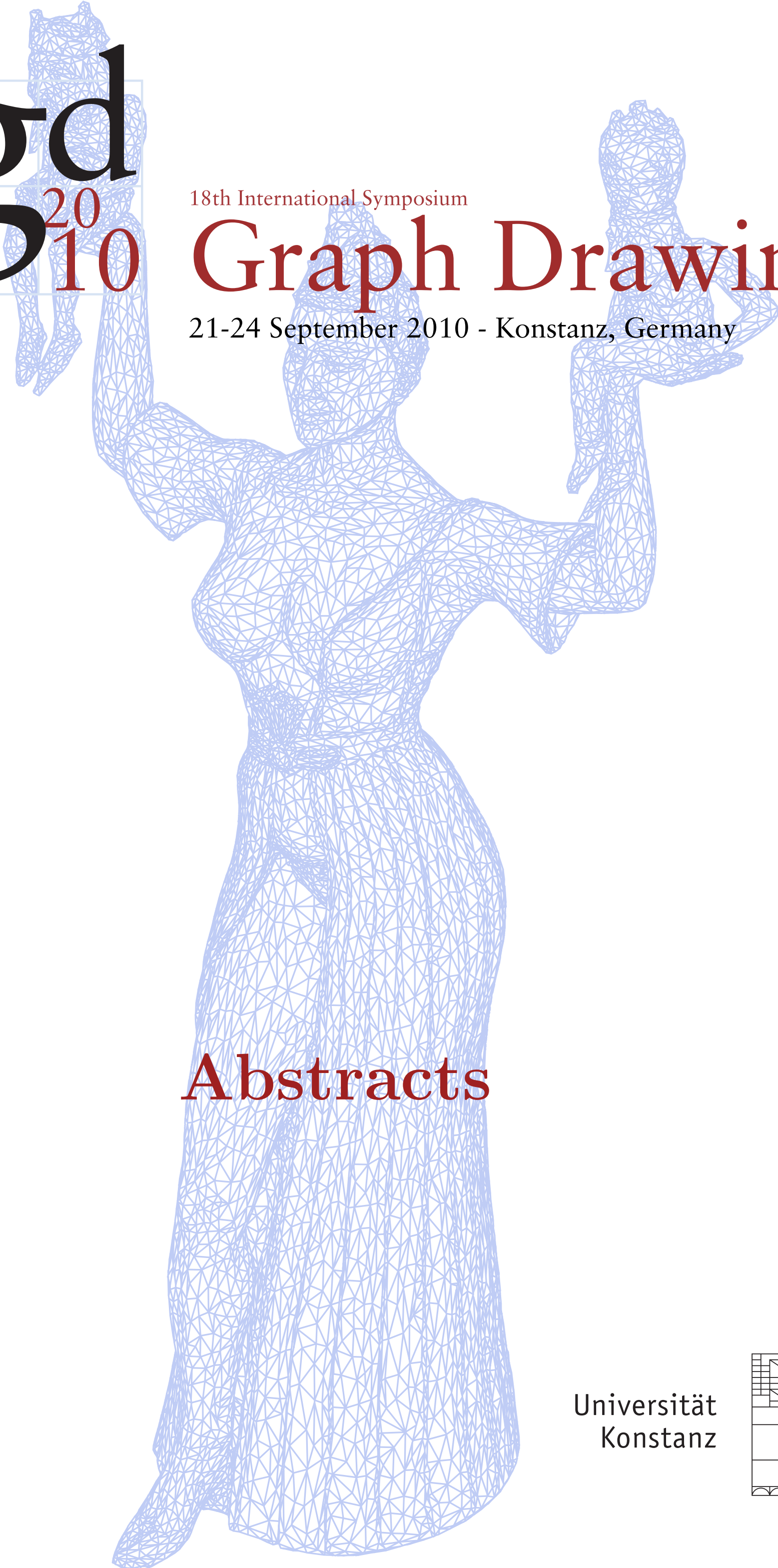
gd 2010

18th International Symposium

Graph Drawing

21-24 September 2010 - Konstanz, Germany



Abstracts

Universität
Konstanz

Wednesday, September 22, 2010

09:00-10:30 Welcome and invited talk

09:00 **Ulrich Rüdiger, Rector of the University of Konstanz.** **Welcome Address.**

