Abstract of the Thesis

Integrating Concepts from Constraint Programming and Operations Research Algorithms

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The integration of concepts from Constraint Programming (CP) and Operations Research (OR) algorithms has emerged in recent years. In this thesis we develop integrated CP and OR techniques. Our findings show that a combined CP and OR approach can increase efficiency, stability and robustness compared to approaches based only on either CP or OR. We apply our techniques to four different application areas.

Typically, solution approaches to the *Airline Crew Rostering Problem* are based on column generation. When using CP techniques in the subproblem, complex airline rules and regulations can be treated efficiently by our CP based column generation framework. Moreover, we show that this approach can be accelerated further by additional CP heuristics.

For the *Home Health Care Problem* we propose a generic mathematical model. Based on this model we develop a combined CP and Tabu Search approach. CP provides feasible solutions quickly, whereas Tabu Search can easily improve them. In order to solve the sequencing subproblems we apply a combined CP and LP approach. CP searches for valid orderings of tasks and the LP assigns an optimal start time to each task in that ordering.

For the *Automatic Recording Problem* we use CP based Lagrangian relaxation. When a given problem is composed of different substructures for which efficient domain filtering techniques are known, CP based Lagrangian relaxation allows us to reformulate the problem such that these filtering techniques can be efficiently applied. Furthermore, we show that the clear mathematical structure of the ARP can be tackled more efficiently by other OR approaches.

Finally, we consider a prominent problem taken from computer science. We propose domain filtering techniques for the *Maximum Clique Problem* and we present a model in which domain filtering from CP and bounding techniques from OR can be compared. We give a taxonomy of OR bounds and show that domain filtering outdoes most of these bounds.

Using two different branch-and-bound methods from literature we demonstrate the efficiency of domain filtering for the maximum clique problem. Enhanced by additional techniques, a fast branch-and-bound algorithm is developed and numerically investigated.