the quasi-polynomial algorithm for the "stubborn problem", and for the "edge-free three-colouring problem".

2004-686 M. Mareš, ed.
IX. Midsummer Combinatorial Workshop

2004-687 M. Chrobak, P. Kolman and J. Sgall
The Greedy Algorithm for the Minimum Common String Partition Problem

In the Minimum Common String Partition problem (MCSP) we are given two strings on input, and we wish to partition them into the same collection of substrings, minimizing the number of the substrings in the partition. This problem is NP-hard, even for a special case, denoted 2-MCSP, where each letter occurs at most twice in each input string. We study a greedy algorithm for MCSP that at each step extracts a longest common substring from the given strings. We show that the approximation ratio of this algorithm is between $\Omega(n^{0.43})$ and $O(n^{0.69})$. In case of 2-MCSP, we show that the approximation ratio is equal to 3. For 4-MCSP, we give a lower bound of $\Omega(\log n)$.

2004-688 G. J. Woeginger and J. Sgall
On the Complexity of Cake Cutting

In the cake cutting problem, $n \geq 2$ players want to cut a cake into n pieces so that every player gets a 'fair' share of the cake by his own measure. Two results are given.

A positive result: For every $\varepsilon > 0$, there exists a cake division scheme for n players that uses at most $c_\varepsilon n$ cuts (with free evaluation queries), and in which each player can enforce to get a share of at least $(1-\varepsilon)/n$ of the cake according to his own private measure.

A negative result: In a certain cake cutting model, every fair cake division protocol for n players must use $\Omega(n \log n)$ cuts and evaluation queries in the worst case. Up to a small constant factor, this lower bound matches a corresponding upper bound in the same model by Even & Paz from 1984.

2004-689 D. Král' and L. Stacho

Hamiltonian threshold for strong products of graphs

We prove that the strong product of any at least $(\ln 2)\Delta + O(\sqrt{\Delta})$ nontrivial connected graphs of maximum degree at most Δ is pancyclic. The obtained result is asymptotically best possible since the strong product of $\lfloor (\ln 2)D \rfloor$ stars $K_{1,D}$ is not even hamiltonian.

2004-690 A. Goldstein, P. Kolman and J. Zheng

Minimum Common String Partition Problem: Hardness and Approximations

String comparison is a fundamental problem in computer science, with applications in areas such as computational biology, text processing or compression. In this paper we address the minimum common string partition problem, a string comparison problem with tight connection to the problem of sorting by reversals with duplicates, a key problem in genome rearrangement.

A *partition* of a string A is a sequence $\mathcal{P} = (P_1, P_2, \ldots, P_m)$ of strings, called the *blocks*, whose concatenation is equal to A. Given a partition $\mathcal{P}$ of a string A and a partition $\mathcal{Q}$ of a string B, we say that the pair $\langle \mathcal{P}, \mathcal{Q} \rangle$ is a *common partition* of A and B if $\mathcal{Q}$ is a permutation of $\mathcal{P}$. The *minimum common string partition* problem (MCSP) is to find a common partition of two strings A and B with the minimum number of blocks. The restricted version of MCSP where each letter occurs at most k times in each input string, is denoted by k-MCSP.

In this paper, we show that 2-MCSP (and therefore MCSP) is NP-hard and, moreover, even APX-hard. We describe a 1.1037-approximation for 2-MCSP and a linear time 4-approximation algorithm for 3-MCSP. We are not aware of any better approximations.

2004-691 T. Kaiser, D. Král', R. Škrekovski and X. Zhu
The circular chromatic index of graphs of high girth

We show that for each $\varepsilon > 0$ and each integer $\Delta \geq 1$, there exists a number g such that for any graph G of maximum degree Δ and girth at least g, the circular chromatic index of G is at most $\Delta + \varepsilon$.

2004-692 E. Ondráčková, T. Valla (eds.)
Spring School on Combinatorics 2004 — Abstracts of Talks

2004-693 Z. Dvořák, V. Jelínek D. Král', J. Kynčl and M. Saks
Three Optimal Algorithms for Balls of Three Colors

We consider a game played by two players, Paul and Carol. Carol fixes a coloring of n balls with three colors. At each step, Paul chooses a pair of balls and asks Carol whether the balls have the same color. Carol truthfully answers yes or no. In the Plurality problem, Paul wants to find a ball with the most common color. In the Partition problem, Paul wants to partition the balls according to their colors. He wants to ask Carol the least number of questions to reach his goal. We find optimal deterministic and probabilistic strategies for the Partition problem and an asymptotically optimal probabilistic strategy for the Plurality problem.

