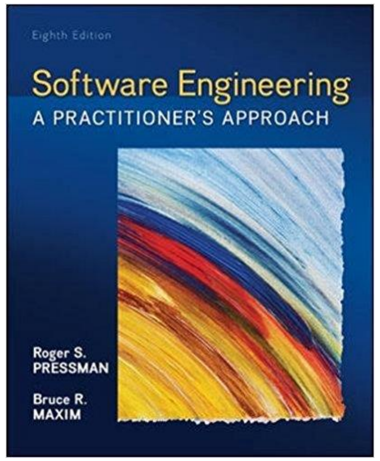
Testing



Chapter 23

(the lecture contains content not covered in the textbook.

Let me know if you have questions regarding the lecture slides.)

Ariane 5 story

Outline

- How to judge the quality of a test suite
- How to design test suite
  - Manually
  - Automatically

How to judge the quality of a test suite

Classical coverage criteria

- Statement coverage
- Branch coverage
- Path coverage
- Data-flow coverage
- Others …

Background: control flow graph; data flow graph

Coverage

- Statement coverage: lines of code (# lines executed / total # of lines)
- Branch coverage: (# of branch decisions exercised/ # of branches x 2)
    - 100% stmt coverage does not mean 100% branch coverage
- Path coverage
    - Unrealistic

Relationship among coverage criteria

- 100% coverage may be infeasible to achieve
- 100% stmt coverage → 100% branch coverage?

- 100% branch coverage → 100% statement coverage?

- Correct under a 100% coverage testing → is bug free?

Relationship among coverage criteria

- 100% coverage may be infeasible to achieve
- 100% stmt coverage → 100% branch coverage?
  - No
- 100% branch coverage → 100% statement coverage?
  - Yes
- Correct under a 100% coverage testing → is bug free?
  - no

Program’s graph representation

- Control flow graph (call graph)
- Data dependency graph

How to compute coverage (automatically)?

Cyclomatic complexity & basis path set testing

- Cyclomatic complexity
  - Based on program flow graph
    - Calculated by E-N+2
  - Represents # of (linearly) independent paths in a graph
    - If one path covers at least one edge/node not covered by existing paths, it is independentBasis path set testing
  - Simplification from path-coverage testing
  - Full test space size = E – N + 2

Data flow testing coverage

- DU coverage
    - Exercise every pair of define-use pairs

What is a “good” test set?

- Achieve good coverage (~100%)
- Little redundancy
  - How to judge redundancy?

How to design test suites

How to design test cases?

- Black box
- White box
- Random
- …

How to design good test set manually?

- White-box testing

How to design good test set manually?

- White-box testing
    - Obtain the list of test properties to cover
    - Cover at least one new property at a time
    - Cover all properties that can be covered
        - Some properties may be infeasible to cover

How to conduct black box testing?

How to conduct black box testing?

- Equivalence class
  - Divide the input spaces into several equivalence classes; test at least one input in each class
- Boundary cases
  - If the expected input is a range of value, …
  - If ….. is a set of value, …
  - If ….. is a string, …
- Common bug patterns

- Fuzz testing

Integration testing

- Use special values as function parameters

How to automatically generate test set?

- Automated random testing
    - Non-structural inputs
    - For structural inputs
        - For even more structural inputs (how to test a compiler?)

- Coverage-oriented testing

Can testing prove bug free?

- No!
- What is the implication of 100% path coverage?

Non-functional testing

- Performance testing
- Security testing
- …

Not covered in lecture; will not appear in quizzes or exams.

Misc.

- To cover later, if we have time
- …
- Mutation testing
- How to save regression testing effort?
- Can we test only part of the program?
- Research topics on testing
- Code Hunt Game

Didn’t have to cover in lecture.