TECHNISCHE UNIVERSITÄT
ILMENAU

59. Workshop über Algorithmen und Komplexität

Ilmenau, den 24.02.2010

Programm

Uhrzeit	
09:15 - 09:55	Ankunft, Kaffee, Tee, Kekse ◡̈
09:55 - 10:00	Begrüßung
10:00 - 12:00	*Session 1*

- Beat Gfeller, Peter Sanders⋆: **Towards Optimal Range Medians**
- Stephan Matos Camacho, Ingo Schiermeyer⋆, Zsolt Tuza: **Approximation Algorithms for the Minimum Rainbow Subgraph Problem**
- Marin Bougeret, Pierre-François Dutot, Klaus Jansen, Christina Otte⋆, Denis Trystram: **Approximation Algorithms for Multiple Strip-packing/Scheduling in Clusters**

12:00 - 13:00	Mittagspause ◡̈
13:00 - 14:00	GI-Fachgruppentreffen
14:00 - 16:00	*Session 2*

- Wim Martens, Matthias Niewerth⋆, Thomas Schwentick: **Schema Design for XML Repositories: Complexity and Tractability**
- Arne Meier, Martin Mundhenk, Thomas Schneider, Michael Thomas, Felix Weiß⋆: **Komplexität des Erfüllbarkeitsproblems für Fragmente Hybrider Logik**
- Christian Herrmann, Martin Ziegler⋆: **Komplexität des Erfüllbarkeitsproblems in der Quantenlogik**

16:00 - 16:30	Kaffeepause ◡̈
16:30 - 17:50	*Session 3*

- René van Bevern⋆, Hannes Moser, Rolf Niedermeier: **Kernelization Through Tidying — A Case Study Based on s-Plex Cluster Vertex Deletion**
- Jiong Guo, Sepp Hartung⋆, Christian Komusiewicz, Rolf Niedermeier, Johannes Uhlmann: **Exact Algorithms and Experiments for Hierarchical Tree Clustering**

⋆ Vortragende(r)

Towards Optimal Range Medians

Beat Gfeller[1], Peter Sanders[2⋆]
Eidgenössische Technische Hochschule Zürich[1],Universität Karlsruhe (TH)[2]

We consider the following problem: given an unsorted array of n elements, and a sequence of intervals in the array, compute the median in each of the subarrays defined by the intervals. We describe a simple algorithm which uses $O(n)$ space and needs $O(n \log k + k \log n)$ time to answer k such median queries. This improves previous algorithms by a logarithmic factor and matches a lower bound for $k = O(n)$. Since, in contrast to previous approaches, the algorithm decomposes the range of element values rather than the array, it has natural generalizations to higher-dimensional problems — it reduces a range median query to a logarithmic number of range counting queries.

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Approximation Algorithms for the Minimum Rainbow Subgraph Problem

Stephan Matos Camacho[1], Ingo Schiermeyer[1⋆], Zsolt Tuza[2]

Technische Universität Bergakademie Freiberg[1], Ungarische Akademie der Wissenschaften Budapest und Pannonische Universität Veszprém[2]

We consider the MINIMUM RAINBOW SUBGRAPH problem (MRS): Given a graph G, whose edges are coloured with p colours. Find a subgraph $F \subseteq G$ of G of minimum order and with p edges such that each colour occurs exactly once.

In this talk we will present upper and lower bounds for the order of the minimum rainbow subgraph F.

For graphs with maximum degree $\Delta(G)$ there is a greedy polynomial-time approximation algorithm for the MRS problem with an approximation ratio of $\Delta(G)$. We will present a polynomial-time approximation algorithm with an approximation ratio of $5/6\Delta$.

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Approximation Algorithms for Multiple Strippacking/Scheduling in Clusters

Marin Bougeret[1], Pierre-François Dutot[1], Klaus Jansen[2], Christina Otte[2⋆], Denis Trystram[1]
Laboratoire d'Informatique de Grenoble[1], Christian-Albrechts-Universität zu Kiel[2]

We study the MULTIPLE STRIPPACKING (MSP) problem, a generalization of the well-known STRIPPACKING problem. For a given set of rectangles, $r_1, \ldots, r_n$, the goal is to find a non-overlapping orthogonal packing without rotations into $N \in \mathbb{N}$ strips of maybe different widths minimizing the maximum of the heights. This problem is closely related to PARALLEL SCHEDULING JOBS IN CLUSTERS (PSC) with the objective to minimize the overall makespan. In contrast to packing rectangles a job has not to be scheduled on contiguous processors. Thus, results for MSP can be applied to instances of PSC obtaining a ratio at least as good as the one for MSP, but not vice versa. By reduction to 3-PARTITION it was shown that MSP is NP-hard even in the case of identical strips (or clusters); consequently there is no approximation algorithm with absolute ratio better than 2, unless P=NP. In this talk we give an overview about our results for MSP and PSC. For MSP with identical strips this includes besides greedy algorithms a tight 2-approximation and an AFPTAS. For PSC with identical clusters we obtained a fast $5/2$-approximation. The same approximation ratio holds in the case of different clusters, if we allow every job to fit everywhere. For MSP with different strips we also obtained an APTAS.

