Programm

Time	Speaker	Talk
10:00	Eyke Hüllermeier (*Marburg*)	Graph-based modeling and algorithms in structural bioinformatics. (*invited talk*)
11:30	Klaus Jansen (*Kiel*)	A fast approximation scheme for the multiple knapsack problem.
12:00	*Lunch break*	
14:00	Henning Fernau (*Trier*)	Kernels for packing and covering problems.
14:30	Mahmudul Huq (*Halle*)	Development of an approximation method for vector optimazation problem.
15:00	Michael Elberfeld (*Lübeck*)	A polynomial-time algorithm for phylogeny-based haplotype inference with allowed and forbidden haplotypes.
15:30	*Coffee break*	
16:00	Maciej Liśkiewicz (*Lübeck*)	Steganography and algorithmic learning.
16:30	Ulrich Schwarz (*Kiel*)	A PTAS for nested restricted assignment.
17:00	Lars Prädel (*Kiel*)	An approximation algorithm for two-dimensional strip-packing with absolute performance bound $\frac{7}{4} + \varepsilon$.
17:30	*End of workshop*	

Location: Universität zu Lübeck, Raum AM S4, Ratzeburger Allee 160

A fast approximation scheme for the multiple knapsack problem

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In this talk we propose an improved efficient approximation scheme for the multiple knapsack problem (MKP). Given a set A of n items and set B of m bins with possibly different capacities, the goal is to find a subset $A' \subseteq A$ of maximum total profit that can be packed into B without exceeding the capacities of the bins. Chekuri and Khanna [1] presented a PTAS for MKP with arbitrary capacities with running time $n^{O(1/\epsilon^8 \log(1/\epsilon))}$. Recently we found an EPTAS for MKP [2] with running time $2^{O(1/\epsilon^5 \log(1/\epsilon))} poly(n)$. Here we present an improved EPTAS with running time $2^{O(1/\epsilon \log(1/\epsilon)^4)} poly(n)$. If the modified round-up property for bin packing with different sizes is true, the running time can be improved to $2^{O(1/\epsilon \log(1/\epsilon)^2)} poly(n)$.

References

[1] C. Chekuri and S. Khanna, A PTAS for the multiple knapsack problem, *Proceedings of ACM-SIAM Symposium on Discrete Algorithms*, SODA 2000, 213-222 and *SIAM Journal on Computing*, 35 (2006), 713-728.

[2] K. Jansen: Parameterized approximation scheme for the multiple knapsack problem, *Proceedings of the ACM-SIAM Symposium on Discrete Algorithms*, SODA 2009, 665-674.

[3] K. Jansen: A fast approximation scheme for the multiple knapsack problem, unpublished manuscript, 2009.

Kernels for packing and covering problems

Jianer Chen
Henning Fernau
Peter Shaw
Jianxin Wang
Zhibiao Yang

The duality between packing and covering problems is well known and can be derived, e.g., with techniques from integer linear programming (ILP). We propose to look at this property from the viewpoint of kernelization. After sketching the general strategy, we will focus on a specific path packing / covering problem to exemplify the proposed approach. More generally speaking, as extremal arguments are easier to derive for maximization (packing) problems than for minimization (covering) problems, the way via ILP duality might provide new ideas for obtaining kernel results for minimization (covering) problems.

Development of an Approximation Method for Vector Optimization Problem

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Abstract

Location and approximation problems play an important role in optimization theory. Many practical problems can be described as location and approximation problems. Besides problems with one objective function, several authors have investigated vector-valued (multi-criteria, multiple-objective) location and approximation problems. In this research paper we will outine a proposal of an efficient algorithm for the solution of multiple-objective approximation problem.

1 Aim of the Research

In my doctorate research I would like to develop an efficient algorithm for the solution of multiple-objective location and approximation problem. Proximal Point Algorithm (PPA) for multiple-objective location and approximation problems is the main focus of my research.