09:15 **Carsten Thomassen.** **Graph Decomposition.** János Barát and I made the following conjecture: For every tree T, there is a natural number k_T such that every k_T-edge-connected graph of size divisible by $|E(T)|$ has an edge-decomposition into subgraphs each isomorphic to T. The conjecture is trivial when T has at most two edges. When we made the conjecture we could not prove it for one single tree with three or more edges. However, we showed that the conjecture holds for the claw (the star with three edges) provided Tutte's 3-flow conjecture is true. In fact, when restricted to the claw, our conjecture is equivalent to the weakening of Tutte's 3-flow conjecture, suggested by Jaeger, that every graph of sufficiently high (but fixed) edge-connectivity has an orientation such that each vertex has the same indegree and outdegree when these numbers are reduced modulo 3. A few years ago, I verified the conjecture for the path with four edges, and later for the path with three edges. I have now verified the conjecture for an infinite family of trees.

11:00-12:15 Session A — Chair: P. Mutzel

11:00 **P. Angelini, E. Colasante, G. Di Battista, F. Frati, M. Patrignani.** **Monotone Drawings of Graphs.** We study a new standard for visualizing graphs: A monotone drawing is a straight-line drawing such that, for every pair of vertices, there exists a path that monotonically increases with respect to some direction. We show algorithms for constructing monotone planar drawings of trees and biconnected planar graphs, we study the interplay between monotonicity, planarity, and convexity, and we outline a number of open problems and future research directions.

11:25 **C. Duncan, D. Eppstein, M. Goodrich, S. Kobourov, M. Nöllenburg.** **Lombardi Drawings of Graphs.** We introduce the notion of Lombardi graph drawings, named after the American abstract artist Mark Lombardi. In these drawings, edges are represented as circular arcs rather than as line segments or polylines, and the vertices have perfect angular resolution: the edges are equally spaced around each vertex. We describe algorithms for finding Lombardi drawings of regular graphs, graphs of bounded degeneracy, and certain families of planar graphs.

11:50 D. Richter. **How to draw a Tait-colored graph.** It is shown that every graph which is bipartite, cubic, and 3-connected has a drawing in the real projective plane in which every edge is represented by a line segment, all the lines supporting the edges sharing a common color are concurrent, and all of the supporting lines are distinct. This result, a generalization of Pappus's classical hexagon theorem, follows as an immediate corollary to this author's result on prescribability of planar point configurations having so-called "ghost symmetries". It is also shown that the converse of this result is far from true, and some examples are provided which demonstrate the complications which arise in an attempt to find a combinatorial characterization of graphs which admit this type of drawing.

14:00-15:30 Session B Chair: G. Liotta

14:00 G. Da Lozzo, G. Di Battista, F. Ingrassia. **Drawing Graphs on a Smartphone.** We present a system for the visualization of relational information on the smartphones. It is implemented on the iPhone and on the Google Android platforms and is based on a new visualization paradigm that poses interesting algorithmic challenges. We also show customizations of the system to explore and visualize popular social networks.

14:25 E. Ackerman, R. Fulek, C. D. Tóth. **On the size of graphs that admit polyline drawings with few bends and crossing angles.** We consider graphs that admit polyline drawings where all crossings occur at the same angle $\alpha \in (0, \frac{\pi}{2}]$. We prove that every graph on n vertices that admits such a polyline drawing with at most two bends per edge has $O(n)$ edges. We also provide several extensions that might be of independent interest.

