Testing II

Week 15

Agenda (Lecture)

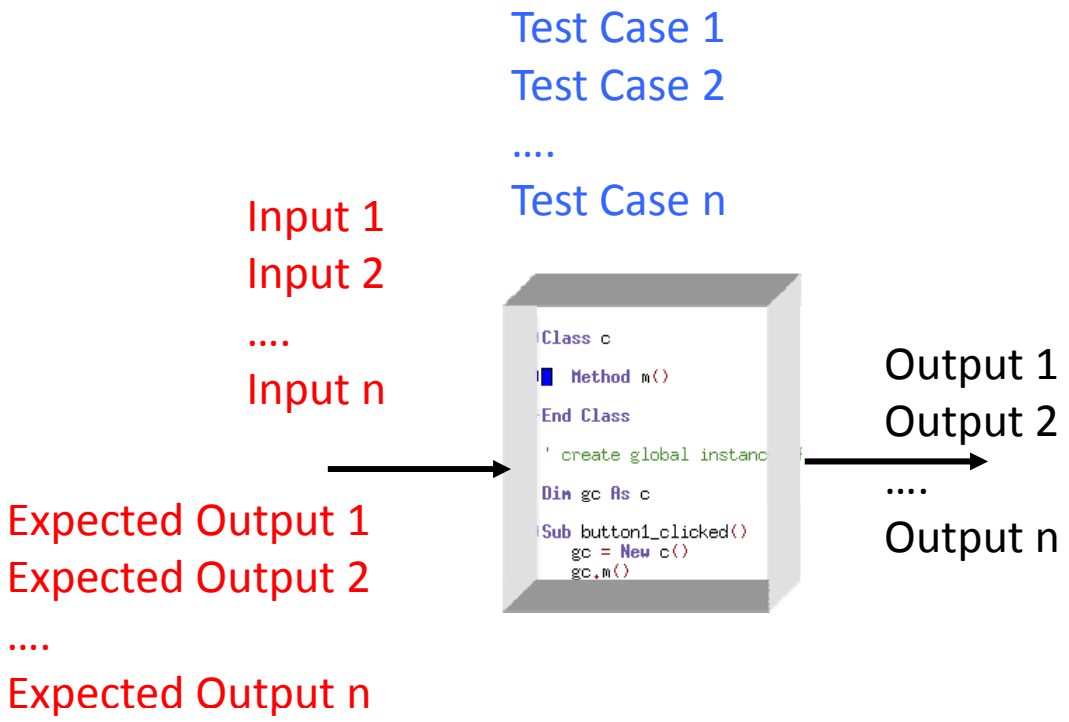
- White box testing
  - Statement coverage
  - Branch coverage

Agenda (Lab)

- Review of SRS/SDD documents
- Implementation
- Submit a weekly project progress report at the end of this week lab session

White Box Testing

- White box testing
- Glass box testing
- Structural testing
- Logic-driven testing
- Path-oriented testing
- Testing to code



The most common form of testing to code requires that each path through the code be executed at least once.

White Box Testing

- Statement coverage
- Branch coverage
- Condition coverage
- Loop coverage
- Path coverage

