Proof techniques for program equivalence in probabilistic higher-order languages

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Abstract

While the theory of functional higher-order languages, starting from lambda-calculi, is a well-established research field, it is only in recent years that the operational semantics of higher-order languages with probabilistic operators has started to be extensively studied. A fundamental notion in the semantics of programming languages is that of program equivalence. In higher-order languages, program equivalence is generally formalized as a contextual equivalence [6], which can be hard to prove directly. This has motivated the study of proof techniques for contextual equivalence, from inductive ones, such as logical relations [7], to coinductive ones, mainly in the form of bisimulations [1]. In this talk I will discuss proof techniques for program equivalence in languages combining higher-order and probabilistic features. Several operational methods, traditionally developed in a deterministic setting, have been adapted to probabilistic higher-order languages [2, 5, 4]. I will discuss these proof methods and focus on bisimulation-based techniques, showing how probabilities, combined with different language features, force a number of modifications to the definition of bisimulation [3, 8].

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