14:50 R. Fulek, J. Pach. **A computational approach to Conway's thrackle conjecture.** A drawing of a graph in the plane is called a *thrackle* if every pair of edges meets precisely once, either at a common vertex or at a proper crossing. Let $t(n)$ denote the maximum number of edges that a thrackle of n vertices can have. According to a 40 years old conjecture of Conway, $t(n) = n$ for every $n \geq 3$. For any $\epsilon > 0$, we give an algorithm terminating in $e^{O((1/\epsilon^2)\ln(1/\epsilon))}$ steps to decide whether $t(n) \leq (1+\epsilon)n$ for all $n \geq 3$. Using this approach, we improve the best known upper bound, $t(n) \leq \frac{3}{2}(n-1)$, due to Cairns and Nikolayevsky, to $\frac{167}{117}n < 1.428n$.

15:15 M. van Kreveld. **The Quality Ratio of RAC Drawings and Planar Drawings of Planar Graphs.** We study how much better a right-angled crossing (RAC) drawing of a planar graph can be than a planar drawing of the same planar graph. We analyze the area requirement, the edge-length ratio, and the angular resolution. For the first two measures, a RAC drawing can sometimes be arbitrarily much better (in ratio) than any planar drawing, whereas for the third measure a RAC drawing can be 2.75 times as good.

16:00-17:15 Session C	Chair: M. Patrignani

16:00 W. Brunner, M. Matzeder. **Drawing Ordered $(k-1)$-ary Trees on k-Grids.** We explore the complexity of drawing (k-1)-ary trees on grids with k directions for k 4, 6, 8 and within a given area. This includes, e. g., ternary trees drawn on the orthogonal grid. For aesthetically pleasing tree drawings on these grids, we additionally present various restrictions similar to the common hierarchical case. We generalize the NP-hardness of minimal width in hierarchical drawings of ordered trees to (k-1)-ary trees on k-grids. In addition, we generalize the Reingold and Tilford algorithm to k-grids.

16:25 C. Duncan, D. Eppstein, M. Goodrich, S. Kobourov, M. Nöllenburg. **Drawing Trees with Perfect Angular Resolution and Polynomial Area.** We study methods for drawing trees with perfect angular resolution, i.e., with angles at each vertex, v, equal to 2/d(v). We show:

1. Any unordered tree has a crossing-free straight-line drawing with perfect angular resolution and polynomial area.
2. There are ordered trees that require exponential area for any crossing-free straight-line drawing having perfect angular resolution.
3. Any ordered tree has a crossing-free Lombardi-style drawing (where each edge is represented by a circular arc) with perfect angular resolution and polynomial area.

Thus, our results explore what is achievable with straight-line drawings and what more is achievable with Lombardi-style drawings, with respect to drawings of trees with perfect angular resolution.

16:50 **D. Eppstein, M. Löffler, E. Mumford, M. Nöllenburg.** **Optimal 3D Angular Resolution for Low-Degree Graphs.** We show that every graph of maximum degree three can be drawn in three dimensions with at most two bends per edge, and with 120 angles between any two edge segments meeting at a vertex or a bend. We show that every graph of maximum degree four can be drawn in three dimensions with at most three bends per edge, and with 109.5 angles, i.e., the angular resolution of the diamond lattice, between any two edge segments meeting at a vertex or bend.

Thursday, September 23, 2010

09:00-10:30 Session D Chair: P. Eades

09:00 D. Archambault, H. C. Purchase, B. Pinaud. **Difference Map Readability for Dynamic Graphs.** Difference maps are one way of depicting changes between timeslices in a dynamic graph. They highlight, using colour, the nodes and edges that were added, removed, or persisted between the two time periods and are calculated using every pair of adjacent timeslices.

Although there has been some work that uses difference maps for visualization, no user study has been performed to gauge their performance. In this paper, we present a user study to evaluate the effectiveness of difference maps over simply presenting the evolution of the dynamic graph over time on three interfaces. We found evidence that difference maps produced significantly fewer errors when determining the number of edges inserted or removed from a graph as it evolves over time. Also, difference maps were significantly preferred on all questions.

