Cutting Plane Separators in SCIP

Kati Wolter

Konrad-Zuse-Zentrum für Informationstechnik Berlin (ZIB),
Division Scientific Computing, Takustr. 7, 14195 Berlin-Dahlem
wolter@zib.de

SCIP, developed at the Zuse Institute Berlin, is a solver for general mixed integer programs (MIPs) and can also be used as a linear programming based branch-and-cut framework. It is highly flexible through many possible user plugins, allows total control of the solution process and provides direct access to detailed information. SCIP is free for academic use and currently the fastest non-commercial MIP solver.

In this talk, I want to show how cutting plane separators work in SCIP. These form one of the most important features of general MIP solvers. The framework comes along with separation algorithms for classes of general cutting planes and with separators generating strong valid inequalities for special problems that are useful relaxations of MIPs. None of these classes of valid inequalities is new, but separating them efficiently in practice is a challenging task.

In my diploma thesis [2], I implemented three different cutting plane separators, namely the separator for the class of complemented mixed integer rounding inequalities (c-MIR inequalities), the separator for the 0-1 single node flow problem, and the separator for the 0-1 knapsack problem. The final cutting plane separator for the class of c-MIR inequalities follows the separation heuristic suggested by Marchand and Wolsey in [1], but uses a more elaborated strategy for constructing the mixed knapsack sets. It turned out that this aspect strongly affects the performance of the cutting plane separator. The resulting separator is the most important one for improving the overall performance of SCIP. For the 0-1 single node flow cutting plane separator, I developed a heuristic that separates a class of inequalities which has been derived in the literature, but for which no computational results had been published.

All considered separation problems are solved heuristically; the corresponding separation algorithms consist of a set of heuristic decisions. My work includes a detailed discussion of different strategies suggested in the literature for making these decisions as well as enhancements of these strategies. In order to obtain efficient cutting plane separators, I conducted an extensive computational study concerning the effect of the different strategies discussed in my thesis. Concluding computational experiments have shown that all of the implemented cutting plane separators have a strong impact on the overall performance of SCIP and are competitive to the ones included in other state-of-the-art MIP solvers.

Literatur

[1] H. Marchand and L.A. Wolsey. Aggregation and mixed integer rounding to solve MIPs. *Operations Research*, 49:363–371, 2001.

[2] K. Wolter. *Implementation of cutting plane separators for mixed integer programs.* Diploma Thesis, Technische Universität Berlin, 2006.