Regression testing

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Main topics of the course

- Overview (1.5)
  - Introduction, V&V techniques
- Static techniques (1.5)
  - Specification, Verifying source code
- Dynamic techniques: Testing (7)
  - Testing overview, Test design techniques
  - Test generation, **Automation**
- System-level verification (3)
  - Verifying architecture, Dependability analysis
  - Runtime verification

Learning outcomes

- Recall approaches for regression testing (K1)
- Perform regression test selection on simple examples (K3)

Regression testing

“selective retesting of a system or component to verify that modifications have not caused unintended effects and that the system or component still complies with its specified requirements”

Source: IEEE Standard24765

Challenge with regression testing

- Default strategy: retest-all
- Too many tests
  - Does not fit into testing window (e.g. nightly build)
  - Retesting all after small change?
  - Slow feedback
- Tradeoff: precision vs. resources

Regression testing approaches

- Test Suite Minimization
  - Reduce test suite by eliminating redundant tests
- Test Case Selection / Regression Test Selection
  - For a given modification, find relevant tests
- Test Case Prioritization
  - Reorder tests to maximize some property (e.g. rate of fault detection, speed)

S. Yoo and M. Harman, “Regression testing minimization, selection and prioritization: a survey,”STVR, 22:2, pp. 67–120, 2012.

Main idea of regression testing approaches

- Elements:
  - P, P’: program versions
  - T: test suite
  - C: coverage items (requirements, code structure…)
- Mapping:
  - T $\rightarrow$ C
- Use this mapping to calculate new test suite

Why is this hard?

- Test Suite Minimization
  - minimal hitting set problem (NP-complete)
- Test Case Selection
  - minimal set cover problem (NP-complete)
- Use heuristics in practice