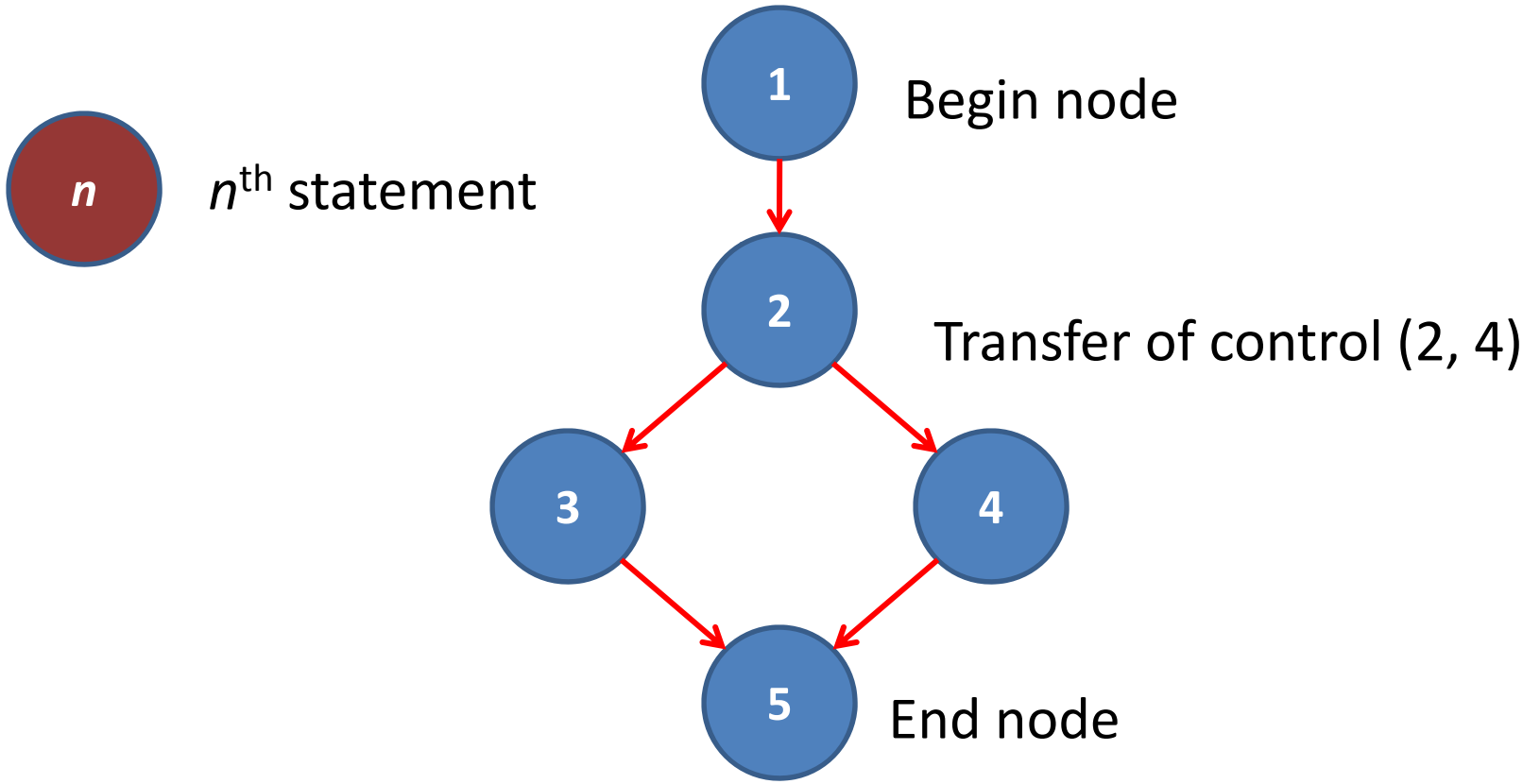
White Box Testing

- Advantages
  - Improve the quality of code
  - Reveals errors in "hidden" code
- Disadvantage
  - Expensive
  - Need access to source

Flow Graph

- A directed graph
  - A set of *N* of nodes
  - A set of $E \subseteq N \times N$ of directed edges between nodes
  - Formal definition: A graph *G* is a pair (*V, E*), where *V* is a set of vertexes, and *E* is a set of edges between the vertexes $E = \{(u,v) \mid u, v \in V\}$.

Flow Graph


n
nth statement
1
Begin node
2
Transfer of control (2, 4)
3
4
5
End node

Conditions of Triangle

- If you have three number, a, b, and c, which are the lengths of the side of a triangle, the conditions in triangle problem might be
  - a = b or a = c or b = c
  - a = b and b = c
  - a < b + c and b < a + c and c < a + b
  - a > 0 and b > 0 and c > 0

Triangle Problem

- Equivalence classes
  - Scalene
  - Isosceles
  - Equilateral
  - Not a triangle
  - Bad inputs

Triangle Problem

- Equivalence classes
  - Scalene
    - Increasing size - (3, 4, 5)
    - Decreasing size - (5, 4, 3)
    - Largest as second - (4, 5, 3)
  - Isosceles
    - a = b & other side larger – (5, 5, 8)
    - a = c & other side larger – (5, 8, 5)
    - b = c & other side larger – (8, 5, 5)
    - a = b & other side smaller – (8, 8, 5)
    - a = c & other side smaller – (8, 5, 8)
    - b = c & other side smaller – (5, 8, 8)

