

Leveraging Linear and Mixed Integer Programming for SMT

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Abstract

SMT solvers combine SAT reasoning with specialized theory solvers to either find a feasible solution to a set of constraints or prove that no such solution exists. Linear programming (LP) solvers come from the tradition of optimization, and are designed to find feasible solutions that are optimal with respect to some optimization function. Typical LP solvers are designed to solve large systems quickly using floating point arithmetic. Because floating point arithmetic is inexact, rounding errors can lead to incorrect results, making inexact solvers inappropriate for direct use in theorem proving. Previous efforts to leverage such solvers in the context of SMT have concluded that in addition to being potentially unsound, such solvers are too heavyweight to compete in the context of SMT. In this paper, we describe a technique for integrating LP solvers that dramatically improves the performance of SMT solvers without compromising correctness. These techniques have been implemented using the SMT solver CVC4 and the LP solver GLPK. Experiments show that this implementation outperforms other state-of-the-art SMT solvers on the QF.LRA SMT-LIB benchmarks and is competitive on the QF.LIA benchmarks.