Branch-and-cut algorithms for graph problems

Valorization

The problems studied in this thesis have applications in various fields.

The minimum triangulation problem is used in Gaussian elimination of sparse positive definite matrices, database management, knowledge based systems, and Bayesian networks, artificial intelligence. The problem is also used in tensor-based recommender systems in order to determine the order of multiplication of sparse tensors.

Even though the graph coloring problem originates from the need to color the maps, it is also used in scheduling, timetabling, bandwidth allocation, and sequencing. In fact the literature on the applications of the problem precedes some of the literature on the graph coloring problem itself.

The optimal dike heights problem is used in order to determine safe dike heights in the Netherlands by balancing the cost of safety against the benefit of security from the floods. Whereas the previous literature focuses on mostly single dike scenarios, we were able to model different types of scenarios with respect to the relation of protection among dikes.

In addition to the good results we obtained using branch-and-cut algorithm, our branch-and-cut approaches for the problems are versatile in the sense that they can be used in combination with other approaches. Furthermore, we believe some of the results in this thesis can initiate further research on their respective problems.

Even though I humbly believe that the research carried in this thesis can be applied and has value in this sense, I strongly believe that trying to justify the value of research has the potential to decrease its value. In an age, where the value of research is strongly linked to publishing (a system that is flawed itself)

pushing for 'valuable' research risks concentrating research on popular topics. As researchers, we should remember that the questions are always there and most of the time we simply do not see them. I believe that the fact that we cannot see somethings does not take away their values. The graph coloring problem originates from the need to color the maps using the minimum number of colors. As it turned out the problem of coloring maps is not interesting (you can always do it with 4 colors) but the graph coloring problem is still researched to this day because of its other uses, which were not known at that time. The problem is used in compiler optimization, even though at that time the computers did not exist. We should remember that the problem would have still existed even if someone had said 'Just color the map!' because he or she could not see the value of the question at that time.