Exploiting Synergy Between Testing and Inferred Partial Specifications

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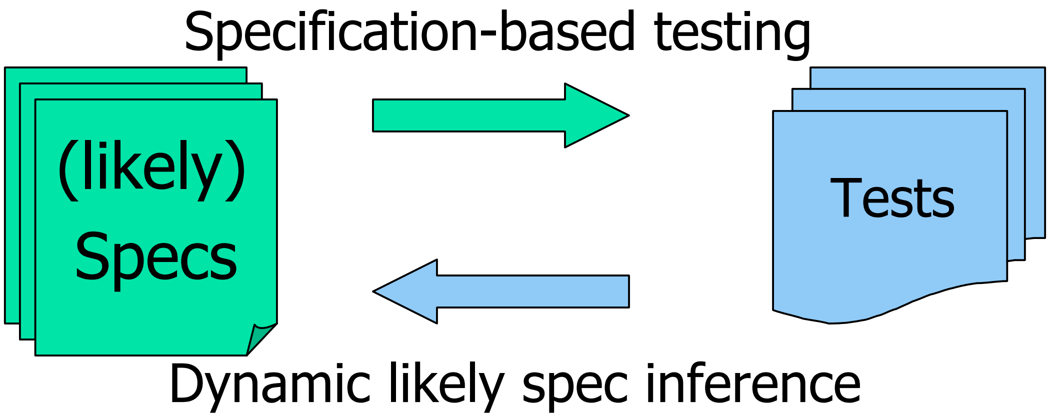
May 9, 2003

Workshop on Dynamic Analysis (WODA 2003)

Outline

- Background
- Synergy issues
- Application
- Why it will fail
- Why it will succeed

Background



Specification-based testing

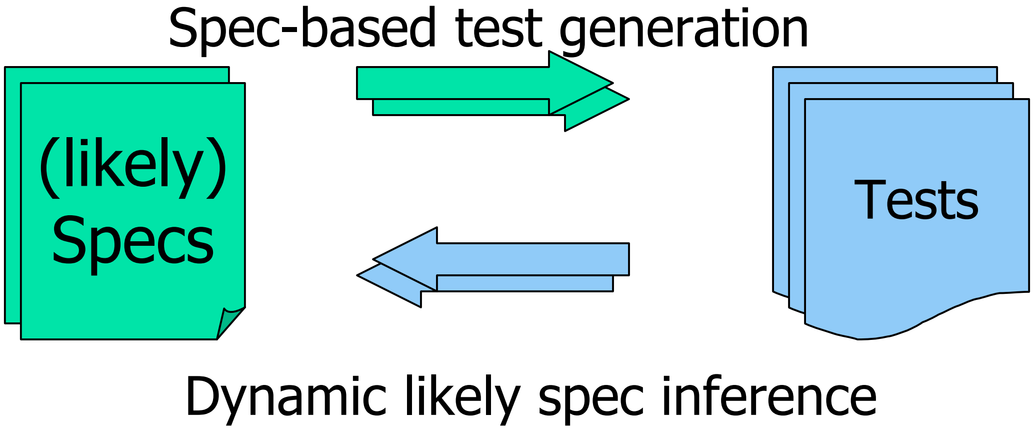
(likely) Specs

Tests

Dynamic likely spec inference

- Test case generation, e.g. Korat [BKM 02], Jtest [ParaSoft] , AsmL [MSR]
- Test oracle generation, e.g. Korat, Jtest, JML+JUnit [CL 01]
- Test selection/coverage criteria, e.g. ADLscope [CR 99], UMLTest [OA 99]
- Likely spec Inference based on test executions, e.g. Daikon operational abstraction [ECGN 01], Strauss [ABL 02], Hastings [WML 02]

