

DISSERTATION DEFENSE

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“Hybrid Approaches to Scheduling and Clustering”

This dissertation consists of four self-contained chapters. The first two chapters concentrate on the circuit constraint. The circuit constraint requires that a sequence of n vertices in a directed graph describe a hamiltonian cycle. The constraint is useful for the succinct formulation of sequencing problems, such as the traveling salesman problem, which it formulates with only one constraint and n variables. In the first chapter, “The Circuit Polytope”, we analyze the circuit polytope as an alternative to the traveling salesman polytope as a means of obtaining linear relaxations for sequencing problems. We provide a nearly complete characterization of the circuit polytope by showing how to generate, using a greedy algorithm, all facet-defining inequalities that contain at most $n - 4$ terms. We suggest efficient separation heuristics. Finally, we show that proper choice of the numerical values that index the vertices can allow the resulting relaxation to exploit structure in the objective function.

In the second chapter, “A Filter for the Circuit Constraint”, we present an incomplete filtering algorithm for the circuit constraint that removes redundant values by eliminating nonhamiltonian edges from the associated graph (i.e., edges that are part of no hamiltonian cycle). We identify nonhamiltonian edges by analyzing a smaller graph with labeled edges that is defined on a separator of the original graph. The complexity of the procedure is roughly the complexity of solving a max flow problem on a graph whose size is related to the size of the separator. We tested the procedure on a few thousand random instances of the circuit constraint having up to 15 variables. We found that it identified all infeasible instances and eliminated about one-third of the redundant domain elements in feasible instances.

In the third chapter, “Optimal Crane Scheduling”, there is a list of jobs to be assigned and scheduled to two cranes that move on the same track and cannot bypass each other. We present a two-phase algorithm developed for ABB Corporate Research. A local search algorithm assigns jobs to cranes and sequences the jobs on each crane. Then, a specialized dynamic programming algorithm obtains optimal crane space-time trajectories for that assignment and sequencing. Theoretical results are proved to limit the number of crane trajectories that must be considered.

In the last chapter, “The Minimum Product Cut Problem”, we consider minimum product cut problem that is to find an edge cut on an undirected graph with two distinct nonnegative edge weight functions where the product of cut values is minimum relative to two weight functions. We give a pseudo-polynomial 4-approximation algorithm for the minimum product cut problem that uses parametric search.