09:25 K. Klein, G. Bartel, C. Gutwenger, P. Mutzel. **An Experimental Evaluation of Multilevel Layout Methods.** Applying the multilevel paradigm to energy-based layout algorithms can improve both the quality of the resulting drawings as well as the running time of the layout computation. In order to do this, approaches for the different multilevel phases refinement, placement, layout, and optionally scaling and postprocessing need to be implemented. A number of multilevel layout algorithms has been proposed already, which differ in the way these phases are realized. We present an experimental study that investigates the influence of varying combinations with respect to running time and quality criteria.

09:50 W. Didimo, G. Liotta, S. A. Romeo. **Topology-driven Force-directed Algorithms.** This paper studies the problem of designing graph drawing algorithms that guarantee good trade-offs in terms of both number of edge crossings, and crossing angle resolution, and geodesic edge tendency. It describes two heuristic methods designed within the topology-driven force-directed framework that combines two classical graph drawing approaches: the force-directed approach and the planarization-based approach. An extensive experimental analysis on two different test suites of graphs shows the effectiveness of the proposed solutions.

10:15 E. Argyriou, M. Bekos, A. Symvonis. **Maximizing the Total Resolution of Graphs.** A major factor affecting the readability of a graph drawing is its resolution. In graph drawing literature, the resolution of a drawing is either measured based on the angles formed by consecutive edges incident to a common node (angular resolution) or by the angles formed at edge crossings (crossing resolution). In this paper, we evaluate both by introducing the notion of "total resolution", that is, the minimum of the angular and crossing resolution. To the best of our knowledge, this is the first time where the problem of maximizing the total resolution of a drawing is studied.

The main contribution of the paper consists of drawings of asymptotically optimal total resolution for complete graphs (circular drawings) and for complete bipartite graphs (2-layered drawings). In addition, we present and experimentally evaluate a force-directed based algorithm that constructs drawings of large total resolution.

11:00-12:15 Session E Chair: P. Healy

11:00 L. Nachmanson, S. Pupyrev, M. Kaufmann. **Improving Layered Graph Layouts with Edge Bundling.** We show how to improve the Sugiyama scheme by using edge bundling. Our method modifies the layout produced by the Sugiyama scheme by bundling some of the edges together. The bundles are created by a new algorithm based on minimizing the total ink needed to draw the graph edges. We give several implementations that vary in quality of the resulting layout and execution time. To diminish the number of edge crossings inside of the bundles we apply a metro-line crossing minimization technique. The method preserves the Sugiyama style of the layout and creates a more readable view of the graph.

11:25 G. Gange, P. Stuckey, K. Marriott. **Optimal *k*-level Planarization and Crossing Minimization.** An important step in laying out hierarchical network dia- grams is to order the nodes on each level. The usual approach is to minimize the number of edge crossings. This problem is NP-hard even for two layers when the first layer is fixed. Hence, in practice crossing minimization is performed using heuristics. Another suggested approach is to maximize the planar subgraph, i.e. find the least number of edges to delete to make the graph planar. Again this is performed using heuristics since minimal edge deletion for planarity is NP-hard. We show that using modern SAT and MIP solving approaches we can find optimal orderings for minimal crossing or minimal edge deletion for planarization on rea- sonably sized graphs. These exact approaches provide a benchmark for measuring quality of heuristic crossing minimization and planarization algorithms. Furthermore, we can straightforwardly extend our approach to minimize crossings followed by maximizing planar subgraph or vice versa; these hybrid approaches produce noticeably better layout then either crossing minimization or planarization alone.