Synergy Issue: Chicken-and-Egg I



Spec-based test generation

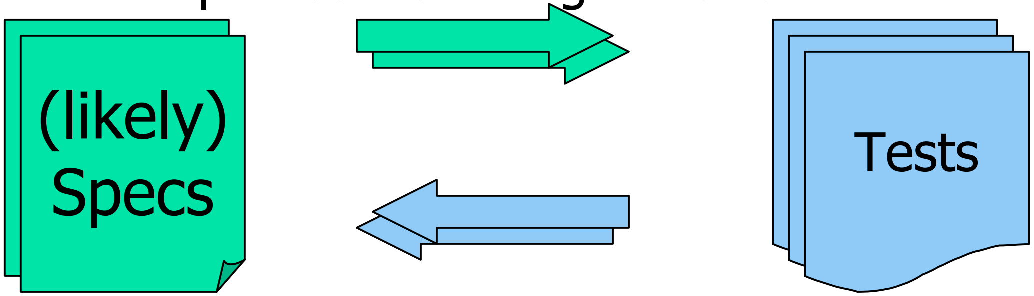
(likely) Specs

Tests

Dynamic likely spec inference

- Win-win feedback loop: better spec ←→ better tests?
- Chicken and egg problem?

Synergy Issue: Chicken-and-Egg II



Spec-based test generation

(likely) Specs

Tests

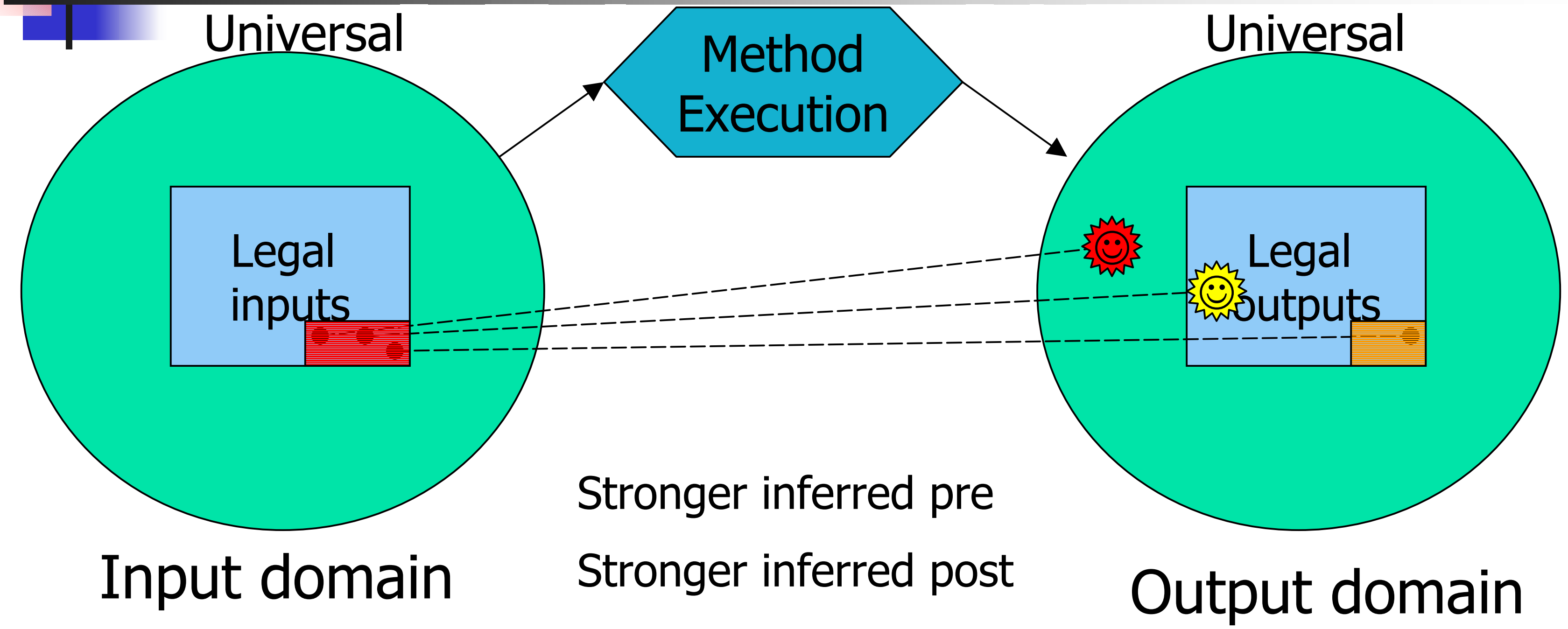
Dynamic likely spec inference

- Initial tests *T* (manually written tests, automatically generated tests w/o specs, etc.)
- Likely specs *S* inferred from *T*
