Lab-7
IT314 Software Engineering

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Course: *IT314 Software Engineering*

- **Previous date Problem:**
- **Test cases:**

Test Case number	Day	Month	Year	Expected Output
1	15	6	1900	14-6-1900
2	15	6	1901	14-6-1901
3	15	6	1962	14-6-1962
4	15	6	2014	14-6-2014
5	15	6	2015	14-6-2014
6	1	6	1962	31-5-1962
7	2	6	1962	1-6-1962
8	30	6	1962	29-6-1962
9	31	6	1962	INVALID
10	15	1	1962	14-1-1962
11	15	2	1962	14-2-1962
12	15	11	1962	14-11-1962
13	15	12	1962	14-12-1962

- **Equivalence Class Partitions:**
- **Day:**

Class Partition ID	Day Range	Expected Output
1	Day between 1 to 28	VALID
2	Less than 1	INVALID
3	Greater than 31	INVALID
4	30	VALID
5	29	VALID FOR LEAP YEAR

6	31	VALID

- **Month:**

Class Partition ID	Range	Expected Output
1	1 to 12	VALID
2	Less than 1	INVALID
3	Greater than 12	INVALID

- **Year:**

Class Partition ID	Range	Expected Output
1	1900 to 2015	VALID
2	Less than 2019	INVALID
3	Less than 2015	INVALID

➔ Main Function Code:

```
package test;
public class programs {
public int linearSearch(int v, int a[]) // p1
{
int i = 0;
while (i < a.length)
{
if (a[i] == v)
return(i);
i++;
}
return (-1);
}
public int countItem(int v, int a[]) //p2
{
int count = 0;
for (int i = 0; i < a.length; i++)
{
if (a[i] == v)
count++;
```

```
}
return (count);
}
public int binarySearch(int v, int a[]) //p3
{
int lo,mid,hi;
lo = 0;
hi = a.length-1;
while (lo <= hi)
{
mid = (lo+hi)/2;
if (v == a[mid])
return (mid);
else if (v < a[mid])
hi = mid-1;
else
lo = mid+1;
}
return(-1);
}
final int EQUILATERAL = 0;
final int ISOSCELES = 1;
final int SCALENE = 2;
final int INVALID = 3;
public int triangle(int a, int b, int c) //p4
{
if (a >= b+c || b >= a+c || c >= a+b)
return(INVALID);
if (a == b && b == c)
return(EQUILATERAL);
if (a == b || a == c || b == c)
return(ISOSCELES);
return(SCALENE);
}
public boolean prefix(String s1, String s2) //p5
{
if (s1.length() > s2.length())
{
return false;
}
for (int i = 0; i < s1.length(); i++)
{
if (s1.charAt(i) != s2.charAt(i))
{
return false;
}
}
return true;
}
```

}

P1. The function linearSearch searches for a value v in an array of integers a. If v appears in the array a, then the function returns the first index i, such that a[i] == v; otherwise, -1 is returned.

```
int linearSearch(int v, int a[])
{
      int i = 0;
      while (i < a.length)
      {
            if (a[i] == v)
                  return(i);
            i++;
      }
      return (-1);
}
```

```
package Tests;
import static org.junit.jupiter.api.Assertions.*;
import org.junit.jupiter.api.Test;
class TestForProg_1{
@Test
public void test1() {
int[] arr1 = { 1, 2, 3, 4, 5 };
Procedures obj1 = new procedures();
int output_1 = obj1.linearSearch(1, arr1);
int output_2 = obj1.linearSearch(3, arr1);
assertEquals(0, output_1);
assertEquals(2, output_2);
}
@Test
public void test2() {
int a[] = {1, 2, 3, 4};
procedures obj1 = new procedures();
int output_f = obj1.linearSearch(3, a);
assertEquals(2, output_f);
}
@Test
public void test3() {
```

```
int[] arr2 = { 5, 4, 3, 2, 1 };
procedures obj1 = new procedures();
int output_1 = obj1.linearSearch(5, arr2);
int output_2 = obj1.linearSearch(6, arr2);
assertEquals(0, output_1);
assertEquals(-1, output_2);
}
@Test
public void test4() {
int[] arr3 = { -1, 0, 1 };
Functions obj1 = new Functions();
int output_1 = obj1.linearSearch(1, arr3);
int output_2 = obj1.linearSearch(-2, arr3);
assertEquals(2, output_1);
assertEquals(-1, output_2);
}
@Test
public void test5() {
int[] arr = null;
Functions obj1 = new Functions();
int output_2 = obj1.linearSearch(1, arr);
assertEquals(-1, output_2);
}
}
```

