SE465 Notes

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0.1 Example 1

```
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));
}
```

1. Identify and fix the fault
   for loop condition should be $i \geq 0$
2. If possible, identify a test case that does not exercise the fault
   x is null
3. if possible, identify a test case that exercise the fault, but no error state
   findLast([1, 2, 3], 2) will return -1
4. if possible, identify a test case that results in an error, but no failure
   trying to findsomething not there ([2], 5)
5. Identify the first error state

0.2 Example 2

```
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);
```

Establishing correctness of intersect:

- case analysis of the inputs

Other answers

- execute every statement of the unit under test
- feed random inputs
- check all outputs
- check values of each clause

rename inputs:
$a = a.x_1$ $\quad b = b.x_1$
$A = a.x_2$ $\quad B = b.x_2$

- assume all points are distinct

- assume $a < b$ (we'll check both ways when constructing test cases)

- assume $a < A, b < B$

aAbB
abAB
abBA

```
# run this test as 'python line-intersection-test.py'

from line_intersection import *
import unittest

class TestIntersection(unittest.TestCase):
    def test_aAbB(self):
        a = LineSegment(0,2)
        b = LineSegment(3,7)
        self.assertFalse(intersect(a,b))
        self.assertFalse(intersect(b,a))

    def test_abAB(self):
        a = LineSegment(0,4)
        b = LineSegment(3,7)
        self.assertTrue(intersect(a,b))
        self.assertTrue(intersect(b,a))

    def test_abBA(self):
        a = LineSegment(0,4)
        b = LineSegment(1,2)
        self.assertTrue(intersect(a,b))
        self.assertTrue(intersect(b,a))

    def test_equality(self):
        a = LineSegment(0,2)
        b = LineSegment(2,4)
        self.assertTrue(intersect(a,b))        # A = b
        self.assertTrue(intersect(b,a))        # B = a
        a = LineSegment(2,2)
        b = LineSegment(0,4)
        self.assertTrue(intersect(a,b))        # a = A
        self.assertTrue(intersect(b,a))        # b = B
        a = LineSegment(0,2)
        b = LineSegment(0,4)
        self.assertTrue(intersect(a,b))        # a = b
        self.assertTrue(intersect(b,a))        # b = a

if __name__ == '__main__':
    unittest.main()
```

0.3 •

Static:

- find faults
  example:
  (a) type checking
  (b) dead code analysis
- code inspection functionality and style
- program verification

Dynamic

- observe failures
- must generate inputs
  what are expected outputs?
- easy to run the program
- keywords
  white-box testing
  black-box testing

static techninques tradeoff:

- exhaustive
- subject to false positives

words I don't like
~~complete testing~~

~~exhaustive testing~~
~~full coverage~~

First big question: When should I stop testing?

1. when I run out of time
   open-ended explorotroy testing
   for automatic input generation
2. when I'm close enough to being exhaustive
   explored enough (all) of
      behaviours / use cases
      program states
      inputs
      statements / branches

observability, controlability

0.4 Coverage

- idea: find reduced space + cover it with test cases

Test Requirement (TR) - an element of an artifact that soe test case must satisfy

Infeasible Test Requirements

unreachable code definition: coverage level - Given a set of test requirements TR and a test set T, The coverage level is the ratio of the number of TRs satisfied by T to the size of TR.

Exploratory Testing

- usually carried out by testers
- unscripted in general
  "Exploratory teesting is simulatneous learning, test design, and test execution"

Exploratory testing is good for

- simulating actual use cases (realism)
  - diversifying testing beyond scripts
- finding single most important bug in sortest time
- being less siloed
- evaluating aparticular risk, see if scripted tests needed

Exploratory Testing Process

1. start with a goal /charter
   - "Explore the product elements"
2. decide which area of the software to test
3. design a test (informally)
4. execute test and log bugs
5. repeat as needed

notes: don't produce exhaustive notes output:

1. set of bug reports
2. test notes (possibly a judgment)
3. artifacts (input, output)