- Tests *T'* generated based on *S*

Executions of *T'* → *select* a subset of *T'*
[*Test augmentation: T* = *T* ∪ the subset of *T'*]   ***Better tests***

- Likely specs S inferred from *T*   ***Better specs***

Executions of Tests Generated From Likely Specifications -I



Universal

Method Execution

Universal

Legal inputs

Legal outputs

Stronger inferred pre

Stronger inferred post

Input domain

Output domain

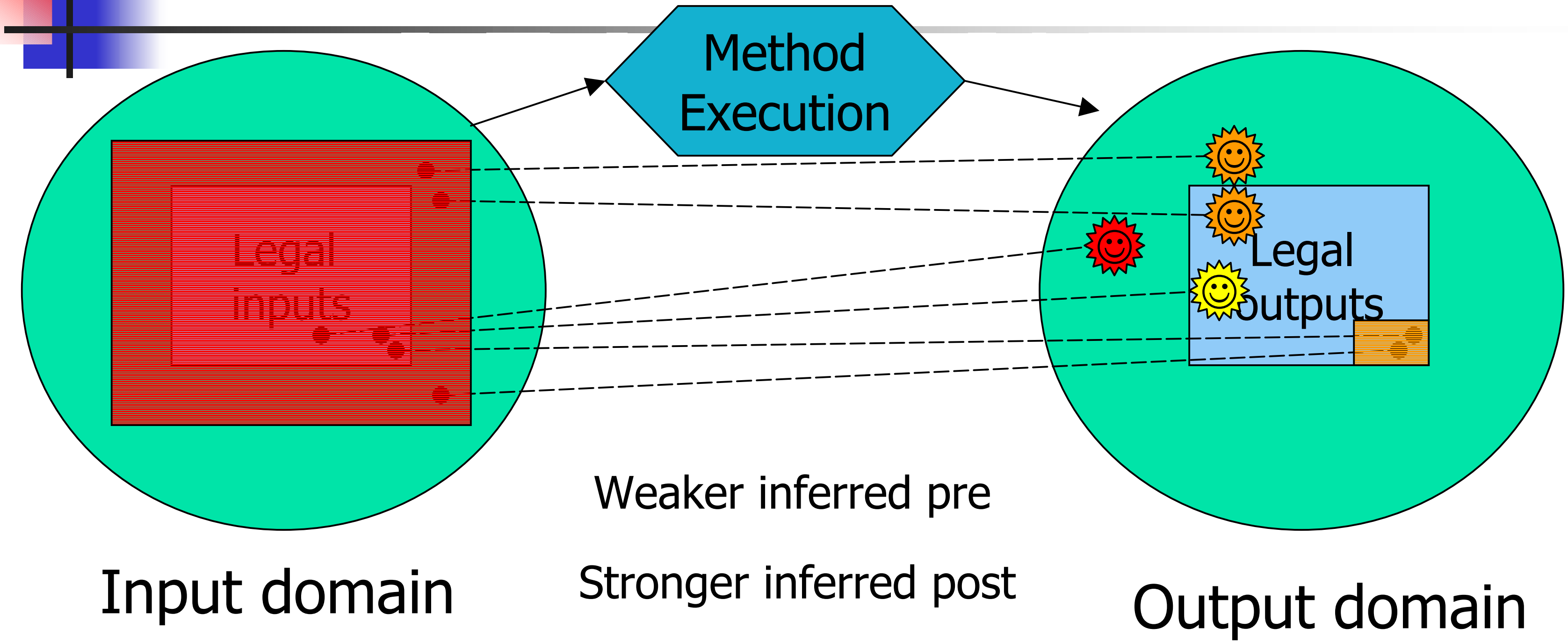
🟥 Inferred precondition constrained domain

