Title	Equational Reasoning by Maximal Ordered Completion
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Abstract

This thesis studies equational theorem proving based on ordered completion. It is known that a reduction order is a critical parameter for ordered completion. To improve the capability of ordered completion, we present a new class of reduction orders, dubbed the generalized weighted path order. While the original weighted path order (Yamada et al. 2013) is a complete characterization of simplification orders including Knuth-Bendix orders and lexicographic path orders, the new class not only subsumes the original one, but also instantiates non-simplification orders. For instance, provided equational axioms for round-up division, refutation of non-theorems is never archived by weighted path orders. In contrast, ordered completion with a generalized weighted path order is capable of giving refutation to non-theorems. However, the generalized weighted path order forces us to revisit a classical problem of ordered completion, namely selection of a reduction order: given an equational system, we do not know an appropriate reduction order in advance. The problem is even worse in the case of the generalized weighted path order since the ordering takes a precedence and a potentially non-simple algebra as its parameters, which have vast search space. As a solution to this problem, we integrate the generalized weighted path order into maximal ordered completion by Winkler and Moser (2018), in which we encode selection of a reduction order into MaxSMT constraints. Furthermore, to improve the efficiency, we propose a new variant of maximal ordered completion, which incorporates ordered completion without deduce, namely simplification, following the approach of Hirokawa (2021). The new ordering and the new ordered completion are implemented in the equational theorem prover Toma, and experimental results show potential of our approach.