The Software Model Checker BLAST: Applications to Software Engineering

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Int. Journal on Software Tools for
Technology Transfer, 2007

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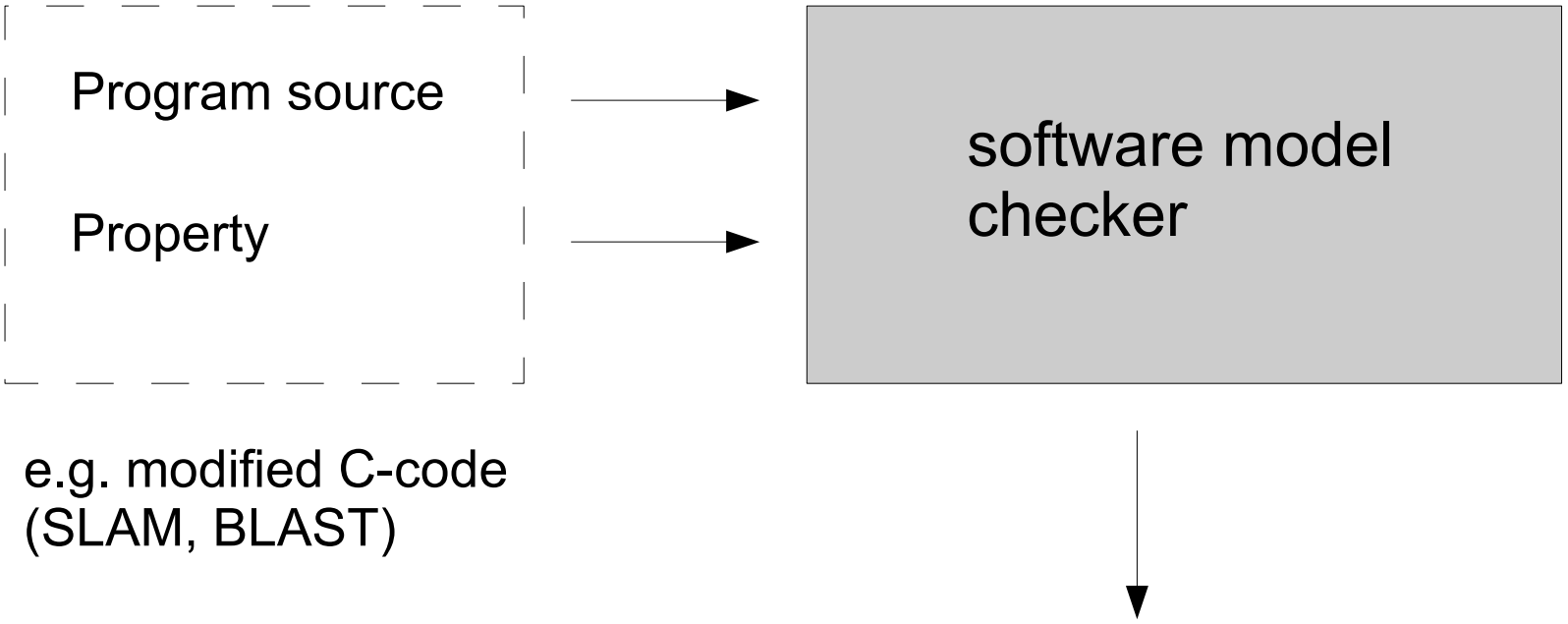
March 17, 2009

Model checking



e.g. modified C-code
(SLAM, BLAST)

- Valid according to the specification
- Error path

Model checking

Goal

Find a path from an initial state to an error state (reachability)

