Bremen–Hamburg Workshop on

Algorithms, Combinatorics, Optimization

Universität Hamburg
June 22, 2018

Program

10:00 *coffee*

10:30 Ruben Hoeksma:
A PTAS for TSP on hyperplanes

11:15 Sándor P. Fekete:
Solving Hard Optimization Problems: Combinatorial Optimization meets Computational Geometry

12:00 *lunch*

13:30 Malin Rau:
Closing the Gap for Pseudo-Polynomial Strip Packing

14:15 Anand Srivastav:
Derandomizing Martingale Inequalities with Applications to Covering in Hypergraphs

15:00 *coffee*

15:30 open problems session

Abstracts

A PTAS for TSP on hyperplanes

Ruben Hoeksma, Universität Bremen

TSP with neighborhoods is a long-studied problem where we are asked to find the shortest tour visiting a given set of regions (=neighborhoods). When the neighborhoods are lines in two dimensions, the problem is efficiently solvable. For lines in three dimensions, the problem is NP-hard and this is generally true in higher dimensions with regions that are low dimensional subspaces. The question we try to answer in this talk concerns the setting where the regions are hyperplanes in three or more dimensions. The complexity of this problem is open (no hardness results are known) and, until now, only a recent (2^d)-approximation algorithm was known. In this talk, we make a step forward in answering this sixteen year old open question by designing a PTAS. In a high-level view, we will see the underlying ideas, including a (new) sparsification technique for polytopes and a linear program that computes the shortest tour.

Solving Hard Optimization Problems: Combinatorial Optimization meets Computational Geometry

Sándor P. Fekete, TU Braunschweig

Many problems of combinatorial optimization can be considered in a geometric context: vertices representing locations correspond to points, and edge weights arise from geometric cost. Moreover, geometric applications give rise to generalizations and variations: For example, if we need to cover a whole region instead of individual points, a Traveling Salesman Problem can turn into a Lawnmowing Problem. This makes is interesting to consider the interaction between discrete optimization and computational geometry.

In this talk I will present a number of results for optimization problems for which geometric variants provide additional twists. Particular examples include touring, location and network problems:

- For the Geometric Maximum Traveling Salesman Problem, geometry helps to compute optimal solutions in very fast time.
- For the Art Gallery Problem, seemingly simple geometric subroutines may become critical for the overall runtime.
- The Maxmin triangulation problem arises from geometry, but also benefits from geometric insights.
- For Covering tours with turn cost, the price for moving about does not arise from traveling along an edge, but from changing direction.

As it turns out, these problems are not only of theoretical interest, but also relevant for a variety of applications.

Closing the Gap for Pseudo-Polynomial Strip Packing

Malin Rau, Universität Kiel

In the Strip Packing problem we are given a set of rectangular axis parallel items and a strip with integral width and infinite height. The objective is to find a packing of the items into the strip which minimizes the packing height. It is known that there is no pseudo-polynomial algorithm for Strip Packing with a ratio better than $5/4$ unless $P = NP$. The best algorithm so far has a ratio of $4/3 + \varepsilon$. We close this gap by presenting an algorithm with pseudo polynomial running time with respect to the width of the strip and approximation ratio $5/4 + \varepsilon$. This algorithm uses a structural result which applies to other problem settings as well, and enabled us to present algorithms with approximation ratio $5/4 + \varepsilon$ for Strip Packing with rotations (90 degrees) and Contiguous Moldable Task Scheduling. This is joint work with Klaus Jansen (Univ. Kiel).

Derandomizing Martingale Inequalities with Applications to Covering in Hypergraphs

Anand Srivastav, Universität Kiel