On the Complexity of Confluence for Ground Rewrite Systems

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Abstract

Programming language interpreters, proving equations (e.g. \( x^3 = x \) implies the ring is Abelian), abstract data types, program transformation and optimization, and even computation itself (e.g., turing machine) can all be specified by a set of rules, called a rewrite system. A fundamental property of a rewrite system is the confluence or Church-Rosser property. In this paper, we show, using new and direct techniques, that: (i) confluence for ground rewrite systems containing one unary symbol and arbitrary many constants is in the complexity class \( P \); (ii) confluence for ground rewrite systems containing arbitrary many unary symbols and constants is in \( \text{co-NP} \); and (iii) confluence for arbitrary ground rewrite systems is in the complexity class deterministic \( \text{EXPTIME} \). The best previous decidability results for these problems are indirectly obtained using tree automata techniques and the upper bounds are not precisely specified in these papers.