2004-694 J. Kynčl, J. Pach and G. Tóth
Long Alternating Paths in Bicolored Point Sets

Given n red and n blue points in convex position in the plane, we show that there exists a noncrossing alternating path of length $n + c\sqrt{\frac{n}{\log n}}$. We disprove a conjecture of Erdős by constructing an example without any such path of length greater than $4n/3 + c'\sqrt{n}$.

2004-695 J. Šíma and J. Sgall
On the Non-Learnability of a Single Spiking Neuron

The computational complexity of training a single spiking neuron $\mathcal{N}$ with adjustable synaptic delays and binary coded inputs and output is studied. A synchronization technique is introduced so that the results concerning the non-learnability of spiking neurons with binary delays are generalized to arbitrary delays. In particular, the consistency problem for $\mathcal{N}$ with programmable delays and its approximation version are proven to be *NP*-complete. It follows that the spiking neurons with arbitrary synaptic delays are not properly PAC-learnable and do not allow robust learning unless $RP = NP$. In addition, the representation problem for $\mathcal{N}$, i.e., a question whether an n-variable Boolean function given in DNF (or as a disjunction of $O(n)$ threshold gates) can be computed by a spiking neuron, is shown to be *coNP*-hard.

2004-696 P. Kolman
Linear Time Approximation Algorithm for Sorting by Reversals with Bounded Number of Duplicates

For a string $A = a_1 \dots a_n$, a *reversal* $\rho(i,j)$, $1 \le i < j \le n$ transforms the string A into a string $A' = a_1 \dots a_{i-1} a_j a_{j-1} \dots a_i a_{j+1} \dots a_n$, that is, the reversal $\rho(i,j)$ reverses the order of symbols in the substring $a_i \dots a_j$ of A. In a case of signed strings, where each symbol is given a sign $+$ or $-$, the reversal operation also flips the sign of each symbol in the reversed substring. Given two strings, A and B, signed or unsigned, *sorting by reversals* (SBR) is the problem of finding the minimum number of reversals that transform the string A into the string B.

Traditionally, the problem was studied for permutations, that is, for strings in which every symbol appears exactly once. We consider a generalization of the problem, k-SBR, and allow each symbol to appear at most k times in each string, for some $k \ge 1$. The main result of the paper is a simple $O(k^2)$-approximation algorithm running in time $O(k \cdot n)$. For instances with $3 < k \le O(\sqrt{\log n \log^* n})$, this is the best known approximation algorithm for k-SBR and, moreover, it is faster than the previous best approximation algorithm. In particular, for $k = O(1)$ which is of interest for DNA comparisons, we have a linear time $O(1)$-approximation algorithm.

2004-697 J. Fiala, P. A. Golovach and J. Kratochvíl
Elegant distance constrained labelings of trees

In our contribution to the study of graph labelings with three distance constraints we introduce a concept of elegant labelings: labelings where labels appearing in a neighborhood of a vertex can be completed into intervals such that these intervals are disjoint for adjacent vertices.

We justify introduction of this notion by showing that use of these labelings provides good estimates for the span of the label space, and also provide a polynomial time algorithm to find an optimal elegant labeling of a tree for distance constraints $(p, 1, 1)$. In addition several computational complexity issues are discussed.

2004-698 J. J. Montellano-Ballesteros, A. Pór and R. Strausz
Tverberg-type theorems for separoids

Let S be a d-dimensional separoid of $(k-1)(d+1)+1$ convex sets in some 'large-dimensional' Euclidean space $\mathbb{E}^N$. We prove a theorem that can be interpreted as follows: *if the separoid S can be mapped with a monomorphism to a d-dimensional separoid of points P in general position, then there exists a k-colouring $\varsigma\colon S \to K_k$ such that, for each pair of colours $i, j \in K_k$, the convex hulls of their preimages do intersect —they are not separated.* Here, by a monomorphism we mean an injective function such that the preimage of separated sets are separated. In a sense, this result is 'dual' to the Hadwiger-type theorems proved by Goodman & Pollack (1988) and Arocha, Bracho, Montejano, Olivereros & Strausz (2002).