11:50 M. Chimani, C. Gutwenger, P. Mutzel, M. Spönemann, H. M. Wong. **Crossing Minimization and Layouts of Directed Hypergraphs with Port Constraints.** Many practical applications for drawing graphs are modeled by directed graphs with domain specific constraints. In this paper, we consider the problem of drawing directed hypergraphs with (and without) port constraints, which cover multiple real-world graph drawing applications like data flow diagrams and electric schematics. Most existing algorithms for drawing hypergraphs with port constraints are adaptions of the framework originally proposed by Sugiyama et al. in 1981 for simple directed graphs. Recently, a practical approach for upward crossing minimization of directed graphs based on the planarization method was proposed. With respect to the number of arc crossings, it clearly outperforms prior (mostly layering-based) approaches. We show how to adopt this idea for hypergraphs with given port constraints, obtaining an upward-planar representation (UPR) of the input hypergraph where crossings are modeled by dummy nodes. Furthermore, we present the new problem of computing an orthogonal upward drawing with minimal number of crossings from such an UPR, and show that it can be solved efficiently by providing a simple method.

14:00-15:30 Session F Chair: J. Kratochvíl

14:00 D. Gonçalves, B. Leveque, A. Pinlou. **Triangle contact representations and duality.** A contact representation by triangles of a graph is a set of triangles in the plane such that two triangles intersect on at most one point, each triangle represents a vertex of the graph and two triangles intersects if and only if their corresponding vertices are adjacent. de Fraysseix, Ossona de Mendez and Rosenstiehl proved that every planar graph admits a contact representation by triangles. We strengthen this in terms of a simultaneous contact representation by triangles of a planar map and of its dual.

A primal-dual contact representation by triangles of a planar map is a contact representation by triangles of the primal and a contact representation by triangles of the dual such that for every edge uv, bordering faces f and g, the intersection between the triangles corresponding to u and v is the same point as the intersection between the triangles corresponding to f and g. We prove that every 3-connected planar map admits a primal-dual contact representation by triangles. Moreover, the interiors of the triangles form a tiling of the triangle corresponding to the outer face and each contact point is a node of exactly three triangles. Then we show that these representations are in one-to-one correspondence with generalized Schnyder woods defined by Felsner for 3-connected planar maps.

14:25 E. Gansner, Y. Hu, S. Kobourov. **On Touching Triangle Graphs.** In this paper, we consider the problem of representing graphs by triangles whose sides touch. We present linear time algorithms for creating touching triangle representations for outerplanar graphs, square grid graphs, and hexagonal grid graphs. The class of graphs with touching triangle representations is not closed under minors, making characterization difficult. We do show that pairs of vertices can only have a small common neighborhood, and we present a complete characterization of the subclass of biconnected graphs that can be represented as triangulations of some polygon.

14:50 E. J. van Leeuwen, J. van Leeuwen. **Convex Polygon Intersection Graphs.** Geometric intersection graphs are graphs determined by intersections of geometric objects. In this paper, we study the complexity of visualizing the arrangements of objects inducing such graphs. We provide a novel, general framework for describing classes of geometric intersection graphs, based on rationally-constrained affine transformations. We prove that every graph in this framework, if the objects come from any finite base set of rationally given convex polygons, has a representation in integers using only a polynomial number of bits. Consequently, the recognition problem of these intersection graphs is in NP (and thus NP-complete). Based on these results, we also give an algorithm to find a drawing of the corresponding arrangement of objects in the plane, if a given graph fits the framework.

15:15 V. Dujmovic, W. Evans, S. Kobourov, G. Liotta, C. Weibel, S. Wismath. **On Graphs Supported by Line Sets.** For a set S of n lines labeled from 1 to n, we say that S supports an n-vertex planar graph G if for every labeling from 1 to n of its vertices, G has a straight-line crossing-free drawing with each vertex drawn as a point on its associated line. It is known from previous work [4] that no set of n parallel lines supports all n-vertex planar graphs. We show that intersecting lines, even if they intersect at a common point, are more "powerful" than a set of parallel lines. In particular, we prove that every such set of lines supports outerpaths, lobsters, and squids, none of which are supported by any set of parallel lines. On the negative side, we prove that no set of n lines that intersect in a common point supports all n-vertex planar graphs. Finally, we show that there exists a set of n lines in general position that does not support all n-vertex planar graphs.