Tester Action and Input Data	Expected Outcome
Equivalence Partitioning	
a=[1,1,7,8,9] ,v=7	2
a=[1,1,7,8,9] ,v=10	-1
a=[] , v=5	-1
Boundary Value Analysis	
a=[], v=6	-1
a=[2] ,v=7	-1
a=[2] ,v=2	0
a=[1,3,4,5,6] , v=1	0
a=[1,3,4,5,6] , v=4	2
a=[1,3,4,5,6] , v=6	4
a=[1,3,4,5,6] , v=7	-1

P2. The function countItem returns the number of times a value v appears in an array of integers a.

```
int countItem(int v, int a[])


{
      int count = 0;
      for (int i = 0; i < a.length; i++)
      {
            if (a[i] == v)
                  count++;
      }
      return (count);
}
```

```
package Tests;
import static org.junit.Assert.*;
import org.junit.Test;
public class TestForProg_2 {
@Test
public void test1() {
int[] arr1 = {1, 2, 3, 4, 5};
procedures obj1 = new procedures();
int output_f = obj1.countItem(3, arr1);
assertEquals(0, output_f);
}
@Test
public void test2() {
int[] arr2 = {5, 5, 5, 5, 5};
procedures obj1 = new procedures();
int output_f = obj1.countItem(5, arr2);
assertEquals(5, output_f);
}
@Test
public void test3() {
int[] arr3 = {0, 0, 0, 0, 0};
procedures obj1 = new procedures();
int output_f = obj1.countItem(0, arr3);
```

```
assertEquals(5, output_f);
}
@Test
public void test4() {
int[] arr4 = {-1, -2, -3, -4, -5};
procedures obj1 = new procedures();
int output_f = obj1.countItem(7, arr4);
assertEquals(0, output_f);
}
@Test
public void test5() {
int[] arr5 = {2, 4, 6, 8, 10};
procedures obj1 = new procedures();
int output_f = obj1.countItem(3, arr5);
assertEquals(0, output_f);
}
}
```

Tester Action and Input Data	Expected Outcome
Equivalence Partitioning	
a=[], v=1	0
a=[1,2,1,3,4], v=5	0
a=[1,2,1,3,4] ,v=1	2
Boundary Value Analysis	
a=[], v=1	0
a=[3], v=2	0
a=[4], v=4	1
a=[1,2,3,4,1] ,v=2	1
a=[1,2,3,4,1] ,v=5	0
a=[1,2,3,4,1] ,v=1	2
a=[1,1,1,1,1] ,v=1	5

P3. The function binarySearch searches for a value v in an ordered array of integers a. If v appears in the array a, then the function returns an index i, such that a[i] == v; otherwise, -1 is returned.

```
int binarySearch(int v, int a[])
{
      int lo,mid,hi;
      lo = 0;
      hi = a.length-1;
      while (lo <= hi)
      {
            mid = (lo+hi)/2;
            if (v == a[mid])
                  return (mid);
            else if (v < a[mid])
                  hi = mid-1;
            else
                  lo = mid+1;
      }
      return(-1);
}
```

```
package Tests;
import static org.junit.jupiter.api.Assertions.*;
import org.junit.jupiter.api.Test;
class TestForProg_3 {
@Test
public void test1() {
int[] array = {1, 2, 3, 4, 5, 6, 7, 8, 9};
int element = 7;
int expectedIndex = 5;
procedures obj1 = new procedures();
int output_f = obj1.binarySearch(element, array);
assertEquals(expectedIndex, output_f);
}
@Test
public void test2() {
int[] array = {1, 2, 3, 4, 5, 6, 7, 8, 9};
int element = 10;
int expectedIndex = -1;
procedures obj1 = new procedures();
int output_f = obj1.binarySearch(element, array);
assertEquals(expectedIndex, output_f);
```

```
}
@Test
public void test3()
{int[] array = {};
int element = 1;
int expectedIndex = -1;
procedures obj1 = new procedures();
int output_f = obj1.binarySearch(element, array);
assertEquals(expectedIndex, output_f);
}
@Test
public void test4()
{ int[] array =
{5};int element =
5;
int expectedIndex = 0;
Functions obj1 = new Functions();
int output_f = obj1.binarySearch(element, array);
assertEquals(expectedIndex, output_f);
}
@Test
public void test5() {
int[] array = {1, 2, 3, 3, 3, 4, 5};
int element = 3;
int expectedIndex = 3;
Functions obj1 = new Functions();
int output_f = obj1.binarySearch(element, array);
assertEquals(expectedIndex, output_f);
}
}
```