I would like to consider the following real-valued optimization problem

$f(x) = c(x) + \sum \alpha_i \|A^i(x) - a^i\|^(\beta_i) \to min$ [1]

On the one hand, the interactive procedure for the solution of multi-criteria approximation problem is to be developed. The procedure will use scalarization method to manipulate PPA. Through the use of duality theory effective stopping criteria for PPA are to be deduced. On the other hand, PPA with the assistance of duality theory can be interpreted as primal-dual method, which opens possiblities of the extenstion of the algorithm on the multiple-objective convex problem. In particular a class of non-linear approximation problems is to be considered, which can be dealt as surrogate problems for multi-objective approximation problem with empty permissible range. The scalar sub-problems can then be solved with PPA.

The developed algorithms are to be implemented, so that at the end versatile usable efficient software is available. The usefulness is to be realized by interfaces to important programming languages and applications.

References

[1] A. Goepfert et. al. (2003). *Variational Methods in Parially Ordered Spaces.* Springer Verlag.

A Polynomial-Time Algorithm for Phylogeny-Based Haplotype Inference With Allowed and Forbidden Haplotypes

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In computational biology, haplotype inference methods are applied to increase the accuracy of genetic information, used to study hereditary diseases. Low-priced sequencing machines typically output the *genotypes* of individuals that describe the bases at genomic marker positions. When it comes to the study of complex diseases that are related to the combined information at different positions, this data is not exact enough and we need to know how bases are arranged on the underlying chromosomes. Since the direct sequencing of this information, called the *haplotypes* of chromosomes, is much more expensive, *haplotype inference methods* are used to computationally predict likely haplotypes for given genotypes.

One promising approach for this task searches for solution haplotypes that are the offsprings of an evolutionary history with few mutations and no recombination events, a *perfect phylogeny*. The corresponding combinatorial problem, *perfect phylogeny haplotype inference* is known to be polynomial-time solvable [3] and, from the complexity theoretical perspective, complete for the class L [1].

A further challenge for haplotype methods is to incorporate information about allowed and forbidden solution haplotypes, so called *haplotype constraints*, that are known from prior studies for the same genomic region. During the course of this talk we show how to algorithmically handle these additional constraints and present a polynomial-time algorithm for the *constrained perfect phylogeny haplotype inference* problem.

Fellows et al.[2] studied the perfect phylogeny haplotype inference problem when the solution haplotypes are restricted to a given set of haplotypes. They presented efficient algorithms for some pathological cases, but did not solved the general case. Since their problem can be formulated as a variant of the *constrained perfect phylogeny haplotype inference* problem, our techniques also lead to a polynomial-time algorithm for this problem.

The content of this talk is joint work with Till Tantau.

References

[1] M. Elberfeld. Perfect phylogeny haplotyping is complete for logspace. *CoRR*, abs/0905.0602, 2009.

[2] M. R. Fellows, T. Hartman, D. Hermelin, G. M. Landau, F. A. Rosamond, and L. Rozenberg. Haplotype inference constrained by plausible haplotype data. In *Proceedings of 20th Annual Symposium on Combinatorial Pattern Matching (CPM 2009)*, volume 5577 of *LNCS*, pages 339–352. Springer, 2009.

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Steganography and Algorithmic Learning*

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September 14, 2009

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The aim of steganography is to hide secret messages in unsuspicious covertexts in such a way that the mere existence of a hidden message is concealed. The basic scenario assumes two communicating parties Alice (sender) and Bob (receiver) as well as an adversary Eve who is often also called a "warden" due to Simmons' [4] motivation of the setting as secret communication among prisoners. Eve wants to find out whether Alice and Bob are exchanging hidden messages among their covertext communication. The stegosystem has to satisfy two conditions – (a) *reliability*, i.e. the ability of Alice to effectively transmit secret information to Bob and (b) *security*, i.e. the ability to prevent Eve from distinguishing between original covertexts and modified stegotexts.

