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Heuristics of the Branch-Cut-and-Price-Framework SCIP

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Abstract

In this paper we give an overview of the heuristics which are integrated into the open source branch-cut-and-price-framework SCIP. We briefly describe the fundamental ideas of different categories of heuristics and present some computational results which demonstrate the impact of heuristics on the overall solving process of SCIP.

1 Introduction

A lot of problems arising in various areas of Combinatorial Optimization and Operations Research can be formulated as *Mixed Integer Programs (MIP)*. Although MIP-solving is an $\mathcal{NP}$-hard optimization problem, many practically relevant instances can be solved in reasonable time. The standard exact method for solving MIPs is *branch-and-cut*, a combination of LP-based branch-and-bound and cutting plane techniques. Besides that, heuristics (Greek εὑρίσκειν – to find) are incomplete methods which quickly try to construct feasible solutions of high quality, but without any guarantee to find one.

In state-of-the-art MIP-solvers like the branch-cut-and-price-framework SCIP (Solving Constraint Integer Programs) [1, 3] heuristics play a major role in finding and improving feasible solutions at early stages of the solution process. This helps to reduce the overall computational effort, guides the remaining search process, and proves the feasibility of the MIP model. Furthermore, a heuristic solution with a small gap to optimality often is sufficient for practical applications.

Overall, there are 23 heuristics integrated into SCIP version 1.00. They can be roughly subclassified into four categories: rounding, diving, objective diving, and large neighborhood search heuristics. In the remainder, we will give a short introduction into these strategies and afterwards we will present some computational results. For more detail, we refer to Achterberg [1] and Berthold [6].

2 Rounding Heuristics

All rounding heuristics in SCIP work in the following way: they take an LP-feasible but fractional point – normally the optimum of some LP-relaxation –

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