🟧 Inferred postcondition constrained domain

🌞 Postcondition violation (exercise a new feature)

🔴 Postcondition violation (expose a fault)

Executions of Tests Generated From Likely Specifications -II



Method Execution

Legal inputs

Legal outputs

Weaker inferred pre

Stronger inferred post

Input domain

Output domain

🟥 Inferred precondition constrained domain

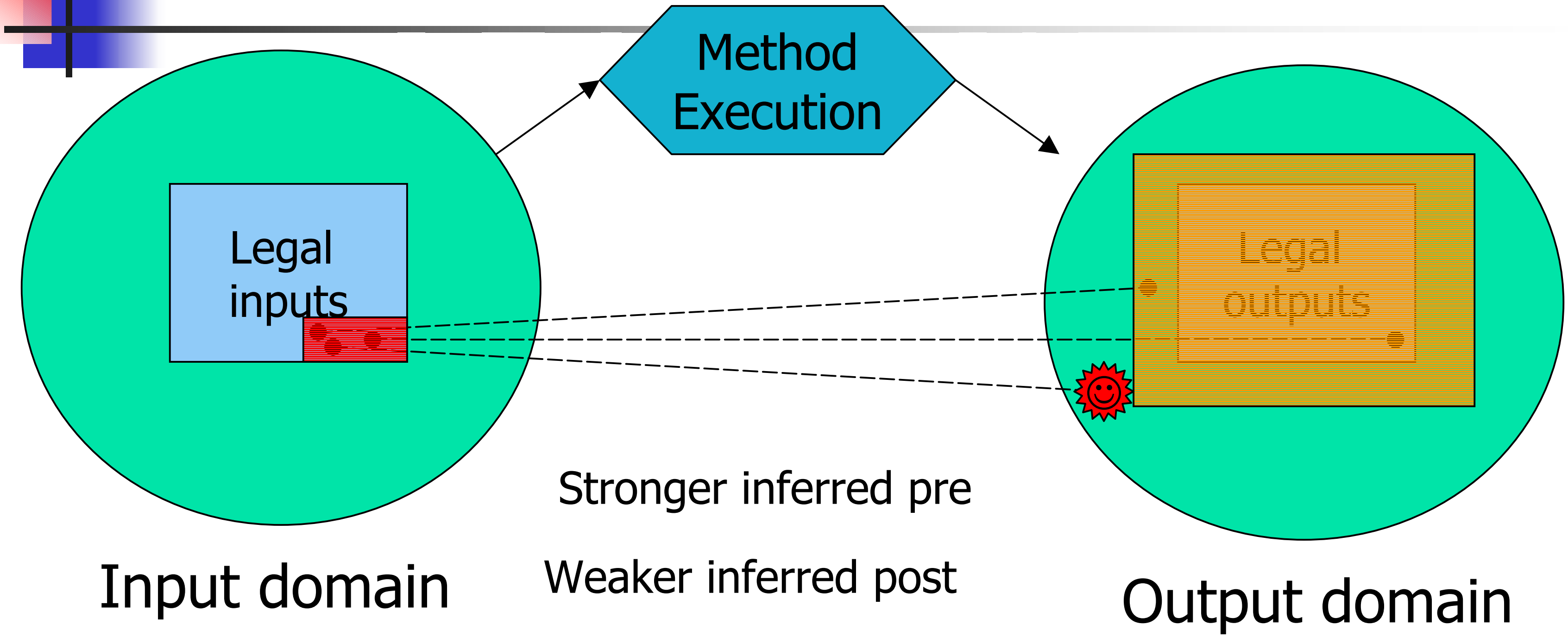
🟧 Inferred postcondition constrained domain