16:00-17:15 Session G Chair: D. Eppstein

16:00 **K. Buchin, B. Speckmann, S. Verdonschot. Optimizing Regular Edge Labelings.** A regular edge labeling (REL) of an irreducible triangulation G uniquely defines a rectangular dual of G. Rectangular duals find applications in various areas: as floor plans of electronic chips, in architectural designs, as rectangular cartograms, or as treemaps. An irreducible triangulation can have many RELs and hence many rectangular duals. Depending on the specific application different duals might be desirable. In this paper we consider optimization problems on RELs and show how to find optimal or near-optimal RELs for various quality criteria. Along the way we give upper and lower bounds on the number of RELs.

16:25 **G. V. Quercini, M. Ancona. Confluent Drawing Algorithms using Rectangular Dualization.** The need of effective drawings for non-planar dense graphs is motivated by the wealth of applications in which they occur, including social network analysis, security visualization and web clustering engines, just to name a few. One common issue graph drawings are affected by is the visual clutter due to the high number of (possibly intersecting) edges to display. Confluent drawings address this problem by bundling groups of edges sharing the same path, resulting in a representation with less edges and no edge intersections. In this paper we describe how to create a confluent drawing of a graph from its rectangular dual and we show two important advantages of this approach.

16:50 **Y. Hu, S. Kobourov, S. Veeramoni. On Maximum Differential Graph Coloring.** We study the maximum differential graph coloring problem, in which the goal is to find a vertex labeling for a given undirected graph that maximizes the label difference along the edges. This problem has its origin in map coloring, where not all countries are necessarily contiguous. We establish the equivalence of the maximum differential coloring problem to that of k-Hamiltonian path. We show that computing the maximum differential coloring is an NP-Complete problem and provide exact and heuristic algorithms for solving this problem.

Friday, September 24, 2010

09:00-10:30 Session H Chair: S. Kobourov

09:00 R. I. Nishat, D. Mondal, Md. S. Rahman. **Point-Set Embeddings of Plane 3-Trees.** A straight-line drawing of a plane graph G is a planar drawing of G, where each vertex is drawn as a point and each edge is drawn as a straight-line segment. Given a set S of n points on the Euclidean plane, a point-set embedding of a plane graph G with n vertices on S is a straight-line drawing of G, where each vertex of G is mapped to a distinct point of S. The problem of deciding if G admits a point-set embedding on S is NP-complete in general and even when G is 2-connected and 2-outerplanar. In this paper we give an $O(n^2 \log n)$ time algorithm to decide whether a plane 3-tree admits a point-set embedding on a given set of points or not, and find an embedding if it exists. We prove an $O(n \log n)$ lower bound on the time complexity for finding a point set embedding of a plane 3-tree. Moreover, we consider a variant of the problem where we are given a plane 3-tree G with n vertices and a set S of $k > n$ points, and give a polynomial time algorithm to find a point-set embedding of G on S if it exists.

09:25 P. Angelini, F. Frati, M. Geyer, M. Kaufmann, T. Mchedlidze, A. Symvonis. **Upward Geometric Graph Embeddings into Point Sets.** We study the problem of characterizing the directed graphs with an upward straight-line embedding into every point set in general or in convex position. We solve two questions posed by Binucci et al. [Computational Geometry: Theory and Applications, 2010]. Namely, we prove that the classes of directed graphs with an upward straight-line embedding into every point set in convex position and with an upward straight-line embedding into every point set in general position do not coincide, and we prove that every directed caterpillar admits an upward straight-line embedding into every point set in convex position. Further, we provide new partial positive results on the problem of constructing upward straight-line embeddings of directed paths into point sets in general position.

