69. Workshop über Algorithmen und Komplexität (Theorietag)

Institut für Theoretische Informatik, TU Ilmenau

28. und 29. Mai 2015

Programm und Abstracts

TECHNISCHE UNIVERSITÄT
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Programm

Donnerstag, 28.5.2015

12:00 – 12:55	Brötchen, Kaffee
12:55 – 13:00	Begrüßung
13:00 – 13:30	Christian Komusiewicz *Editing Graphs into few Cliques: Complexity, Approximation, and Kernelization Schemes*
13:30 – 14:00	Maurice Chandoo *Deciding Circular-Arc Graph Isomorphism in* $O(k + \log n)$ *Space*
14:00 – 14:30	Jens M. Schmidt *Computing Tutte Cycles*
14:30 – 15:00	Kaffee
15:00 – 16:00	Eingeladener Vortrag: Uwe Schöning *Local Search for Satisfaction*
16:00 – 16:30	Kaffee
16:30 – 17:00	Robert Bredereck *Large-Scale Election Campaigns: Combinatorial Shift Bribery*
17:00 – 17:30	Moritz Gobbert *Edge Hop (Ein Modell zur Komplexitätsanalyse von kombinatorischen Spielen)*
17:30 – 18:00	Holger Thies *Analytic Continuation in iRRAM*
Ab 18:15	Gemeinsames Abendessen im Hotel Tanne

Freitag, 29.5.2015

09:00 – 09:30	Pascal Lenzner *Selfish Network Creation: Think Global – Act Local*
09:30 – 10:00	Pavel Podlipyan *Almost collisionless gathering*
10:00 – 10:30	Christopher Mattern *On Probability Estimation via Relative Frequencies and Discount*
10:30 – 11:00	Kaffeepause
11:00 – 11:30	Andreas Jakoby *How to Generate Random Graphs with given Vertex-Cover Size*
11:30 – 12:00	Ralf Rothenberger *Ultra-Fast Load Balancing in Scale-Free Networks*
12:00 – 12:30	Naveen Kumar Goswami *Cardinality-Based Algorithms for the Vertex Cover Problem*

Editing Graphs into few Cliques: Complexity, Approximation, and Kernelization Schemes.

Christian Komusiewicz, TU Berlin

Given an undirected graph G and a positive integer k, the NP-hard Sparse Split Graph Editing problem asks to transform G into a graph that consists of a clique plus isolated vertices by performing at most k edge insertions and deletions; similarly, the P3-Bag Editing problem asks to transform G into a graph which is the union of two possibly overlapping cliques. We give a simple linear-time 3-approximation algorithm for Sparse Split Graph Editing, an improvement over a more involved known factor-3.525 approximation. Further, we show that P3-Bag Editing is NP-complete. Finally, we present a kernelization scheme for both problems and additionally for the 2-Cluster Editing problem. This scheme produces for each fixed ε in polynomial time a kernel of order εk.

(This is joint work with Falk Hüffner and André Nichterlein.)

Deciding Circular-Arc Graph Isomorphism in $O(k + \log n)$ Space.

Maurice Chandoo, Leibniz Universität Hannover

Currently the best known complexity upper bound for deciding isomorphism of CA graphs is the same as for graph isomorphism in general. A recent result of Köbler et al from 2013 shows that isomorphism for the subclass of Helly CA graphs can be decided in logspace. We generalize their argument to CA graphs in a parameterized context. In this approach a specific subproblem arises that we solve by choosing the parameter k such that brute force can be applied. Solving this subproblem in logspace would yield a logspace algorithm for isomorphism of CA graphs, which is a tight upper bound.

Computing Tutte Cycles.

Jens M. Schmidt, TU Ilmenau

Tutte cycles build a powerful tool for proving structural results on planar graphs. One particular implication of them is the existence of 2-walks in 3-connected graphs: A 2-walk of a graph is a walk visiting every vertex at least once and at most twice. Gao, Richter and Yu proved that every 3-connected planar graph contains a closed 2-walk such that all vertices visited twice are contained in 3-separators. For both, Tutte cycles and 2-walks, the algorithmic challenge is to overcome big overlapping subgraphs in the decomposition, which are also inherent in Tutte's and Thomassen's decompositions. We solve this problem by extending the decomposition of Gao, Richter and Yu in such a way that all pieces, in which the graph is decomposed into, are edge-disjoint. This implies the first polynomial-time algorithm that computes the closed 2-walk mentioned above.

(This is joint work with Andreas Schmid.)

Local Search for Satisfaction.

Uwe Schöning, Universität Ulm

Das Erfüllbarkeitsproblem SAT ist NP-vollständig und daher scheinen entsprechende Algorithmen, zumindest im schlechtesten Fall, exponentielle Laufzeit zu haben. Für die ebenfalls NP-vollständige „3 Literale pro Klausel“-Variante 3-SAT trifft diese Aussage ebenfalls zu, jedoch lassen sich in diesem Fall Algorithmen der Laufzeit c^n angeben, wobei die Konstante c wesentlich kleiner als 2 ist. Hier sind es vor allem Algorithmen, die auf dem einfachen Lokale Suche-Prinzip beruhen, die hier erfolgreich sind. Neben den theoretischen Ergebnissen, die sich um die kleinste solche Konstante c bemühen, soll gezeigt werden, wie diese „theoretischen Algorithmen“ in „praktische“ überführt werden können, so dass wir auch bei der „SAT Competiton“ in den letzten Jahren Erfolge verbuchen konnten.

