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Decision Diagrams for Discrete Optimization

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Abstract

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In recent years, decision diagrams (DDs) have been applied to various applications within the context of operations research. These include sequential pattern data mining, cut generation, product configuration, and post-optimality analysis in integer programming, to name a few. Through these applications and others, DDs have proven to be a useful tool for a variety of tasks. Unfortunately, DDs may grow exponentially large, which prohibits their application to large-scale problems.

To overcome this difficulty, we introduce the notion of limited-width approximate decision diagrams. By limiting the width of a decision diagram, the size of the data structure can be controlled to the level of accuracy desired.

In this talk, we will discuss the application of approximate DDs to discrete optimization problems, where we investigate their use as problem relaxations and restrictions of the feasible set. Approximate DDs can then be used to generate both upper and lower bounds on the objective function value for any separable objective function.

We then discuss how relaxed and restricted DDs can be used together to create a DD-based branch-and-bound algorithm. The algorithm differs substantially from traditional branch-and-bound algorithms on this class of problems in several important ways. First, relaxed DDs provide a discrete relaxation as opposed to a continuous relaxation (for example a linear programming relaxation), which is typically employed. In addition, subproblems are generated by branching on several partial solutions taken at once, thereby eliminating certain symmetry from the search. We discuss the application of the algorithm to the classical maximum independent set problem. Computational results show that the algorithm is competitive with state-of-the-art integer programming technology