We also introduce $\vartheta(k, d)$, the minimum number n such that all d-dimensional separoids of order at least n can be k-coloured as before. By means of examples and explicit colourings, we show that for all $k > 2$ and $d > 0$,

$$(k-1)(d+1)+1 < \vartheta(k, d) < \binom{k}{2}(d+1)+1.$$

Furthermore, by means of a probabilistic argument, we show that for each d there exists a constant $C = C(d)$ such that for all k, $\vartheta(k, d) \leq Ck \log k$.

2004-699 D. Zeps
Free Planar Graphs on Torus: examining triconnected graphs for unbounded augmentability

Free toroidal graphs are examined whether they may be augmented unboundedly retaining freeness. Two types of augment are distinguished where both so called punkah and ladder augments applied unboundedly can retain freeness for graphs that are not projective planar.

2004-700 T. Kaiser and R. Škrekovski
Cycles intersecting edge-cutsof prescribed sizes

We prove that every cubic bridgeless graph G contains a 2-factor which intersects all (minimal) edge-cuts of size 3 or 4. This generalizes an earlier result of the authors, namely that such a 2-factor exists provided that G is planar. As a further extension, we show that every graph contains a cycle (a union of edge-disjoint circuits) that intersects all edge-cuts of size 3 or 4. Motivated by this result, we introduce the concept of a coverable set of integers and discuss a number of questions, some of which are related to classical problems of graph theory such as Tutte's 4-flow conjecture or the Dominating cycle conjecture.

2004-701 R. Babilon, V. Jelínek, D. Král' and P. Valtr
Labelings of graphs with fixed and variable edge-weights

Motivated by $L(p,q)$-labelings of graphs, we introduce a notion of λ-graphs: a λ-graph G is a graph with two types of edges: 1-edges and x-edges. For a parameter $x \in [0,1]$, a proper labeling of G is a labeling of vertices of G by non-negative reals such that the labels of the end-vertices of a 1-edge differ by at least 1 and the labels of the end-vertices of an x-edge differ by at least x; $\lambda_G(x)$ is the smallest real such that G has a proper labeling by labels from the interval $[0, \lambda_G(x)]$.

We study properties of the function $\lambda_G(x)$ for finite and infinite λ-graphs and establish the following results: if the function $\lambda_G(x)$ is well-defined, then it is a piecewise linear function of x with finitely many linear parts. Surprisingly, the set $\Lambda(\alpha,\beta)$ of all functions λ_G with $\lambda_G(0) = \alpha$ and $\lambda_G(1) = \beta$ is finite for any $\alpha \leq \beta$. We also prove a tight upper bound on the number of segments for finite λ-graphs G with convex functions $\lambda_G(x)$.

2004-702 D. Král'
Channel assignment problem with variable weights

A λ-graph G is a (finite or infinite) graph with k types of edges, x_1-edges, ..., x_k-edges. A labeling c of the vertices of G by non-negative reals is proper with respect to reals $x_1, \ldots, x_k$, if the labels of the end-vertices of an x_i-edge differ by at least x_i. The span of the labeling c is the supremum of the labels used by c. The λ-function $\lambda_G(x_1, \ldots, x_k)$ is the infimum of the spans of all the proper labelings with respect to $x_1, \ldots, x_k$.

We show that the λ-function of any graph G is piecewise linear in $x_1, \ldots, x_k$ with finitely many linear parts. Moreover, we show that for every integers k and Λ, there exist constants $C_{k,\Lambda}$ and $D_{k,\Lambda}$ such that the λ-function of every λ-graph G with k types of edges and chromatic number at most Λ is comprised of at most $C_{k,\Lambda}$ linear parts, and the coefficients of $x_1, \ldots, x_k$ of the linear functions comprising $\lambda_G(x_1, \ldots, x_k)$ are integers between 0 and $D_{k,\Lambda}$. Among others, our results yield proofs of Piecewise Linearity Conjecture, Coefficient Bound Conjecture and Delta Bound Conjecture of Griggs and Jin.

