Semantically-Guided Goal-Sensitive Theorem Proving

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Abstract

SGGS, for Semantically-Guided Goal-Sensitive theorem proving, is a new inference system for first-order logic. It was inspired by the idea of generalizing to first-order logic the model-based style of the Davis-Putnam-Logemann-Loveland (DPLL) procedure for propositional logic. Model-based reasoning is a key feature of SAT solvers, SMT solvers, and model-constructing decision procedures for specific theories, and a crucial ingredient to their practical success (e.g., [4]). However, model-based reasoning in first-order logic is challenging, because the logic is only semi-decidable, the search space is infinite, and model representation is harder than in the propositional case. SGGS meets the challenge by realizing a seemingly rare combination of properties: it is model-based à la DPLL; semantically guided by an initial interpretation, to avoid blind guessing in an infinite search space; proof confluent, to avoid backtracking, which may be cumbersome for first-order problems; goal-sensitive, which is important when there are many axioms or a large knowledge base; and it uses unification to avoid enumeration of ground terms, which is inefficient, especially for rich signatures. In terms of operations, SGGS combines instance generation, resolution, and constraints, in a model-centric approach: it uses sequences of constrained clauses to represent models, instance generation to extend the model, resolution and other inferences to repair it. This talk advertises SGGS to the rewriting community, presenting the main ideas in the method: a main direction for future work is extension to first-order logic with equality, which requires rewrite-based reasoning. A manuscript including all aspects of SGGS, the technical details, the proofs of refutational completeness and goal-sensitivity, a comparison with other work (e.g., resolution with set of support [6], the disconnection calculus [2], the model evolution calculus [1], the Inst-Gen method [5]) and more references, is available as [3].

References