REGRESSION TEST SELECTION

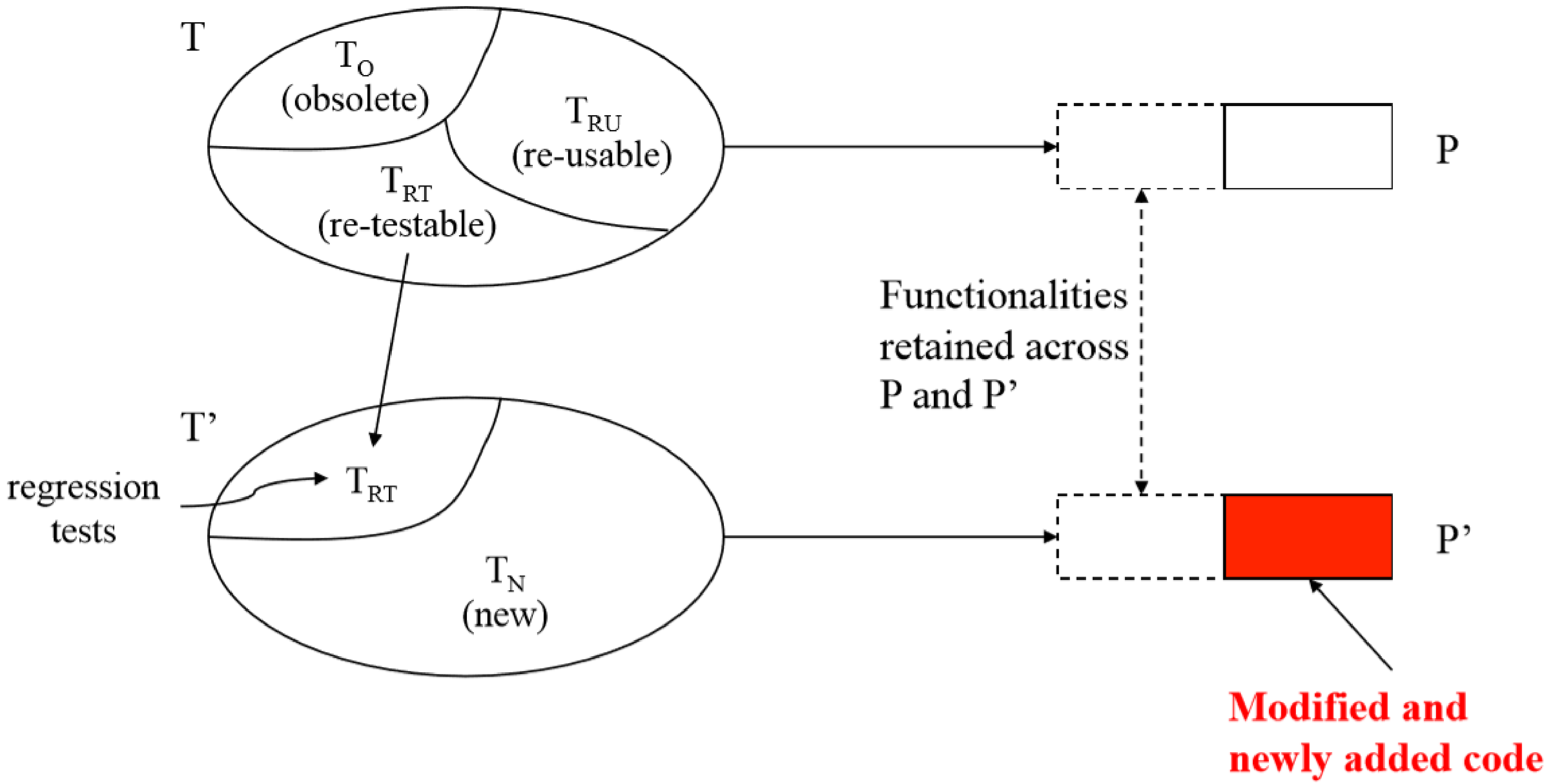
Example

- Tests: t1, t2, t3, t4
- Requirements: r1, r2, r3
- Mapping:
  - t1 -> r1
  - t2 -> r1, r2
  - t3 -> r2
  - t4 -> r3
- Change: r2 and r3
- Which tests to execute?

Classification of tests

- Re-usable: tests that exercise unmodified parts of the system.
- Re-testable: tests that are changed or are able to cover changed parts in the system.
- Obsolete: tests that cannot be used anymore due to changed specification or system structure.
- New structure tests that contribute to the overall coverage of the current, new system structure.
- New specification tests that verify new elements in the current specification.

Classification of tests



Source: Lionel Briand. An Introduction to Regression Testing, Simula Research Lab. 2011

Scope and granularity of RTS

What coverage items to use?

- Requirements (traceability is needed)
- Structural: code coverage
  - Component / File / Class / Method / Line …
  - Precision vs. speed of RTS

