Problem Statement

- Optimize linear objective functions $T = \{t_1, \ldots, t_f\}$ subject to quantifier-free linear real arithmetic (QF_LRA) constraints $\phi$.
- Geometrically, find tightest bounds for non-convex polyhedron.

The problem is known as Symbolic Optimization.

Applications in PL

- Counterexample generation: finding optimal counterexamples that maximize/minimize certain criteria.
- Program synthesis: synthesizing programs with lowest costs in performance critical contexts.
- Interpolation generation: simplifying unsatisfiability proofs which can be used to generate simpler interpolants [3].

The SYMBA Approach

SYMBA maintains an under-approximation ($U$) of the optimal solution and grows $U$ as a series of SMT-based sampling rule applications:

- GlobalPush (GP): sample a point outside of $U$.
- Unbounded (UB): check unboundedness and sample a vertex as a side effect.

Experimental Evaluation

Performance comparisons on benchmark set obtained from Competition on Software Verification (SV-COMP 2013) program analysis tasks

Our Solution: SYMBA

SYMBA is a novel SMT-based optimization algorithm for objective functions in linear real arithmetic:

- Utilizes efficient SMT solvers as black boxes
- Handles a mix of different theories, e.g., array, Boolean, LRA
- Flexible and configurable algorithm that is easy to optimize
- Optimizes a set of objective functions, reusing information among them to speed up the optimization task
- Extensive evaluation against other proposed techniques on program analysis benchmarks
- Implementation and benchmarks are available at: http://bitbucket.org/arie/g

Conclusion and Next Step

SYMBA solves the symbolic optimization problem by systematic and efficient point sampling via SMT queries. Experimental evaluation indicates advantages over other techniques. Future work:

- Extend to integer arithmetic
- Handle non-linear objective functions
- Exploit parallelism in implementation

References