Software Testing, Quality Assurance & Maintenance—Lecture 3

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Plan

More examples on faults, errors and failures:

- numZero example (again);
- assignment 1-like exercise for `findLast`;
- testing line intersection algorithm

```
public static numZero(int[] x) {
  int count = 0;
  for (int i = 1; i < x.length; i++) {
    if (x[i] == 0) count++;
  }
  return count;
}
```

```
static public int findLast(int[] x, int y) {
    for (int i = x.length - 1; i > 0 ; i--) {
        if (x[i] == y) {
            return i;
        }
    }
    return -1;
}

@Test
public void testFindLast() {
    int[] x = new int[] {2, 3, 5};
    assertEquals(0, FindLast.findLast(x, 2));
}
```

Exercise: Faults

Read the faulty program `findLast`, which includes a test case exhibiting a failure.

b) trick question, x = null, y = 3

Answer the following questions:

(a) Identify the fault, and fix it. i > 0, should be i >= 0

(b) If possible, identify a test case that does not execute the fault. x = [1, 2], y = 2 <— wrong because still executes i > 0

(c) If possible, identify a test case that executes the fault, but does not result in an error state. x = [1, 2], y = 2. executes i > 0

(d) If possible, identify a test case that results in an error, but not a failure. (Hint: PC) x = [0], y=1 or x=[0, 2], y=1

(e) For the given test case, identify the first error state. Be sure to describe the complete state.

x = [0, 2], y = 1, i = 0, PC = i > 0
PC never reaches inside the loop when i = 0

```
class LineSegment:
  def __init__(self, x1, x2):
      self.x1 = x1; self.x2 = x2;

  def intersect(a, b):
      return (a.x1 < b.x2) & (a.x2 > b.x1);
```

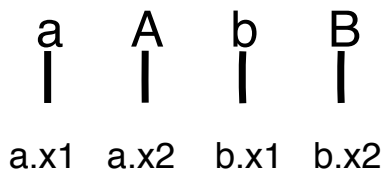
```
def test_aAbB(self):
  a = LineSegment(0, 2)
  b = LineSegment(3, 7)
  self.assertFalse(intersect(a, b))
  self.assertFalse(intersect(b, a))
```

—> satisfies statement coverage (trivially) and branch coverage

Other ways of generating tests:
- be sure to cover all outputs (or at least all classes of outputs)
- generate cases randomly
  - need to know expected answer
  - hard to hit known interesting points in the problem space
- cover all values of logical sub-expressions
- cover all interesting combinations of input classes (input space coverage)

Sketch of proof of correctness of intersect

Rename inputs:



assume all points distinct (then check the assumption!)

write cases

a = A	a = b	a = B
b = a	b = A	b = B

assume a < b (and then swap them)
assume a < A and b < B (constructor should reject violating lines)

Have reduced input space to permutations:
aAbB
abAB
abBA