

Static Analysis through Abstract Interpretation, Convex Optimization, and Strategy Iteration

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In this presentation, we will briefly discuss how convex optimization techniques, such as linear programming, can be used to statically infer numerical invariants of programs. We do this as follows: we formulate the static analysis problem as a problem of finding the least fixpoint of a monotonic operator. The latter problem we consider as a 2-players zero-sum game between a maximizer and a minimizer. Intuitively, the maximizer aims at broaden the numerical invariant we want to compute, whereas the minimizer aims at tighten the numerical invariant. This view finally allows us to construct a strategy improvement algorithm for performing template-based numerical static program analysis by abstract interpretation without losing precision due to widening and narrowing. This gives us, for instance, a practical method for computing the tightest numerical invariants for a given program within a given template linear constraint domain. The algorithmic tools we developed further allow us to prove that the associated decision problems are in coNP. Beside the mentioned applications in the field of static program analysis, our methods can also be applied for solving stochastic mu-calculus formulas and stochastic 2-players games.