Tester Action and Input Data	Expected Outcome
Equivalence Partitioning	
a=[], v=5	-1
a=[1,2,3,5] ,v=4	-1
a=[1,2,3,5,6,7] ,v=5	4
Boundary Value Analysis	
a=[], v=5	-1
a=[1], v=1	0
a=[2],v=3	-1
a=[1,2,3,5,6] ,v=6	4
a=[1,2,3,5,6] ,v=1	0
a=[1,2,3,5,6] ,v=3	2
a=[1,2,3,5,6] ,v=0	-1
a=[1,2,3,5,6] ,v=8	-1

P4. The following problem has been adapted from The Art of Software Testing, by G. Myers (1979). The function triangle takes three integer parameters that are interpreted as the lengths of the sides of a triangle. It returns whether the triangle is equilateral (three lengths equal), isosceles (two lengths equal), scalene (no lengths equal), or invalid (impossible lengths).

```
final int EQUILATERAL = 0;
final int ISOSCELES = 1;
final int SCALENE = 2;
final int INVALID = 3;
int triangle(int a, int b, int c)
{
      if (a >= b+c || b >= a+c || c >= a+b)
            return(INVALID);
      if (a == b && b == c)
            return(EQUILATERAL);
      if (a == b || a == c || b == c)
            return(ISOSCELES);
      return(SCALENE);


}
```

```
package Tests;
import static org.junit.jupiter.api.Assertions.*;
import org.junit.jupiter.api.Test;
class TestForProg_4 {
final int EQUILATERAL = 0;
final int ISOSCELES = 1;
final int SCALENE = 2;
final int INVALID = 3;
@Test
public void Test1() {
int a = 5;
int b = 5;
int c = 5;
int expectedType = EQUILATERAL;
procedures obj1 = new procedures();
int output_f = obj1.triangle(a, b, c);
assertEquals(expectedType, output_f);
}
@Test
public void Test2() {
int a = 7;
```

```
int b = 7;
int c = 10;
int expectedType = ISOSCELES;
procedures obj1 = new procedures();
int output_f = obj1.triangle(a, b, c);
assertEquals(expectedType, output_f);
}
@Test
public void Test3() {
int a = 3;
int b = 4;
int c = 5;
int expectedType = SCALENE;
procedures obj1 = new procedures();
int output_f = obj1.triangle(a, b, c);
assertEquals(expectedType, output_f);
}
@Test
public void Test4() {
int a = 2;
int b = 2;
int c = 5;
int expectedType = INVALID;
procedures obj1 = new procedures();
int output_f = obj1.triangle(a, b, c);
assertEquals(expectedType, output_f);
}
@Test
public void Test5() {
int a = 0;
int b = 0;
int c = 0;
int expectedType = INVALID;
procedures obj1 = new procedures();
int output_f = obj1.triangle(a, b, c);
assertEquals(expectedType, output_f);
}
@Test
public void Test6() {
int a = -1;
int b = 2;
int c = 5;
int expectedType = INVALID;
Functions obj1 = new Functions();
```

```
int output_f = obj1.triangle(a, b, c);
assertEquals(expectedType, output_f);
}
@Test
public void Test7()
{int a = 1000000;
int b = 1000000;
int c = 1000000;
int expectedType = EQUILATERAL;
Functions obj1 = new Functions();
int output_f = obj1.triangle(a, b, c);
assertEquals(expectedType, output_f);
}
}
```