Large-Scale Election Campaigns: Combinatorial Shift Bribery.
Robert Bredereck, TU Berlin

We study the complexity of a combinatorial variant of the Shift Bribery problem in elections. In the standard Shift Bribery problem, we are given an election where each voter has a preference order over the candidate set and where an outside agent, the briber, can pay each voter to rank the briber's favorite candidate a given number of positions higher. The goal is to ensure the victory of the briber's preferred candidate. The combinatorial variant of the problem, introduced in this paper, models settings where it is possible to affect the position of the preferred candidate in multiple votes, either positively or negatively, with a single bribery action. This variant of the problem is particularly interesting in the context of large-scale campaign management problems (which, from the technical side, are modeled as bribery problems). We show that, in general, the combinatorial variant of the problem is highly intractable (NP-hard, hard in the parameterized sense, and hard to approximate), but we provide some (approximation) algorithms for natural restricted cases.

(This is joint work with Piotr Faliszewski, Rolf Niedermeier and Nimrod Talmon.)

Edge Hop (Ein Modell zur Komplexitätsanalyse von kombinatorischen Spielen).

Moritz Gobbert, Universität Trier

In meinem Vortrag werde ich ein Spiel namens EdgeHop vorstellen, bei dem es darum geht einen markierten Spielstein auf einem Graphen von einem Startknoten zu einem Zielknoten zu bewegen. Manche Knoten des Graphen sind mit weiteren Spielsteinen besetzt, die der Spieler unter passenden Bedingungen ebenfalls bewegen kann. Weiterhin hat der Graph bestimmte Eigenschaften, wie z. B. dass auf jedem Knoten nur eine bestimmte Anzahl an Spielsteinen liegen darf oder dass jede Kante vom markierten Spielstein nur einmal passiert werden kann. Weiter werde ich zeigen, dass EdgeHop, bzw. die Frage, ob der markierte Spielstein den Zielknoten erreichen kann, *NP-vollständig* ist. Für die Reduktion werde ich verschiedene Gadgets konstruieren, die ein Gerüst für die Komplexitätsanalyse anderer (kombinatorischer) Spiele bzw. ähnlicher Fragestellungen bieten. Zuletzt werde ich kurz auf die Spiele *Latrunculi*, *Minecraft*, *2048* und *Game about Squares* eingehen und erläutern, welche spezifischen Fragestellungen der Spiele mithilfe von EdgeHop untersucht werden können.

Keywords: Komplexität, Kombinatorische Spiele, Latrunculi, Minecraft, 2048, Game about Squares.

Analytic Continuation in iRRAM

Holger Thies, Technische Universität Darmstadt

Analytic functions play a central role in analysis and have therefore also been investigated in Computable Analysis and Real Complexity Theory. Many operators that are hard in the general case map polynomial time computable functions to polynomial time computable functions when restricted to analytic functions. It can for example be shown, that the anti-derivative of every polynomial time computable function is polynomial time computable if and only if $\mathcal{FP} = \#\mathcal{P}$ (Friedman). The anti-derivative of a polynomial time computable analytic function, however, can be computed in polynomial time without further assumptions.

Analytic functions are represented by power series. However, it is known that the evaluation of power series is not uniformly computable. Therefore it is necessary to include additional information about the function in the representation. A representation that makes many operators uniformly polynomial time computable is extending the series by two Integers that fulfill certain conditions.

We present a prototype implementation of power series and analytic functions on a fixed rectangular domain as abstract 'arrow' data type in `iRRAM`, supporting basic operations like evaluation, point wise addition and multiplication, composition, differentiation and integration. Building on that, we explore the practical potential for analytic continuation by iterated evaluation/interpolation in exact real arithmetic. Our empirical evaluation compares practical with predicted running times and suggests a refinement to the above parametrized complexity analysis.

(This is joint work with Akitoshi Kawamura and Florian Steinberg.)

Selfish Network Creation: Think Global – Act Local.

Pascal Lenzner, FSU Jena

Network Creation Games model the construction of a communication network by selfish agents without any external coordination. Agents are nodes in a network which can buy incident edges to connect to other nodes. Each agent tries to occupy a central position in the network at minimum cost for building edges. It is well-known that equilibrium networks of these games have desirable properties like a small diameter and low social cost. However, the original model assumes that any node may buy a link to any other node in the network, independently of their position in the network. Especially for modeling large communication or social networks, this is a very unrealistic assumption since no agent may have complete knowledge of the network structure. Very recently this observation has led to an analysis of several variants where agents only have local knowledge of the network and are therefore restricted to act locally. We take this approach on step further by allowing agents to probe and evaluate different local strategies and then choose the most profitable one of them. For this more optimistic locality model we analyze the impact on the agents' cost, the game dynamics and on the resulting equilibrium networks.

