Computer Science 507
Software Engineering
The College of Saint Rose
Spring 2015

Lab 7: More Software Testing

Due: 6:00 PM, Monday, April 13, 2015

For this week's lab, we will refine our techniques for unit testing a bit. Unit testing techniques might include equivalence testing, state-based testing, boundary testing, domain testing, and control flow-based testing (statement, branch).

You may work alone or in groups of up to size 4 on this lab. Only one submission per group is needed.

Getting Set Up

Create a document where you will record your answers to the lecture assignment and lab questions. If you use plain text, call it "`lab7.txt`". If it's a Word document, you can call it whatever you'd like, but when you submit, be sure you convert it to a PDF document "`lab7.pdf`" before you submit it.

Guest Speaker Reactions

Note: this portion must be done individually and is graded separately.

Participate in the discussion of this week's speaker, Bowden Wise, on the speaker blog. To earn full credit, you should make at least 3 comments on this week's post or replies to comments (at least 1 should be a reply, and at least 1 should be posted within the day following the talk). Comments may address any aspect of the speaker's presentation, including how it relates to topics from other parts of the class. You are welcome to start this process during the talk, if you wish. (5 points)

Lecture Assignment Questions

Note: these remain due at the start of our next meeting.

We will usually discuss these questions at the start of class on the lab due date, so no credit can be earned for late submissions of lecture assignment questions.

? LA Question 1:

Sommerville Exercise 24.2, p. 678. (4 points)

? LA Question 2:

Sommerville Exercise 24.7, p. 679. (4 points)

? LA Question 3:
Sommerville Exercise 25.5, p. 703. (4 points)

? LA Question 4:
Sommerville Exercise 25.6, p. 703. (4 points)

Equivalence Partitioning

Equivalence partitioning is a *blackbox* testing technique that minimizes the number of test cases. Possible inputs are partitioned into equivalence testing classes, and a test case is selected from each class. We make the assumption that the system behaves in a similar way for all members of an equivalence class.

For example, suppose we have a function or method that compute the number of days in a month. Since we cannot reasonably test all possible month/year combinations, we find equivalence classes of inputs and sample inputs and outputs for each to perform what are hoped to be fairly complete tests. In this example, we will want combinations of months with different numbers of days, covering both leap years and non leap years.

One possible set of equivalance classes for this might be:

- Months with 31 days, non-leap years. Example input: July 1901
- Months with 31 days, leap years. Example input: July 1904
- Months with 30 days, non-leap years. Example input: June 1901
- Months with 30 days, leap years. Example input: June 1904
- Months with 28/29 days, non-leap years. Example input: February 1901
- Months with 28/29 days, leap years. Example input: February 1904

We will not write actual unit tests for such a method, but hopefully you see how you could.

? Question 1:
Look up the rules for determining leap years. Are the equivalence classes above sufficient for a general day-of-month method that would work, say, for all years from 1901 to 2099? (2 points)

Now consider the Triangle program on `mogul.strose.edu` in `/home/cs507/s15/testinglab`.

? Question 2:
Come up with a set of equivalence classes and sample inputs that will thoroughly test this program. (4 points)

Question 3:
Write a program that implements JUnit tests for the test cases from your equivalance classes determined in the previous question, and report any errors in the original program that your tests uncover. (6 points)

Control Flow Adequacy Testing

We now consider a *whitebox* testing mechanism. Note that a method or program can be represented by a *flow graph*.

A *segment* is represented by a node (circle) in the flow graph. A segment is one or more contiguous statements with no conditionally executed statements. That is, if we start executing a segment, there is no way to proceed except through the entire segment.

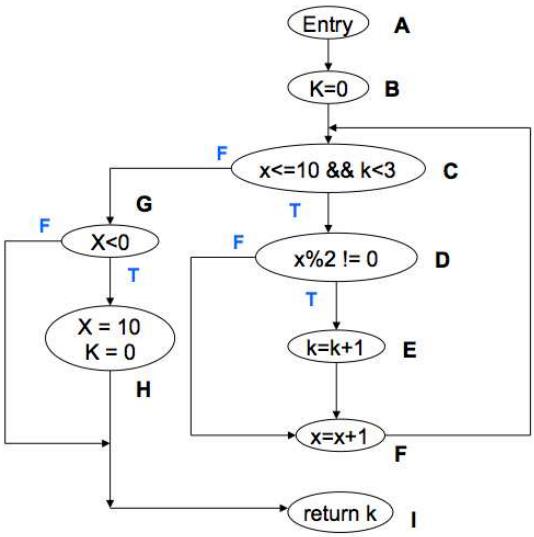
A conditional transfer of control is a *branch*. A branch is represented by an outgoing edge in the flow graph.

The entry point of a method is represented by the *entry node*, which is a node no incoming edges. The exit point of a method is represented by the *exit node*, which has no outbound edges.

For example, the method:

```
public int fun1(int x){
   k = 0;
   while (x <= 10 && k < 3){
      if (x%2 != 0)
         k = k + 1;
      x = x + 1;
   }
   if (x < 0){
      x = 10;
      k = 0;
   }
   return k;
}
```

would be represented by the flow graph:



where each segment is labelled with a letter.

Given such a flow graph, we would like to form tests that exercise all parts of the flow graph.

The first standard is *statement coverage*. A set P of execution paths satisfies the statement coverage criterion iff for all nodes n in the flow graph, there is at least one path p in P s.t. n is on the path p. We would like to generate test inputs that will cause each statement in the program to execute at least once.

? Question 4:

Identify a set of values of the input `x` that will execute all statements in `fun1`'s flow graph at least once. Show your work by identifying each statement as it gets executed by your inputs, showing that your inputs, taken as a set, cover all statements. (4 points)

A second standard is *branch coverage*. A set P of execution paths satisfies the branch coverage criterion iff for all edges e in the flow graph, there is at least one path p in P s.t. p contains edge e. Here, we want to generate test inputs to exercise both the true and false outcomes of each decision.

? Question 5:

Identify a set of values of the input `x` that will execute every branch (edge) in `fun1`'s flow graph at least once. Again, show your work, indicating the sequence of edges traversed by each input, and showing that the set of inputs, as a whole, traverses every edge. (4 points)

A larger example:

```
public int fun2(int x, int y){
   k = 0;
   while (x <= 10 && k < 10){
      if (x%2 != 0){
         k = k + y;
         k = k - 2;
```

```
        }
        x = x + 1;
        k = x + k;
    }
    if (x < 0){
        x = y;
        k = k + x;
    }
    return k;
}
```

Question 6:

For the above example, develop a flow graph and identify pairs of inputs `x` and `y` such that both the statement coverage and branch coverage criteria are satisfied. (10 points)

Submitting

Before 6:00 PM, Monday, April 13, 2015, submit your lab for grading. Package up all required files into an appropriate archive format (`.tar.gz`, `.zip`, and `.7z` are acceptable) and upload a copy of the using Submission Box at `http://sb.teresco.org` under assignment "Lab7".

Grading

This assignment is worth 45 points, which are distributed as follows:

Feature	Value	Score
LA 1 (24.2)	4	
LA 2 (24.7)	4	
LA 3 (25.5)	4	
LA 4 (25.6)	3	
Question 1: leap year rules	2	
Question 2: triangle equivalence classes and inputs	4	
Question 3: JUnit tests for `Triangle`	6	
Question 4: statement coverage of `fun1`	4	
Question 5: branch coverage of `fun1`	4	
Question 6: `fun2` analysis	10	
Total	45	