CS 5154

Testing Concepts (continued)

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The following are modified versions of the publicly-available slides for Chapters 1 and 2 in the Ammann and Offutt Book, "Introduction to Software Testing"
(http://www.cs.gmu.edu/~offutt/softwaretest)

Outline for today's class

- Fundamental testing terminology ✓
- The costs of insufficient, non-existent, or late testing ✓
- The goals of a software tester ✓
- Foundations of software testing ✓
- Levels of software testing ✓
- Types of testing activities ✓
- Model-Driven Test Design ⇒ This lecture

last lecture

Coverage Criteria

- Exhaustive testing of even small programs requires too many inputs
  - private static double computeAverage (int A, int B, int C)
  - On 32-bit machines: A, B, C have over 4 billion possible values
  - Over 80 octillion possible tests!!
  - Input space might as well be infinite
- Testers search a huge input space
  - Trying to find the fewest inputs that will find the most problems
- Coverage criteria give structured, practical ways to search the input space
  - Search the input space thoroughly
  - Not much overlap in the tests

Advantages of Coverage Criteria

- Maximize the "bang for the buck"
- Provide traceability from software artifacts to tests
  - Source, requirements, design models, …
- Make regression testing easier
- Give testers a "stopping rule" … when testing is finished
- Can be well supported with powerful tools

There are many Coverage Criteria

- Testing researchers have defined dozens of criteria
- **One view:** they are all just a few criteria on four types of software structures:
  - Input Domains
  - Graphs
  - Logic Expressions
  - Syntax Descriptions
- **This class:** We will learn about test design using these four structures

Model-Driven Test Design

- *Test Design* is the process of designing input values that will effectively test software

- Test design is one of several activities for testing software
  - Most mathematical
  - Most technically challenging

Using MDTD in Practice

- First do the math or analysis to obtain test requirements

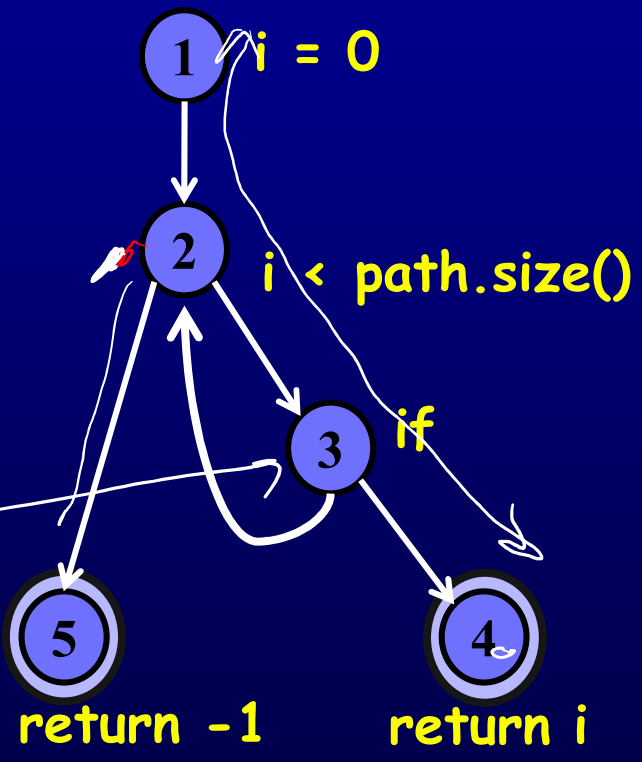
- Then
  - Find input values that satisfy the test requirements
  - Automate the tests
  - Run the tests
  - Evaluate the tests

MDTD: Small Illustrative Example

Software Artifact : Java Method

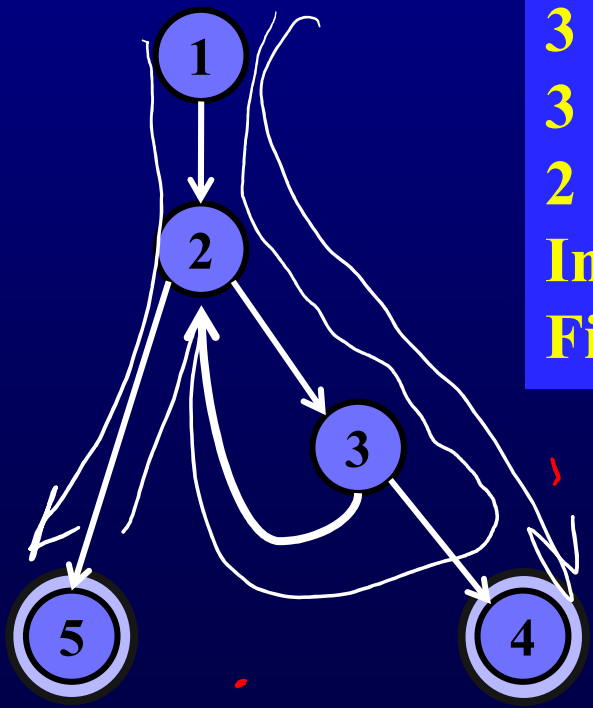
```
/**
    * Return index of node n at the
    * first position it appears,
    * -1 if it is not present
*/
public int indexOf (Node n)
{
    for (int i=0; i < path.size(); i++)
        if (path.get(i).equals(n))
            return i;
    return -1;
}
```

Control Flow Graph



Example (2)

Graph
Abstract version



Edges
1 2
2 3
3 2
3 4
2 5
Initial Node: 1
Final Nodes: 4, 5

6 requirements for Edge-Pair Coverage
1. [1, 2, 3]
2. [1, 2, 5]
3. [2, 3, 4]
4. [2, 3, 2]
5. [3, 2, 3]
6. [3, 2, 5]

Test Paths
[1, 2, 5]
[1, 2, 3, 2, 5]
[1, 2, 3, 2, 3, 4]

Find values ...

In-Class Exercise (8 minutes)

- https://docs.google.com/document/d/1e5YgQ5WSXselfgI1aUpjCbULaGgIAZm4y5KfnJ7v43c/edit

- Tasks:
  - meet one another
  - Complete the task

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