Summary of the work

Lower Bounds and Exact Algorithms for the Graph Partitioning Problem using Multicommodity Flows

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The Graph Partitioning problem is one of the most famous problems in computer science: The vertices of a graph have to be partitioned into a given number of equally sized sets such that the number of edges which are adjacent to vertices in different sets is minimized.

In this work a new method for the calculation of lower bounds on the Graph Partitioning problem is presented. This new method is a kind of generalization of a well known method which became popular by the works of F.T. Leighton. This known method is based on the idea of embedding a clique into the given graph; the calculation of this embedding is equivalent to the calculation of a specific Multicommodity Flow problem. The presented new bounds are based on the observation that arbitrary Multicommodity Flow problems can be used also.

In the given work the principles of the new bounds and theoretical analyses are presented, efficient methods for their computation are introduced and an exact algorithm for solving Graph Partitioning problems is given.

The theoretical analyses show that on a large number of graphs the new bounds give clearly better results than the Leighton-bound. Furthermore when comparing the new bounds with the famous eigenvalue-based bounds the new ones often give better results. Using the presented exact algorithm it was possible to solve problems which have been unsolvable until now, e.g. calculating the bisection width of DeBruijn-networks of dimension 8 and 9. This new exact algorithm is also superior to the until now best exact algorithms on a large number of graphs (especially on sparse or structured graphs).