(This is joint work with Andreas Cord-Landwehr from University Paderborn.)

Almost collisionless gathering.

Pavel Podlipyan, Universität Paderborn

In the following talk we are going to consider the gathering of the point like robots with limited viewing range on Euclidean plane in the continuous time model. We are going to consider modification of Go-To-The-Center algorithm due to Ando, Suzuki, and Yamashita. We will enhance the common unit disc graph model by the Gabriel graph.

In the first part of the talk we are going to present the model and runtime analysis results of our modified algorithm. Then we are going to show the simulation results that will lead us to the second part of the talk. The second part will be dedicated to current analysis of specific emergent properties of our algorithm, that we obtained due to performed modifications. Namely, we will show our progress on the proof of the fact that the robot using modified algorithm gather without collisions from almost every initial configuration.

(This is joint work with Friedhelm Meyer auf der Heide.)

On Probability Estimation via Relative Frequencies and Discount.

Christopher Mattern, TU Ilmenau

Probability estimation is an elementary building block of every statistical data compression algorithm. In practice probability estimation is often based on relative letter frequencies which get scaled down, when their sum is too large. Such algorithms are attractive in terms of memory requirements, running time and practical performance. However, there still is a lack of theoretical understanding. In this work we formulate a typical probability estimation algorithm based on relative frequencies and frequency discount, Algorithm RFD. Our main contribution is its theoretical analysis. We show that Algorithm RFD performs almost as good as any piecewise stationary model with either bounded or unbounded letter probabilities. This theoretically confirms the recency effect of periodic frequency discount, which has often been addressed.

How to Generate Random Graphs with given Vertex-Cover Size.
Andreas Jakoby, Bauhaus-Universität Weimar

The minimum vertex cover is a classical $\mathcal{NP}$-hard optimization problem in computer science theory. Its decision version is one of Karp's 21 original $\mathcal{NP}$-complete problems. There are several applications where the knowledge of a minimum cover will be very useful, e.g. to test the quality of an approximation algorithm.

Since the size of an minimum cover is hard to determine, we will present within this talk an alternative direction. We will present a strategy to generate a families of random graphs where the size of the minimum cover can be given as a parameter of the process. For this process will introduce the set of graphs that are irreducible according to the minimum vertex cover problem.

Furthermore, we will show how one can efficiently generate a huge set of this irreducible graphs.

(This is joint work with Naveen Kumar Goswami.)

Ultra-Fast Load Balancing in Scale-Free Networks.

Ralf Rothenberger, HPI Potsdam

The performance of large distributed systems crucially depends on efficiently balancing their load. This has motivated a large amount of theoretical research how an imbalanced load vector can be smoothed with local algorithms. For technical reasons, the vast majority of previous work focuses on regular (or almost regular) graphs including symmetric topologies such as grids and hypercubes, and ignores the fact that large networks are often highly heterogeneous. We model large scale-free networks by Chung-Lu random graphs and analyze a simple local algorithm for iterative load balancing. On n-node graphs our distributed algorithm balances the load within $O((\log \log n)^2)$ steps. It does not need to know the exponent $\beta \in (2, 3)$ of the power-law degree distribution or the weights w_i of the graph model. To the best of our knowledge, this is the first result which shows that load-balancing can be done in double-logarithmic time on realistic graph classes.

(This is joint work with Karl Bringmann, Tobias Friedrich, Martin Hoefer, and Thomas Sauerwald.)

Cardinality-Based Algorithms for the Vertex Cover Problem.
Naveen Kumar Goswami, Bauhaus-Universität Weimar

This paper studies a class of polynomial-time approximation algorithms, called cardinality-based algorithms, for the minimum-vertex-cover problem. We show that algorithms of this class give useful approximative solutions in practice by evaluating well-known existing instances that fall into this class (Naive-Greedy, Min-Greedy, NOVCA, and VSA) on the well-known DIMACS and BHOSLIB benchmarks. This renders them a well-suited alternative to local-search heuristics which despite their success, possess two major drawbacks: First, they usually require an a-priori guess of the size of the final cover as a halting criterion. An underestimation of the cover size may yield an unpredictably extended computational effort, whereas an overestimation results in a greatly deviating solution from optimal. Second, in applications that must handle huge graphs, the computational and memory requirements imposed by the iteration intensive local-search-based approaches become practically infeasible for large and dense graphs. In addition, we introduce a promising novel instance, called Weakest Neighbor.

The tightest known lower bound for the approximation ratio of MVC algorithms is 1.3606, which assumes that P not equal to NP. We prove an assumption-independent lower bound of 1.25 for cardinality-based algorithms. Moreover, we show that all considered cardinality-based algorithms cannot be bounded by any constant factor. Finally, we propose two families of scalable benchmark graphs with known hidden optimums, which are particularly well-suited to challenge cardinality-based algorithms.

(This is joint work with Eik List, Stefan Lucks, and Andreas Jakoby.)