09:50 P. Angelini, M. Geyer, M. Kaufmann, D. Neuwirth. **On a Tree and a Path with no Geometric Simultaneous Embedding.** Two graphs $G_1 = (V, E_1)$ and $G_2 = (V, E_2)$ admit a geometric simultaneous embedding if there exists a set of points P and a bijection $M : P \rightarrow V$ that induce planar straight-line embeddings both for G_1 and for G_2. The most prominent problem in this area is the question whether a tree and a path can always be simultaneously embedded. We answer this question in the negative by providing a counterexample. Additionally, since the counterexample uses disjoint edge sets for the two graphs, we also negatively answer another open question, that is, whether it is possible to simultaneously embed two edge-disjoint trees. Finally, we study the same problem when some constraints on the tree are imposed. Namely, we show that a tree of height 2 and a path always admit a geometric simultaneous embedding. In fact, such a strong constraint is not so far from closing the gap with the instances not admitting any solution, as the tree used in our counterexample has height 4.

10:15 M. van Garderen, G. Liotta, H. Meijer. **Universal Pointsets for 2-coloured Trees.** Let R and B be two sets of distinct points such that the points of R are coloured red and the points of B are coloured blue. Let $\mathcal{G}$ be a family of planar graphs such that for each graph in the family $|R|$ vertices are red and $|B|$ vertices are blue. The set $R \cup B$ is a universal pointset for $\mathcal{G}$ if every graph $G \in \mathcal{G}$ has a straight-line planar drawing such that the blue vertices of G are mapped to the points of B and the red vertices of G are mapped to the points of R. In this paper we describe universal pointsets for meaningful classes of 2-coloured trees and show applications of these results to the coloured simultaneous geometric embeddability problem.

11:00-12:15 Session I — Chair: M. Kaufmann

11:00 J. Manuch, M. Patterson, S.-H. Poon, C. Thachuk. **Complexity of Finding Non-Planar Rectilinear Drawings of Graphs.** We study the complexity of the problem of finding non-planar rectilinear drawings of graphs. This problem is known to be NP-complete. We consider natural restrictions of this problem where constraints are placed on the possible orientations of edges. In particular, we show that if each edge has prescribed direction “left”, “right”, “down” or “up”, the problem of finding a rectilinear drawing is polynomial, while finding such a drawing with the minimum area is NP-complete. When assigned directions are “horizontal” or “vertical” or a cyclic order of edges at each vertex is specified the problem NP-complete. We show that these two NP-complete cases are fixed parameter tractable in the number of vertices of degree 3 or 4.

11:25 T. Bläsius, M. Krug, I. Rutter, D. Wagner. **Drawing Orthogonal Graphs with Flexibility Constraints.** In this work we consider the following problem. Given a planar graph G with maximum degree 4 and a function $\mathrm{flex} : E \longrightarrow \mathbb{N}_0$ that gives each edge a *flexibility*. Does G admit a planar embedding on the grid such that each edge e has at most flex(e) bends? Note that in our setting the combinatorial embedding of G is not fixed.

We give a polynomial-time algorithm for this problem when the flexibility of each edge is positive. This includes as a special case the problem of deciding whether G admits a drawing with at most one bend per edge.

11:50 B. Keszegh, D. Pálvölgyi, J. Pach. **Drawing planar graphs of bounded degree with few slopes.** We settle a problem of Dujmović, Eppstein, Suderman, and Wood by showing that there exists a function f with the property that every planar graph G with maximum degree d admits a drawing with noncrossing straight-line edges, using at most $f(d)$ different slopes. If we allow the edges to be represented by polygonal paths with *one* bend, then $2d$ slopes suffice. Allowing *two* bends per edge, every planar graph with maximum degree $d \geq 3$ can be drawn using segments of at most $\lceil d/2 \rceil$ different slopes. There is only one exception: the graph formed by the edges of an octahedron is 4-regular, but requires 3 slopes. These bounds cannot be improved.

