TITLE: "Solving quantified formulas in SMT by finite model finding"

ABSTRACT: SMT solvers have been used successfully as reasoning engines in formal methods and other application areas. Current techniques for dealing with quantified formulas in SMT are generally incomplete, forcing SMT solvers to report "unknown" when they fail to prove the unsatisfiability of a formula with quantifiers. Their inability to return models for these formulas limits their usefulness in applications that generate quantified queries. We present a novel finite model finding method that reduces these limitations in the case of quantifiers ranging over uninterpreted sorts. The method is fully integrated into the general architecture used by most SMT solvers and relies on an efficient solver for sort cardinality constraint and a module for complete quantifier instantiation over finite domains. Efficient quantifier instantiation is achieved through the explicit construction of candidate models and the use of strategies that identify and avoid large sets of unnecessary instantiations.
We present the method and its main features. Then, we discuss experimental evidence showing that it is practical for use in industrial applications and competitive with other approaches in SMT and first-order theorem proving. Time permitting, we will also discuss a promising extension of the method to bounded quantifiers over the integers.