2004-703 R. N. Ball, A. Pultr and J. Sichler
The Mysterious 2-Crown

We show that the 2-crown is not coproductive, which is to say that the class of those bounded distributive lattices whose Priestley spaces lack any copy of the 2-crown is not productive. We do this by first exhibiting a general construction to handle questions of this sort. We then use a particular instance of this constrution, along with some of the combinatorial features of projective planes, to show that the 2-crown is not coproductive.

2004-704 M. Bálek and J. Nešetřil
Towards Mathematical Aesthetics

We discuss a possibility of visual data global analysis with respect to the aesthetic (harmonious) criteria. We explain our approach that is mathematical based and expressed by the Hereditary Entropy Thesis. We give some computational evidence which outlines aims and indicates meaning of this project.

2004-705 J. Nešetřil and R. Strausz
Universality of Separoids

A *separoid* is a symmetric relation $\dagger \subset \binom{2^S}{2}$ defined on disjoint pairs of subsets of a given set S such that it is closed as a filter in the canonical partial order induced by the inclusion (i.e., $A \dagger B \preceq A' \dagger B' \iff A \subseteq A'$ and $B \subseteq B'$). We introduce the notion of *homomorphism* as maps which preserve the so-called "minimal Radon partitions" and show that separoids, endowed with these maps, admits an embedding from the category of all finite graphs. This proves that separoids constitute a *countable universal partial order*. Furthermore, by embedding also all hypergraphs (all set systems) into such a category, we prove a "stronger" universality property.

We further study some structural aspects of the category of separoids. We completely solve the *density* problem for (all) separoids as well as for separoids of points. We also generalise the classic Radon's theorem in a categorical setting as well as Hedetniemi's product conjecture (which can be proved for oriented matroids).

2004-706 P. Nejedlý

Choosability of Graphs with Infinite Sets of Forbidden Differences

The notion of the list-T-coloring is a common generalization of the T-coloring and the list-coloring. Given a set of non-negative integers T, a graph G and a list-assignment L, the graph G is said to be T-colorable from the list-assignment L if there exists a coloring c such that the color $c(v)$ of each vertex v is contained in its list $L(v)$ and $|c(u) - c(v)| \notin T$ for any two adjacent vertices u and v. The T-choice number of a graph G number is the minimum integer k such that G is T-colorable for any list-assignment L which assigns each vertex of G a list of at least k colors.

We focus on list-T-colorings with infinite sets T. In particular, we show that for any fixed set T of integers, all graphs have finite T-choice number if and only if the T-choice number of K_2 is finite. For the case when the T-choice number of K_2 is finite, two upper bounds on the T-choice number of a graph G are provided: one being polynomial in the maximum degree of the graph G, and one being polynomial in the T-choice number of K_2.

2004-707 W. Krauth and M. Loebl

Jamming and geometric representation of graphs

We expose a relationship between jamming and a generalisation of Tutte's barycentric embedding. This provides a basis for the systematic treatment of jamming and maximal packing problems on two-dimensional surfaces.

2004-708 M. Janata, M. Loebl and J. Szabó

The Edmonds-Gallai Decomposition for the k-Piece Packing Problem

Generalizing Kaneko's long path packing problem, Hartvigsen, Hell and Szabó consider a new type of undirected graph packing problem, called the *k-piece packing problem.* A k-piece is a simple, connected graph with highest degree exactly k so in the case $k = 1$ we get the classical matching problem. They give a polynomial algorithm, a Tutte-type characterization and a Berge-type minimax formula for the k-piece packing problem. However, they leave open the question of an Edmonds-Gallai type decomposition. This paper fills this gap by describing such a decomposition. We also prove that the vertex sets coverable by k-piece packings have a certain matroidal structure.

2004-709 R. A. Brualdi, M. Loebl and O. Pangrác
Perfect Matching Preservers

For two bipartite graphs G and G', a bijection $\psi : E(G) \to E(G')$ is called a (perfect) matching preserver provided that M is a perfect matching in G if and only if $\psi(M)$ is a perfect matching in G'. We characterize bipartite graphs G and G' which are related by a matching preserver and the matching preservers between them.

2004-710 M. Bálek and R. Šámal (eds.)
Abstracts of KAM-DIMATIA Series Year 2002

2004-711 M. Bálek and R. Šámal (eds.)
Abstracts of KAM-DIMATIA Series Year 2003

2004-712 R. Šámal and J. Nešetřil
Tension continuous maps—their structure and applications

We consider mappings between edge sets of graphs that lift tensions to tensions. Such mappings are called tension-continuous mappings (shortly TT mappings). Existence of TT mapping induces a (quasi)order on the class of graphs, which seems to be an essential extension of the homomorphism order. We prove that TT quasiorder is dense and universal. We also discuss the relation between this quasiorder and homomorphism order. We stress the similarities and the differences in both deterministic and random setting.