14:00-15:30 Session J Chair: S. Wismath

14:00 C. Auer, C. Bachmaier, F. J. Brandenburg, W. Brunner, A. Gleißner. **Plane Drawings of Queue and Deque Graphs.** In stack and queue layouts the vertices of a graph are linearly ordered from left to right, where each edge corresponds to an item and the left and right end vertex of each edge represents the addition and removal of the item to the used data structure. A graph admitting a stack or queue layout is a stack or queue graph, respectively. Typical layouts of stacks and queues are rainbows and twists visualizing the LIFO and FIFO principles, respectively. However, in such visualizations, twists cause many crossings, which make the drawings incomprehensible.

We introduce linear cylindric layouts as a visualization technique for queue and deque (double-ended queue) graphs. It provides new insights into the characteristics of these fundamental data structures and extends to the visualization of mixed layouts with stacks and queues. Our main result states that a graph is a deque graph if and only if it has a plane linear cylindric drawing.

14:25 **R. J. Kang, T. Müller. Dot-product Representations of Planar Graphs.** A graph G on n vertices is a k-dot product graph if there are vectors $u_1, \ldots, u_n \in \mathbb{R}^k$, one for each vertex of G, such that $u_i^T u_j \geq 1$ if and only if $ij \in E(G)$. Fiduccia et al. asked whether every planar graph is a 3-dot product graph. We show that the answer is "no". On the other hand, we show that every planar graph is a 4-dot product graph.

14:50 **E. Chambers, D. Eppstein, M. Goodrich, M. Löffler. Drawing Graphs in the Plane with a Prescribed Outer Face and Polynomial Area.** We study the classic graph drawing problem of drawing a planar graph using straight-line edges with a prescribed convex polygon as the outer face. Unlike previous algorithms for this problem, which may produce drawings with exponential area, our method produces drawings with polynomial area. In addition, we allow for collinear points on the boundary, provided such vertices do not create overlapping edges. Thus, we solve an open problem of Duncan et al., which, when combined with their work, implies that we can produce a planar straight-line drawing of a combinatorially-embedded genus-g graph with the graph's canonical polygonal schema drawn as a convex polygonal external face.

15:15 **F. Frati. Improved Lower Bounds on the Area Requirements of Series-Parallel Graphs.** We show that there exist series-parallel graphs requiring $\Omega(n2^{\sqrt{\log n}})$ area in any straight-line or poly-line grid drawing, improving the previously best known $\Omega(n \log n)$ lower bound.

16:00-17:15 Invited talk and farewell

16:00 **Peter Eades. On the Future of Graph Drawing.**

Posters

B. Pinaud and P. Kuntz. **GVSR: an On-Line Guide for Choosing a Graph Visualization Software.**

J. Bregenzer. **GraphML-based Exploration and Evaluation of Efficient Parallelization Alternatives for Automation Firmware.**

K. Kakoulis and I. Tollis. **Placing Edge Labels by Modifying an Orthogonal Graph Drawing.**

Q. Nguyen, P. Eades, S.-H. Hong, and W. Huang. **Large Crossing Angles in Circular Layouts.**

G. Sander. **IBM ILOG Multiplatform Graph Layout Technology.**

R. Krug, M. Kaufmann, and M. Geyer. **Visualizing Small Differences Between two Large Graphs.**

B. Zimmer, D. Ackermann, M. Schöder, A. Kerren, and V. Ahlers. **Comparative Visualization of User Flows in Voice Portals**

A. Gemsa, M. Nöllenburg, T. Pajor, and I. Rutter. **Automatic Generation of Route Sketches.**

PhD Project Posters

A. Ismaeel. **Dynamic Aspects of Hierarchical Graph Drawing.**

S. A. Romeo. **New Methods, Models, and Systems for the Visual Analysis of Networks.**

A. E. Aladağ, C. Erten, and M. Sözdinler. **Visualization of Weighted PPI Networks**

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