Problem

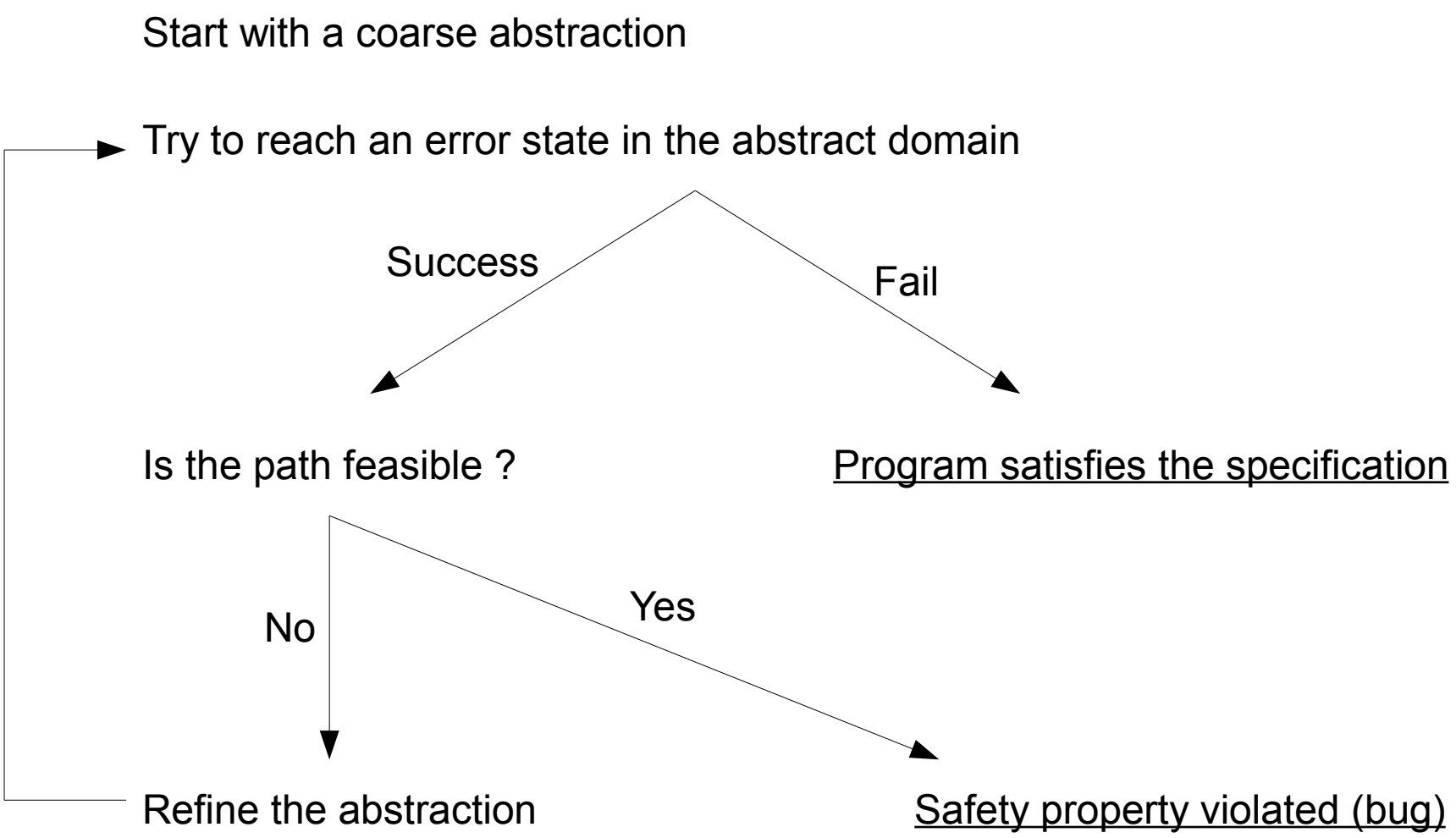
State explosion ! Infeasible to check every state.

BLAST's solution

Dynamic (lazy) predicate abstraction

CEGAR

Counterexample-guided abstraction refinement



Optimizations

Lazy predicate abstraction

- don't refine error-free regions

Interpolation-based predicate discovery

- add predicates locally when refining

Applications

Reduce runtime memory-checks

- Test their reachability and remove unnecessary ones

Automatic test generation

- For any counterexample found try to generate a test vector

BLASTing Linux Code

Demonstration

Open source !

http://mtc.epfl.ch/software-tools/blast/

Limitations

False alarms (can't show infeasability of a path)

- Mathematical integers (no overflows modeled)
- Decision functions only implement linear arithmetic
- Uninterpreted functions (e.g. bit-level manipulations)
- Simple pointer arithmetic and alias-handling

Weak predicate language

- No logical quantifiers
- No precise reasoning about recursive functions possible

Conclusion

+ Good performance and scalability

- Limitations make it impractical for a lot of real world applications (pointer arithmetic !)

- Manually modifying the source code is always required

BACKUP

Data structures

Control flow automaton (CFA)

- Internal representation of a program
- Nodes are control points, edges are operations

Abstract reachability tree (ART)

- Represents a portion of the reachable state space
- A path in the ART corresponds to a program execution
- Each node stores a link to a CFA-location, the current call stack and the state of variables

Automatic test generation

Target Predicate Coverage

Can a location be reached and the variables satisfy a predicate p ? e.g. p = true for location coverage

Coverage of a location L

Test if L is reachable (dead code detection)

When a feasible path is found generate a variable assignment that guides it to the location

Embarrassingly parallel