In the past few years significant advances have been achieved in the development of theoretical foundations of steganography. Using notions from cryptography such as *indistinguishability* and adapting them to a steganography scenario, Hopper et al. have shown that it is possible to construct stegosystems that are provably secure against passive and active attacks [2]. However, their construction has several drawbacks in terms of practicality, in particular a very low transmission rate. Dedić et al. have analysed a generalisation of the scheme to a larger number of bits per document [1]. They have shown that for a reliable and secure *black-box stegosystem* (i.e. one in which Alice has no knowledge whatsoever of the covertext channel), the number of sample documents drawn from the covertext channel grows exponentially in the number of bits embedded per document. Furthermore, Hundt et al. have shown that the construction of a history-based sampling oracle, a core component of all black-box stegosystems, can lead to an intractable problem for practically relevant covertext channels [3].

The inequality in knowledge between the encoder and the adversary is not adequate to model typical situations when steganography is used in practice. In reality, Alice neither has zero nor full knowledge about the covertext channel, but rather something in between, since she has the option to choose which kind of covertext channels (pictures, texts, music, ...) to be used. Eve has to accept this choice. Therefore, we propose a more realistic model of steganography, called *grey-box steganography*. Here, the encoder starts with at least some partial knowledge about the type of covertext channel. Using the sampling oracle, he first uses machine learning techniques to learn the covertext distribution and then tries to actively construct a suitable stegotext – either by modifying a covertext or by creating a new one.

We illustrate our concept with communication channels that can be described as concept classes and consider channels for which PAC-learning [5] algorithms exist and channels for which approximate learning algorithms are known. A generic construction is given showing that besides the learning complexity, the efficiency of grey-box steganography depends on the complexity of the membership test, and suitable modification procedures. For the concept classes considered we present efficient algorithms for changing a covertext into a stegotext.

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References

[1] N. Dedić, G. Itkis, L. Reyzin, S. Russell, Upper and Lower Bounds on Black-box Steganography, J. Cryptology 22, 2009, 365-394.

[2] N. Hopper, J. Langford, L. von Ahn, Provably Secure Steganography, IEEE Tr. Computers 58, 2009, 662–676.

[3] C. Hundt, M. Liśkiewicz, U. Wölfel, Provably Secure Steganography and the Complexity of Sampling, in Proc. ISAAC 2006, 754–763.

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A PTAS for Nested Restricted Assignment

Ulrich M. Schwarz*

August 26, 2009

Restricted Assignment is the problem of assigning jobs to machines to minimize the maximal load of a machine, under the constraint that every job is only feasible on a subset of the available machines. While easy for unit-length jobs, this problem is notoriously stubborn for jobs of different lengths, and no better approximation ratio than $2 - 1/m$ (via general unrelated machine scheduling) is known for the general case.

We consider the case of *nested* restrictions, i.e. if job j is feasible on all machines in M_j and j' on $M_{j'}$, then $M_j \cap M_{j'} \in \{M_j, M_{j'}, \emptyset\}$. We show that this problem admits a polynomial-time approximation scheme. The main idea is a way to allow additional nested restrictions on many dynamic programming formulations, and as such is applicable to many further problems.

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An Approximation Algorithm for Two-Dimensional Strip-Packing with Absolute Performance Bound $\frac{7}{4} + \varepsilon$

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In the last years there has been much research in two-dimensional packing problems, the most classical among them being the strip-packing problem. Given a set of rectangles $L = \{r_1, \ldots, r_n\}$ of specified widths w_i and heights h_i, the problem is to find a feasible orthogonal packing without rotations into a strip of width 1 and minimum height. In this paper we present an approximation algorithm for the strip-packing problem with absolute approximation ratio of $\frac{7}{4} + \varepsilon$ for an arbitrary $\varepsilon > 0$. This result improves the previous best absolute approximation ratio of 2 by Schiermeyer [2] and Steinberg [3].

These results are joint work with Klaus Jansen.

References

[1] K. Jansen and L.Prädel: An Approximation Algorithm for Two-Dimensional Strip-Packing with Absolute Performance Bound $\frac{7}{4} + \varepsilon$. unpublished manuscript, 2009.

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