Tester Action and Input Data	**Expected Outcome**
Equivalence Partitioning	
a=b<c where a>,b>0,c>0	ISOSCELES
a=b=c where a>0,b>0,c>0	EQUILATERAL
a<b+c, b<a+c, c<a+b where a>0,b>0,c>0	SCALENE
a=0 ,b=0,c=0	INVALID
a>=b+c, b>=a+c, c>=a+b where a>0,b>0,c>0	INVALID
a=0, b=c where b>0 ,c>0	INVALID
Boundary Value Analysis	
a=3,b=3,c=3	EQUILATERAL

a=3,b=3,c=7	INVALID
a=3,b=3,c=5	ISOSCELES
a=2147483647,b=2147483647,c=2147483647	EQUILATERAL
a=2147483647,b=2147483647,c=2147483645	ISOSCELES
a=1,b=1,c=0	INVALID
a=1,b=1,c=2147483647	INVALID

P5. The function prefix (String s1, String s2) returns whether or not the string s1 is a prefix of string s2 (you may assume that neither s1 nor s2 is null).

```
public static boolean prefix(String s1, String s2)
{
      if (s1.length() > s2.length())
      {
            return false;
      }
      for (int i = 0; i < s1.length(); i++)
      {
            if (s1.charAt(i) != s2.charAt(i))
            {
                  return false;
            }
      }
      return true;
}
```

```
package Tests;
import static org.junit.jupiter.api.Assertions.*;
import org.junit.jupiter.api.Test;
class TestForProg_5 {
@Test
public void test1()
{ String s1 =
"hello";
String s2 = "hello world";
boolean expectedResult = true;
procedures obj1 = new procedures();
boolean output_f = obj1.prefix(s1, s2);
assertEquals(expectedResult, output_f);
}
@Test
public void test2()
{ String s1 = "";
String s2 = "hello";
boolean expectedResult = true;
procedures obj1 = new procedures();
boolean output_f = obj1.prefix(s1, s2);
assertEquals(expectedResult, output_f);
}
@Test
public void test3()
{ String s1="hello";
String s2 = "hello";
boolean expectedResult = true;
procedures obj1 = new procedures();
boolean output_f = obj1.prefix(s1, s2);
assertEquals(expectedResult, output_f);
}
@Test
```

```
public void test4()
{ String s1 =
"hello";String s2 =
"world";
boolean expectedResult = false;
Functions obj1 = new Functions();
boolean output_f = obj1.prefix(s1, s2);
assertEquals(expectedResult, output_f);
}
@Test
public void test5()
{ String s1 = " ";
String s2 = "hello";
boolean expectedResult = false;
Functions obj1 = new Functions();
boolean output_f = obj1.prefix(s1, s2);
assertEquals(expectedResult, output_f);
}
}
```

Tester Action and Input Data	Expected Outcome
Equivalence Partitioning	
s1 is Empty But s2 is not Empty	True
s1 is not Empty but s2 is Empty	False
s1=”abc” ,s2=”abcdfg”	True
s1=”abc” ,s2=”abdefg”	False
s1=”ABc” ,s2=”abc”	False
s1=”abc” ,s2=”abc”	True
s1=”defg” ,s2=”ab”	False
Boundary Value Analysis	
s1=”d” ,s2=”de”	True
s1=”de”, s2=”d”	False
s1=”p” ,s2=”p”	True
s1=”p”, s2=”P”	False
s1=”abcdejhk” ,s2=”abcdejhk”	True

s1=”” , s2=””	True
s1=”abcdjklmn” ,s2=”abcdjkl”	False

P6: Consider again the triangle classification program (P4) with a slightly different specification: The program reads floating values from the standard input. The three values A, B, and C are interpreted as representing the lengths of the sides of a triangle. The program then prints a message to the standard output that states whether the triangle, if it can be formed, is scalene, isosceles, equilateral, or right angled. Determine the following for the above program:

1). Identify the equivalence classes for the system.

