Simulation Preorder on Simple Process Algebras

Abstract:
We consider the problem of simulation preorder/equivalence between infinite-state processes and finite-state ones. We prove that simulation preorder (in both directions) and simulation equivalence are intractable between all major classes of infinite-state systems and finite-state ones. This result is obtained by showing that the problem whether a BPA (or BPP) process simulates a finite-state one is PSPACE-hard, and the other direction is coNP-hard; consequently, simulation equivalence between BPA (or BPP) and finite-state processes is also coNP-hard. The decidability border for the mentioned problem is also established. Simulation preorder (in both directions) and simulation equivalence are shown to be decidable in EXPTIME between pushdown processes and finite-state ones. On the other hand, simulation preorder is undecidable between PA and finite-state processes in both directions. The obtained results also hold for those PA and finite-state processes which are deterministic and normed, and thus immediately extend to trace preorder. Regularity (finiteness) w.r.t. simulation and trace equivalence is also shown to be undecidable for PA. Finally, we describe a way how to utilize decidability of bisimulation problems to solve certain instances of undecidable simulation problems. We apply this method to BPP processes.

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