2004-713 J. Kára, A. Pór and D. R. Wood
On the Chromatic Number of the Visibility Graph of a Set of Points in the Plane

The visibility graph $\mathcal{V}(P)$ of a point set $P \subseteq \mathbf{R}$ has vertex set P, such that two points $v, w \in P$ are adjacent whenever there is no other point in P on the line segment between v and w. We study the chromatic number of $\mathcal{V}(P)$. We characterise the 2- and 3-chromaric visibility graphs. It is an open problem whether the chromatic number of a visibility graph is bounded by its clique number. Our main result is a super-polynomial lower bound on the chromatic number (in terms of the clique number).

2004-714 J. Nešetřil and C. Tardif
Short answers to exponentially long questions: Extremal aspects of homomorphism duality

We prove that there exists a constant k such that for every n there exist directed core graphs H with at least 2^n vertices such that a directed graph G is H-colourable if and only if every subgraph of G with at most $kn\log(n)$ vertices is H-colourable. Our examples show that in general the "duals of relational structures" in the sense of [Nešetřil, Tardif: Duality Theorems for Finite Structures, 2000] can have superpolynomial size. The construction given in [Nešetřil, Tardif, 2000] gives a double exponential upper bound for such a construction. Here we improve this to an exponential upper bound.

2004-715 D. R. Wood
Drawing a Graph in a Hypercube

A *d-dimensional hypercube drawing* of a graph represents the vertices by distinct pooints in $\{0,1\}^d$, such that the line-segments representing the edges do not cross. We study lower and upper bounds on the minimum number of dimensions in hypercube drawing of a given graph. This parameter turns out to be related to Sidon sets and antimagic injections.

2004-716 D. R. Wood
Vertex Partitions of Chordal Graphs

A *k-tree* is a chordal graph with no $(k+2)$-clique. An *l-tree-partition* of a graph G is a vertex partition of G into 'bags', such that contracting each bag to a single vertex gives an l-tree (after deleting loops and replacing parallel edges by a single edge). We prove that for all $k \geq l \geq 0$, every k-tree has an l-tree-partition in which every bag induces a connected $\lfloor k/(l+1) \rfloor$-tree. An Analogous result is proved for oriented k-trees.

2004-717 J. Nešetřil and Y. Nigussie
Density of Universal classes in $\mathcal{G}/K_4$

A class of graphs $\mathcal{C}$ ordered by the homomorphism relation is *universal* if every countable partial order can be embedded in $\mathcal{C}$. It was shown by

Hedrlín (1969) that the class $\mathcal{C}_k$ of k-colorable graphs, for any fixed $k \geq 3$, induces a universal partial order. A surprisingly small subclass of $\mathcal{C}_3$ which is a proper subclass of K_4-minor-free graphs $(\mathcal{G}/K_4)$ is shown to be universal by Hubička and Nešetřil (2003). We have shown that if we assume the class of graphs are closed under the minor relation, then the results of Hubička and Nešetřil is a minimal set.

2004-718 Z. Dvořák and R. Škrekovski
A Theorem About a Contractible and Light Edge

In 1955 Kotzig proved that every planar 3-connected graph contains an edge such that sum of degrees of its endvertices is at most 13. Moreover, if the graph does not contain 3-vertices, then this sum is at most 11. Such an edge is called light. The well-known result of Steinitz that the 3-connected planar graphs are precisely the skeletons of 3-polytopes, gives an additional trump to Kotzig's theorem. On the other hand, in 1961, Tutte proved that every 3-connected graph, distinct from K_4, contains a contractible edge. In this paper, we strengthen Kotzig's theorem by showing that every 3-connected planar graph distinct from K_4 contains an edge which is both light and contractible. A consequence is that every 3-polytope can be constructed from the Tetrahedron by a sequence of splittings of vertices of degree at most 11.

2004-719 M. Bálek and R. Šámal (eds.)
Abstracts of KAM-DIMATIA Series Year 2004