→ **Class 1**: Equilateral Triangle (Three sides are equal and non zero value)
→ **Class 2**: Isosceles Triangle (Two sides are equal)
→ **Class 3**: Scalene Triangle (all sides are different)
→ **Class 4**: Right Angle triangle (satisfies Pythagoras Theorem)
→ **Class 5**: Invalid (negative or zero value)
→ **Class 6**: Non-Triangle(Sum of two sides is less than third side)

2) Identify test cases to cover the identified equivalence classes. Also, explicitly mention which test case would cover which equivalence class.

Test Case 1 For Class 1:
→ a=7,b=7,c=7
→ a=9,b=9,c=9
This Test Case Satisfied Class 1

Test Case 2 For Class 2:
→ a=3,b=3,c=5
→ a=6,b=6,c=8
This Test Case Satisfied Class 2

Test Case 3 For Class 3:
→ a=4, b=2, c=3
→ a=6,b=8,c=5
This Test Case Satisfied Class 3

Test Case 4 for Class 4:
→ a=3,b=4,c=5
→a=6,b=8,c=10
This Test Case Satisfied Class 4

Test Case 5 for Class 5:
→ a=0,b=1,c=1;
→ a=5,b=0,c=5
This Test Case Satisfied Class 5

Test Case 6 for Class 6:
→ a=-1,b=2,c=3
→ a=5,b=-2,c=6
This Test case Satisfied Class 6

3). For the boundary condition A + B > C case (scalene triangle), identify test cases to verify the boundary.

Test case:
a=6,b=9,c=11
a=3,b=7,c=5
This above Test case Satisfies A+B > C.

4). For the boundary condition A = C case (isosceles triangle), identify test cases to verify the boundary.

Test case:
a=5,b=9,c=5
a=4,b=7,c=4
This above Test case Satisfies A=C.

5). For the boundary condition A = B = C case (equilateral triangle), identify test cases to verify the boundary.

Test case:
a=10,b=10,c=10
a=12,b=12,c=12
This above Test case Satisfies A=B=C.

6). For the boundary condition $A^2 + B^2 = C^2$ case (right angle triangle), identify test case to verify boundary.

Test case:
a=8,b=5,c=13
a=3,b=4,c=5
This Above test case Satisfies $A^2 + B^2 = C^2$

7). For the non-triangle case, identify test cases to explore the boundary. Test case:
a=6,b=2,c=3
a=2,b=4,c=2
This Above Test case is Satisfies non-triangle case.

8). For non-positive input, identify test points. Test case:
a=-1,b=0,c=5
a=0,b=7,c=-3
This Above Test case is Satisfies non-positive case.

- **Section B:**

The code below is part of a method in the ConvexHull class in the VMAP system. The following is a small fragment of a method in the ConvexHull class. For the purposes of this exercise you do not need to know the intended function of the method. The parameter p is a Vector of Point objects, p.size() is the size of the vector p, (p.get(i)).x is the x component of the ith point appearing in p, similarly for (p.get(i)).y. This exercise is concerned with structural testing of code and so the focus is on creating test sets that satisfy some particular coverage criterion.

