SCIP8: rethinking nonlinear constraint representation and recent progress

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1 Introduction

SCIP is a solver framework for exact optimization in the mixed-integer linear and nonlinear settings, and more broadly for Constraint Integer Programs; academically developed, freely available and source-open for researchers. The talk will provide an overview of the recent development appearing in SCIP 8 [1] with an emphasis on the change in the representation of nonlinear constraints and on improvements leveraging some specific discrete structures.

2 A new constraint expression framework

A major novelty of the SCIP 8 release is the development of a new framework for nonlinear constraints, coined *constraint expressions*. We present motivations for this rewrite of the representation of nonlinear expressions, how it impacts the MINLP solving process and makes the solver numerically more robust. In the new framework, special nonlinear structures such as quadratic constraints, second-order cone constraints are detected within the linear expression instead of being declared separately by users.

3 Leveraging discrete structures

Other improvements brought by SCIP 8 leverage specific discrete structures in the solving process. These include in particular generalization of the symmetry handling mechanism to MINLP and to general integer variables instead of only binary variables. Mixing cuts, along with the appropriate separation procedure, were added to SCIP for specific types of mixed-binary constraints naturally arising in chance-constrained optimization. Finally, improvements were brought to decomposition heuristics in SCIP, in particular to the Penalty Alternating Direction Method for MINLPs and a new Dynamic Partition Search heuristic for problems with a block structure and linking constraints.

4 Computational experiments

We will present computational studies showing the effect of some particular new features and an aggregated view comparing SCIP 8 to the previous major release on the MIPLib and MINLPLib instance sets. These experiments show performance improvements on MILPs, with a higher speed-up on harder instances, and an overall improvement on MINLP with more instances being solved, but also some subsets where the new framework degraded performance.

References

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