Triangle Problem (cont'd)

- Equilateral
  - All sides equal (5, 5, 5)
- Not a triangle
  - Largest first (6, 4, 2)
  - Largest second (4, 6, 2)
  - Largest third (1, 2, 3)
- Bad inputs
  - One bad input (-1, 2, 4)
  - Two bad inputs (3, -2, -5)
  - Three bad inputs (0, 0, 0)

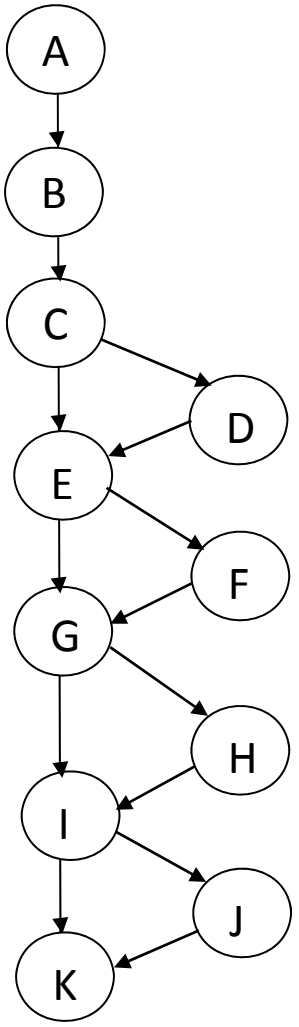
Statement Coverage

- Every statement in program is executed at least once
- Every node in Control Flow Graph is visited at least once
- Minimize number of test cases

Statement Coverage

Node	Source Line
A	read a, b, c
B	type = “scalene”
C	if (a==b || b==c || a==c)
D	type = “isosceles”
E	if (a == b && b == c)
F	type = “equilateral”
G	if (a >= b + c || b > a + c || c > = a + b)
H	type = “not a triangle”
I	if (a <= 0 || b <= 0 || c <=0)
J	type = “bad inputs”
K	print type

* ***Minimal*** number of test cases for the statement coverage: ??



Statement Coverage

Example – Euclid's algorithm to compute GCD

```
A   read (x);
B   read (y);
C   while x ≠ y loop
D   if x > y then
E           x := x – y;
F   else
G           y := y – x;
H   end loop
I   gcd := x;
```

Find minimal test cases for the statement coverage.

Statement Coverage

```
if x < 0 then
        x := -x;
end;
z := log(x);
```

Statement Coverage

- Drawbacks
  - Some control transfers may be missed
  - Statement coverage does not adequately take into account the fact that many lines of code (and many bugs) involve branching and decision-making.
    - Simple if statements
    - Logical operators
    - Consecutive switch labels
    - Loop termination decisions
    - Do-while loops

Branch Coverage

- Select test cases such that every edge in the graph is visited
  - Guarantees that every branch in the source code is executed at least once
- More thorough than statement coverage
  - More likely to reveal logical errors
- However, even if all branches are exercised, this does not mean that all combinations of control transfers are checked

Branch Coverage

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B	type = “scalene”
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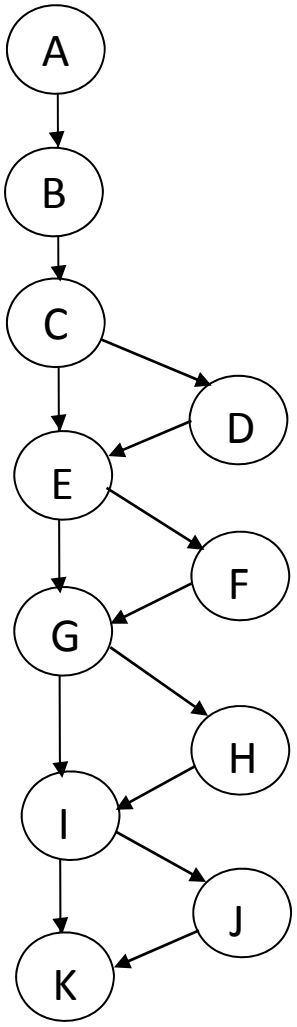

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Find minimal test cases for the branch coverage.