☀ Postcondition violation (exercise a new feature)

☀ Postcondition violation (narrow down precondition)

☀ Postcondition violation (expose a fault)

Executions of Tests Generated From Likely Specifications -III

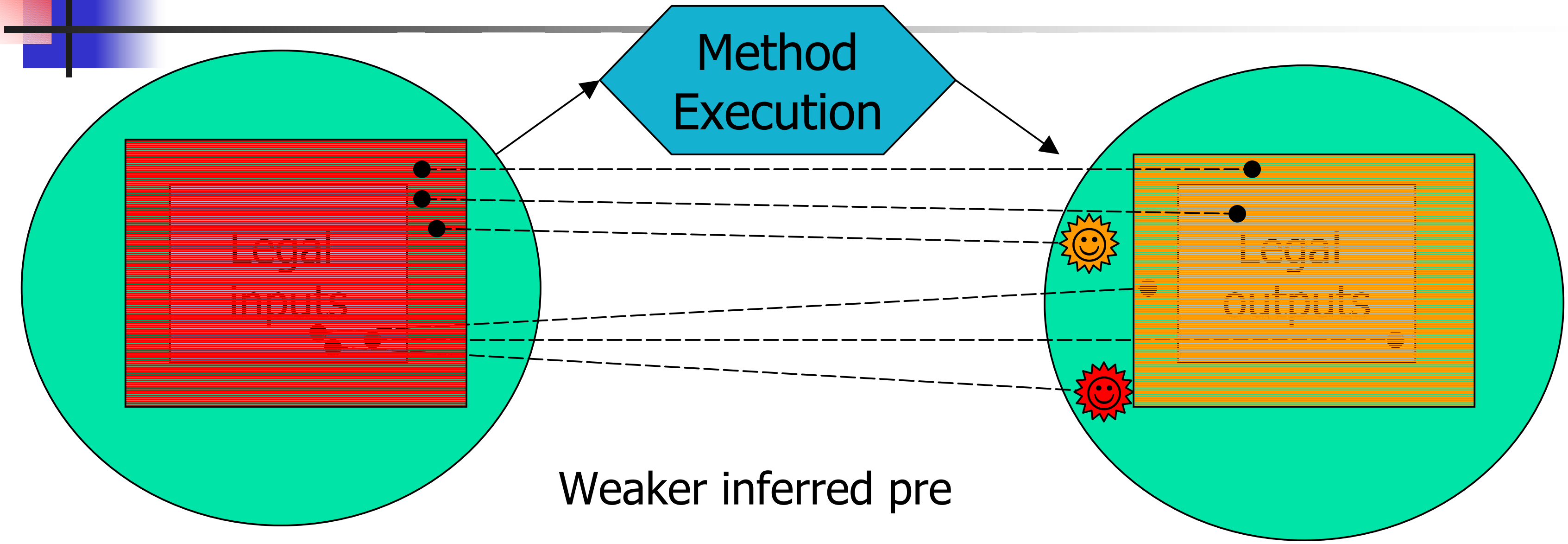


🟥 Inferred precondition constrained domain

🟧 Inferred postcondition constrained domain

✹ Postcondition violation (expose a fault)

