Abstract

Decidability and Undecidability Results of Modal μ-calculi with N_∞ Semantics

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In our previous study, we defined the semantics of modal μ-calculus on min-plus algebra N_∞ and developed a model-checking algorithm. N_∞ is the set of all natural numbers and infinity (∞), and has two operations min and plus. In the semantics, disjunctions are interpreted by min and conjunctions by plus. This semantics allows interesting properties of a Kripke structure, such as the shortest path to some state or the number of states that satisfy a specified condition, to be expressed using simple formulae. In this study, we investigate the satisfiability problem in N_∞ semantics and prove decidability and undecidability results. First, the problem is decidable if the logic does not contain the implication operator. We prove this result by defining a translation $\mathrm{tr}(\varphi)$ of formula φ such that the satisfiability of φ in N_∞ semantics is equivalent to that of $\mathrm{tr}(\varphi)$ in ordinary semantics. Second, the satisfiablity problem becomes undecidable if the logic contains the implication operator.

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