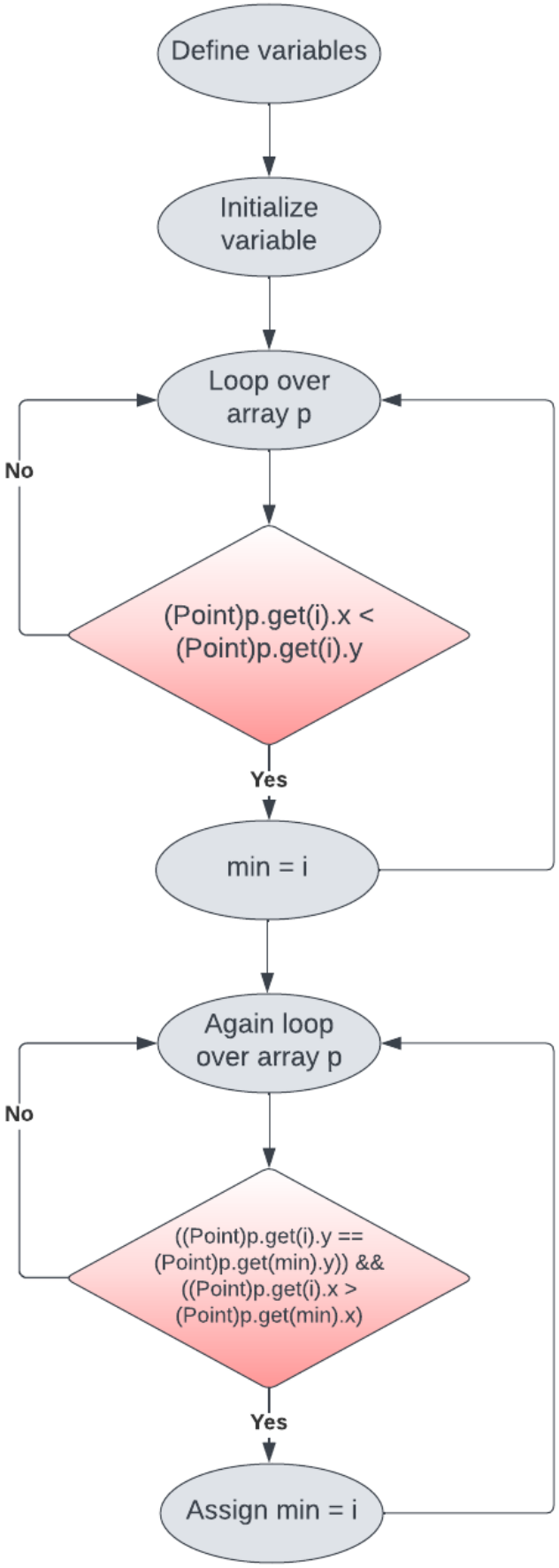
```
Vector doGraham(Vector p) {
        int i,j,min,M;

        Point t;
        min = 0;

        // search for minimum:
        for(i=1; i < p.size(); ++i) {
            if( ((Point) p.get(i)).y <
                        ((Point) p.get(min)).y )
            {
                min = i;
            }
        }

        // continue along the values with same y component
        for(i=0; i < p.size(); ++i) {
            if(( ((Point) p.get(i)).y ==
                        ((Point) p.get(min)).y ) &&
                 (((Point) p.get(i)).x >
                        ((Point) p.get(min)).x ))
            {
                 min = i;
            }
        }
```

For the given code fragment you should carry out the following activities.
1). Convert the Java code comprising the beginning of the doGraham method into a control flow graph (CFG).


Define variables
Initialize variable
Loop over array p
No
(Point)p.get(i).x < (Point)p.get(i).y
Yes
min = i
Again loop over array p
No
((Point)p.get(i).y == (Point)p.get(min).y)) && ((Point)p.get(i).x > (Point)p.get(min).x)
Yes
Assign min = i

2. Construct test sets for your flow graph that are adequate for the following criteria:

a. Statement Coverage:

→ Covers as possible as lines of code
Test Case:
p={(0,0),(2,0)}
p={(0,6),(0,4),(1,2),(3,2),(5,2))}
So here x should decrease so we traverse as much as the loop statement and y should increase so we traverse as much as the next loop statement.

b. Branch Coverage:

→ Covers as many as Branch (if else)
Test Cases:
p={(0,0),(2,0})
p={(0,6),(0,4),(1,2),(3,2),(5,2))}
p={(1,5),(1,4),(1,3),(0,2),(0,1)}

c. Basic Condition Coverage:

→ Covers as possible as Boolean operation
Test Cases:
p={(0,0),(2,0})
p={(0,6),(0,4),(1,2),(3,2),(5,2))}
p={(0,7),(0,6),(0,5),(1,3),(2,3),(3,3),(4,3),(5,3))}
So here we have to put points so that for minimum value y we get maximum point.