Executions of Tests Generated From Likely Specifications -IV



Weaker inferred pre

Weaker inferred post

Input domain

Output domain

🟥 Inferred precondition constrained domain

🟧 Inferred postcondition constrained domain

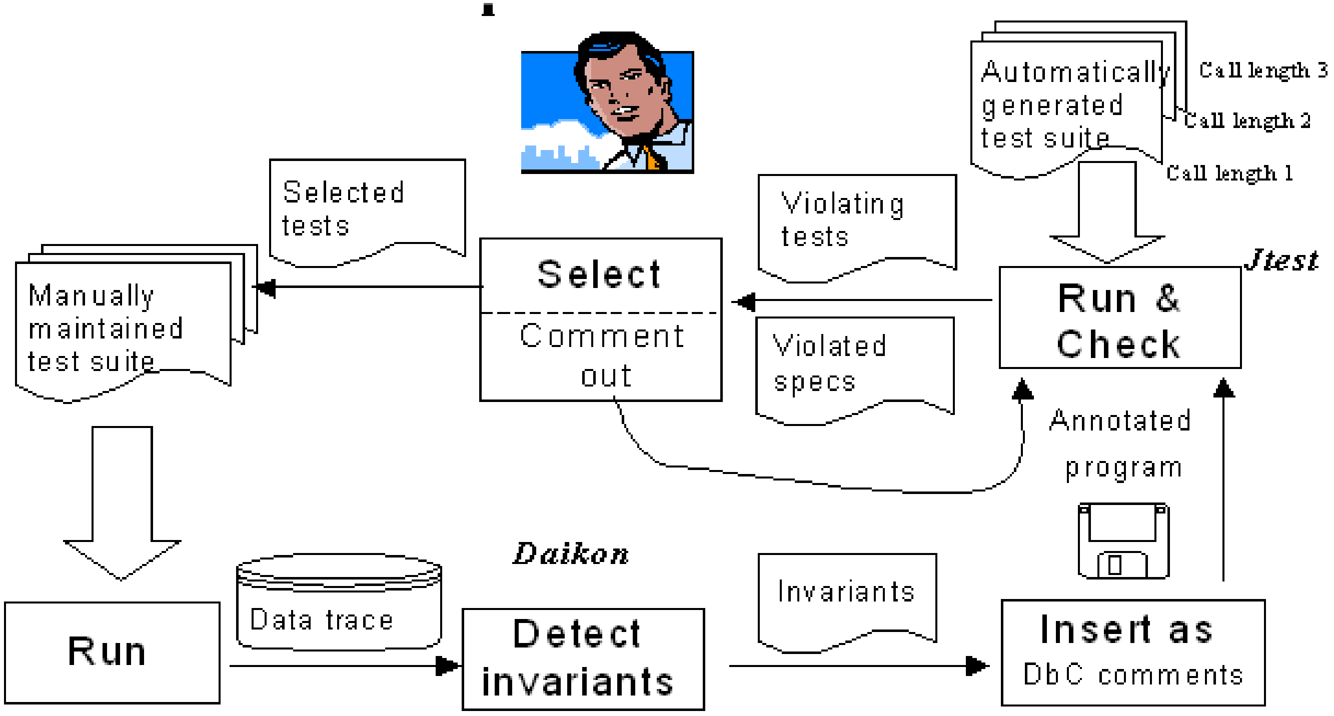
☀ Postcondition violation (narrow down precondition)

☀ Postcondition violation (expose a fault)

Handling Synergy Issues

- Precondition guard removal
  - Too restrictive preconditions may leave (maybe important) legal unit inputs untested
- Iterations until reaching a fixed point
  - Add new violating tests (legal inputs) to the existing test suite for spec inference in next cycle
  - Add stronger preconditions manually

Application: Spec-Violation Approach to Unit Test Data Selection



- Problem
  - Insufficiency of the manually maintained unit test suite A (small number)
  - Oracle unavailability of the automatically generated unit test suite B (large number)
- Goal: Selectively augment A with a small (most valuable) subset of B
- Related work: Operational Difference [HME 03], DIDUCE [HL 02]

Why it will fail

- Not enough inferred postconditions to violate
  - Improved inference techniques can help
- Precondition guard removal might induce false positives
  - Precondition guard relaxation can help
- Postcondition violations are due to limited test data value range uninteresting to testers
- Manually commenting out violated specs is tedious
  - Improved Jtest to support it can help

Why it will succeed

- Without a priori specification, there are few effective black box unit test data selection approaches.
- Violating tests can guarantee to exercise a new program feature
- The violated specs for the corresponding violating tests can help developers to make selection decision easily.
- The approach can be largely automated