Results of WaterlooWorks Testing

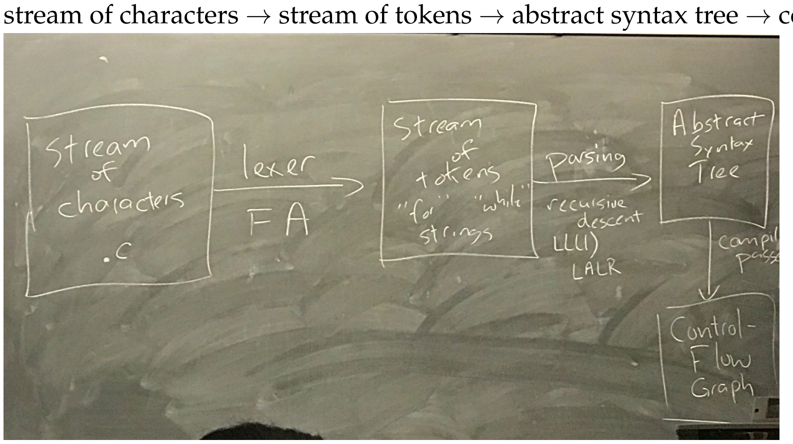
1. sort order reversed on navigating to subsequent page
2. use of ophrase "current term" is ambiguous when choosing a term
3. on mobile, sort order not preserved when navigating to a job posting and going back

Overall

1. want some sort of judgment on overall usability of system
   do the primary functions work well enough

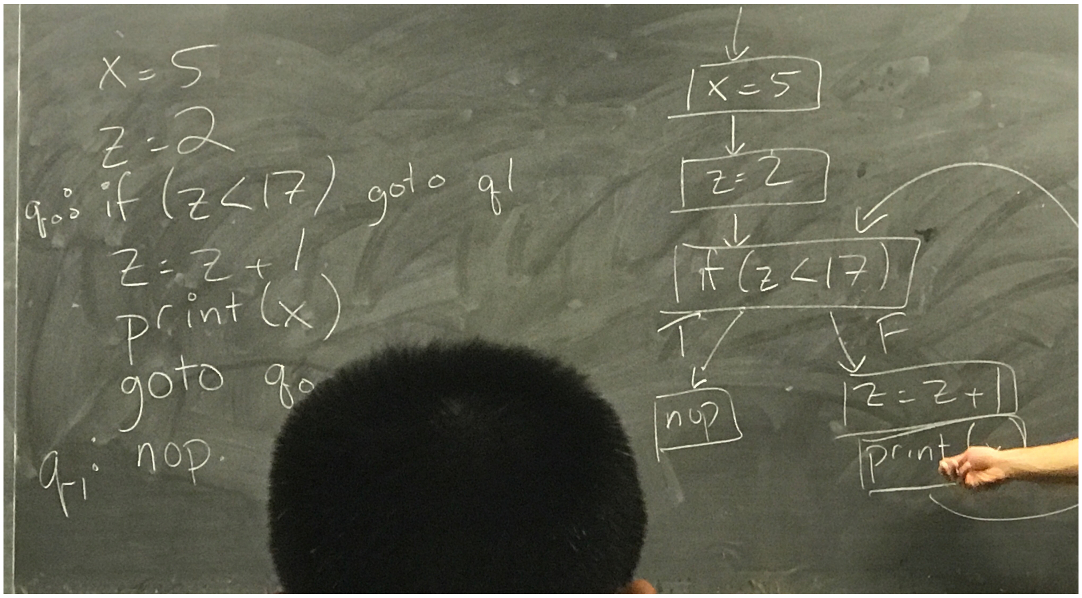
Control flow graphs

Coverage criteria for source code
stream of characters → stream of tokens → abstract syntax tree → control flow graph



Control Flow Graph

1. representation of program which is easier to analyze
   Nodes: represent 0 or more statements
   Edge (directed) (s_1, s_2) means s_2 may follow s_1 in an execution


x = 5
z = 2
q0: if (z<17) goto q1
z = z + 1
print(x)
goto q0
q1: nop.
x = 5
z = 2
if (z<17)
T
F
nop
z = z + 1
print