Guarded Kleene Algebra with Tests: Verification of Uninterpreted Programs in Nearly Linear Time

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Abstract

Guarded Kleene Algebra with Tests (GKAT) is a variation on Kleene Algebra with Tests (KAT) that arises by restricting the union (+) and iteration (*) operations from KAT to predicate-guarded versions. We develop the (co)algebraic theory of GKAT and show how it can be efficiently used to reason about imperative programs. In contrast to KAT, whose equational theory is PSPACE-complete, we show that the equational theory of GKAT is (almost) linear time. We also provide a full Kleene theorem and prove completeness for an analogue of Salomaa’s axiomatization of Kleene Algebra. We will also discuss how this result has practical implications in the verification of programs, with examples from network and probabilistic programming. This is joint work with Nate Foster, Justin Hsu, Tobias Kappe, Dexter Kozen, and Steffen Smolka.

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