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Schema Design for XML Repositories: Complexity and Tractability

Wim Martens, Matthias Niewerth*, Thomas Schwentick
Technische Universität Dortmund

Abiteboul et al. initiated the systematic study of distributed XML documents consisting of several logical parts, possibly located on different machines. The physical distribution of such documents immediately raises the following question: how can a global schema for the distributed document be broken up into local schemas for the different logical parts? The desired set of local schemas should guarantee that, if each logical part satisfies its local schema, then the distributed document satisfies the global schema.

Abiteboul et al. proposed three levels of desirability for local schemas: local typing, maximal local typing, and perfect local typing. Immediate algorithmic questions are: (i) given a typing, determine whether it is local, maximal local, or perfect, and (ii) given a document and a schema, establish whether a (maximal) local or perfect typing exists. This paper improves the open complexity results in their work and initiates the study of (i) and (ii) for schema restrictions arising from the current standards: DTDs and XML Schemas with deterministic content models. The most striking result is that these restrictions yield tractable complexities for the perfect typing problem.

Furthermore, an open problem in Formal Language Theory is settled: deciding language primality for deterministic finite automata is PSPACE-complete.

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Komplexität des Erfüllbarkeitsproblems für Fragmente Hybrider Logik

Arne Meier[1], Martin Mundhenk[2], Thomas Schneider[3], Michael Thomas[1], Felix Weiß[2⋆]
Leibniz Universität Hannover[1], Friedrich-Schiller-Universität Jena[2], Universität Manchester[3]

Hybride Logik ist als Erweiterung der Modallogik sehr ausdrucksstark, das Erfüllbarkeitsproblem im allgemeinen Fall unentscheidbar. Wir haben uns auf die Suche nach Fragmenten mit entscheidbarem Erfüllbarkeitsproblem begeben. Dabei gibt es verschiedene Möglichkeiten, Fragmente der Hybriden Logik zu bilden. Aus syntaktischer Sicht kann man einerseits die Menge der hybriden Operatoren eingrenzen und andererseits die aussagenlogischen Verknüpfungen einschränken. Wir betrachten Hybride Logik mit Hilfe der Kripke Semantik; dies erlaubt eine weitere Möglichkeit der Einschränkung. Man kann hier zum Beispiel zyklische Frames wie transitive und totale Frames oder azyklische Frames wie lineare Frames und Bäume betrachten. Unsere Resultate reichen von LOGSPACE-Vollständigkeit bis zu Fragmenten in NEXPTIME.

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Komplexität des Erfüllbarkeitsproblems in der Quantenlogik

Christian Herrmann, Martin Ziegler*
Technische Universität Darmstadt

Quantum logic generalizes, and in dimension one coincides with, Boolean logic. The satisfiability problem of quantum logic formulas is shown NP-complete in dimension two. We then extend these considerations to three and higher-dimensional Euclidean spaces $\mathbb{R}^d$ and $\mathbb{C}^d$. For fixed $d > 2$, QUANTUM SATISFIABILITY turns out polytime-equivalent to the real feasibility of a multivariate quartic polynomial equation: a well-known problem lying (probably strictly) between NP and PSPACE. We finally investigate the problem over INdefinite finite dimensions and relate it to the real feasibility of quartic NONcommutative $*$-polynomial equations.

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Kernelization Through Tidying — A Case Study Based on s-Plex Cluster Vertex Deletion

René van Bevern*, Hannes Moser, Rolf Niedermeier
Friedrich-Schiller-Universität Jena

We introduce the NP-hard graph-based data clustering problem s-PLEX CLUSTER VERTEX DELETION, where the task is to delete at most k vertices from a graph so that the connected components of the resulting graph are s-plexes. In an s-plex, every vertex has an edge to all but at most $s-1$ other vertices; cliques are 1-plexes. We propose a new method for kernelizing a large class of vertex deletion problems and illustrate it by developing an $O(k^2s^3)$-vertex problem kernel for s-PLEX CLUSTER VERTEX DELETION that can be computed in $O(ksn^2)$ time, where n is the number of graph vertices. The corresponding "kernelization through tidying" exploits polynomial-time approximation results.

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Exact Algorithms and Experiments for Hierarchical Tree Clustering

Jiong Guo[1], Sepp Hartung[2⋆], Christian Komusiewicz[2], Rolf Niedermeier[2], Johannes Uhlmann[2]
Universität des Saarlandes[1], Friedrich-Schiller-Universität Jena[2]

We perform new theoretical as well as first-time experimental studies for the NP-hard problem to find a closest ultra-metric for given dissimilarity data on pairs. This is a central problem in the area of hierarchical clustering, where so far only polynomial-time approximation algorithms were known. In contrast, we develop efficient preprocessing algorithms (known as kernelization in parameterized algorithmics) with provable performance guarantees and a simple search tree algorithm. These are used to find optimal solutions. Our experiments with synthetic and biological data show the effectiveness of our algorithms and demonstrate that an approximation algorithm due to Ailon and Charikar [FOCS 2005] often gives (almost) optimal solutions.

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