Approaches for RTS

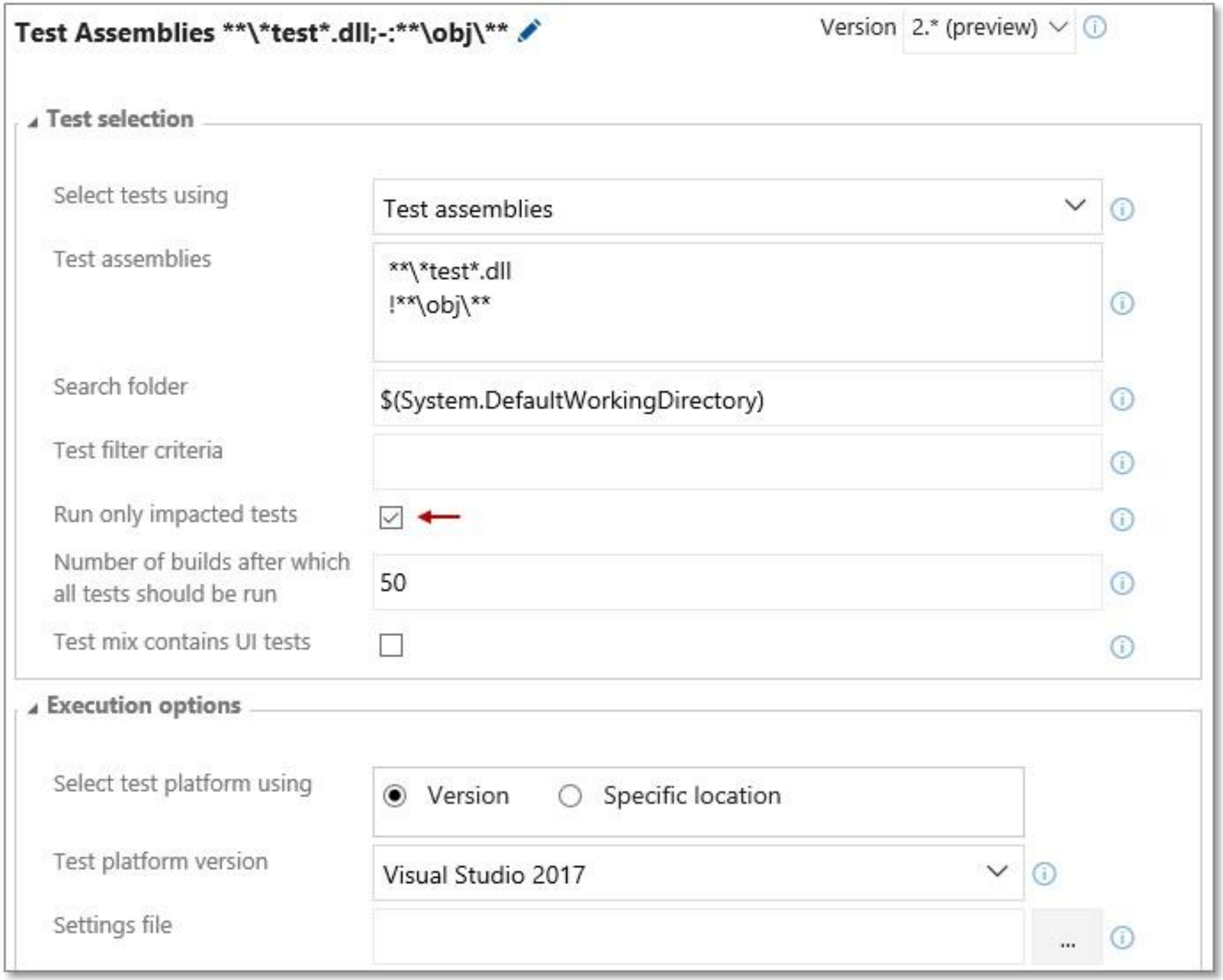
- Integer programming
- Data-flow analysis
- Dynamic slicing
- Textual difference (e.g. diff)
- …

Simple greedy algorithm

- Essential test case: if a requirement is tested by only one test case

- Algorithm:
  - Select first the essential test cases
  - While there are uncovered requirements
    - Select the test case that satisfies the maximum number of unsatisfied test requirements

Tool support: Visual Studio



Test Assemblies **\*test*.dll;-:\\obj\****

Version 2.* (preview)

Test selection

Select tests using: Test assemblies

Test assemblies:

```
**\*test*.dll
!**\obj\**
```

Search folder: $(System.DefaultWorkingDirectory)

Test filter criteria:

Run only impacted tests: ☑

Number of builds after which all tests should be run: 50

Test mix contains UI tests: □

Execution options

Select test platform using: ● Version ○ Specific location

Test platform version: Visual Studio 2017

Settings file:

Microsoft DevOps Blog: Accelerated Continuous Testing with Test Impact Analysis
https://blogs.msdn.microsoft.com/devops/2017/03/02/accelerated-continuous-testing-with-test-impact-analysis-part-1/

Case study: Cisco Systems

- Videoconferencing software
  - Features: video call, multi-site call…

- Test suite: more than 5000 tests

- Test case: 30 min. manual preparation for each
  - → retest-all 100 days vs. couple of days testing budget

A. Gotlieb et al. Automated Regression Testing Using Constraint Programming, AAAI, pp. 4010-4015, 2016.

Summary

- Retest-all is not practical in many situations
- Regression testing approaches
  - Test Suite Minimization
  - Test Case Selection
  - Test Case Priorization
- Many heuristics and tools