IT314 - Software Engineering

Name : Patel Harsh Bharatbhai
Id : 202001165

Lab 7

Section A:

Consider a program for determining the previous date. Its input is triple of day, month and year with the following ranges 1 <= month <= 12, 1 <= day <= 31, 1900 <= year <= 2015.The possible output dates would be previous date or invalid date. Design the equivalence class test cases?

Ans.

1. Equivalence Classes for the Day parameter:
    a. Valid classes: 1 <= day <= 31
    b. Invalid classes: day < 1, day > 31

2. Equivalence Classes for the Month parameter:
    a. Valid classes: 1 <= month <= 12
    b. Invalid classes: month < 1, month > 12

3. Equivalence Classes for the Year parameter:
    a. Valid classes: 1900 <= year <= 2015
    b. Invalid classes: year < 1900, year > 2015

Test Cases

1. **Equivalence Partitioning**

In equivalence partitioning, we divide the input data into groups, or partitions, where each group contains a set of equivalent or similar values that are expected to exhibit similar behaviour in the system under test.

Here are some partitions based on different values:

Partition 1: Valid dates with a day between 1 and 31, a month between 1 and 12, and a year between 1900 and 2015.
Partition 2: Invalid dates with a day less than 1 or greater than 31.
Partition 3: Invalid dates with a month less than 1 or greater than 12.
Partition 4: Invalid dates with a year less than 1900 or greater than 2015.
Partition 5: Invalid dates with a day that is out of range for a given month (e.g., February 30).
Partition 6: Invalid dates with a day that is out of range for a given year (e.g., February 29 in a non-leap year).

Some sample test cases for different partitions:

Partition 1: 01/05/2008, 15/04/1992, 31/8/2005
Partition 2: 00/01/2004, -11/04/2002, 32/11/2001

Partition 3: 05/00/2002, 10/13/2010, 30/16/2011
Partition 4: 02/10/0000, 15/03/11000, 03/10/9999
Partition 5: 30/02/2023, 31/04/2023, 02/05/2101
Partition 6: 29/02/2021, 29/02/1900, 29/02/2102

Boundary Value Analysis

In boundary value analysis, we check for input values near the boundaries of valid and invalid values that are more likely to cause errors, so testing these boundary values can help identify potential problems in the software.

We first identify the boundary values for day, month, and year

- Day: 1, 28, 29, 30, 31
- Month: 1, 2, 12
- Year: 1, 4, 100, 400 (for checking Leap Years).

We then find valid and invalid input ranges for day, month, and year

- **Day**: valid input range is from 1 to 31, invalid input range is from 32 to infinity.
- **Month**: valid input range is from 1 to 12, invalid input range is from 13 to infinity.
- **Year**: valid input range is from 1900 to 2015, invalid range is anything outside that range.

Using these to sample generate test cases:

Test case 1: Valid date (boundary value) - Day: 1, Month: 1, Year: 2010
Test case 2: Valid date (boundary value) - Day: 31, Month: 12, Year: 1990
Test case 3: Valid date (boundary value) - Day: 29, Month: 2, Year: 2000 (leap year)
Test case 4: Invalid date (boundary value) - Day: 32, Month: 1, Year: 2002
Test case 5: Invalid date (boundary value) - Day: 13, Month: 2, Year: 1910
Test case 6: Invalid date (boundary value) - Day: 30, Month: 2, Year: 2003
Test case 7: Invalid date (boundary value) - Day: 31, Month: 4, Year: 1935
Test case 8: Valid date (within valid range) - Day: 11, Month: 8, Year: 2013
Test case 9: Invalid date (year is outside valid range) - Day: 10, Month: 7, Year: 2032
Test case 10: Invalid date (day is outside valid range) - Day: 32, Month: 7, Year: 2012
Test case 11: Invalid date (month is outside valid range) - Day: 15, Month: 13, Year: 2014

Programs:

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);
}
```

Boundary Partitioning:

Tester Action and Input Data	Expected Output
Test with v as a non-existent value and an empty array a[]	-1
Test with v as a non-existent value and a non-empty array a[]	-1
Test with v as an existent value and an empty array a[]	-1
Test with v as an existent value and a non-empty array a[] where v exists	the index of v in a[]
Test with v as an existent value and a non-empty array a[] where v does not exist	-1

Boundary Value Analysis:

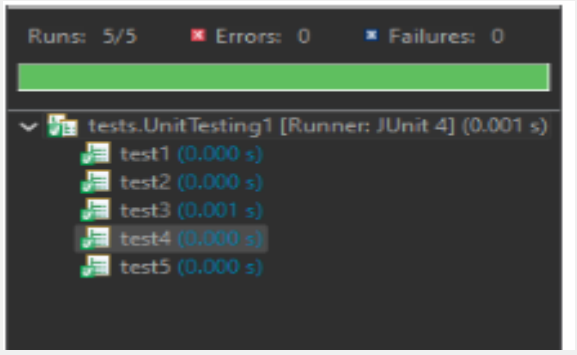
Tester Action and Input Data	Expected Output
Test with v as a non-existent value and an empty array a[]	-1
Test with v as a non-existent value and a non-empty array a[]	-1
Test with v as an existent value and an array a[] of length 0	-1
Test with v as an existent value and an array a[] of length 1, where v exists	0
Test with v as an existent value and an array a[] of length 1, where v does not exist	-1
Test with v as an existent value and an array a[] of length greater than 1, where v exists at the beginning of the array	0
Test with v as an existent value and an array a[] of length greater than 1, where v exists at the end of the array	the last index where v is found

Test Cases in eclipse:

```
public class UnitTesting1  {
    @Test
    public void test1() {
        int arr[] = { 10, 20, 30, 40, 50 };

        Programs program = new Programs();
        int output = program.linearSearch(20, arr);

        System.out.println(output);
        assertEquals(1, output);
    }
    @Test
    public void test2() {
        int arr[] = { 50 };

        Programs program = new Programs();
        int output = program.linearSearch(50, arr);

        System.out.println(output);
        assertEquals(0, output);
    }
    @Test
    public void test3() {
        int arr[] = { };

        Programs program = new Programs();
        int output = program.linearSearch(10, arr);

        System.out.println(output);
        assertEquals(-1, output);
    }
    @Test
    public void test4() {
        int arr[] = { 100 };

        Programs program = new Programs();
        int output = program.linearSearch(1, arr);

        System.out.println(output);
        assertEquals(-1, output);
    }
    @Test
    public void test5() {
```

```
        int arr[] = { 10, 20, 30 };

        Programs program = new Programs();
        int output = program.linearSearch(60, arr);

        System.out.println(output);
        assertEquals(-1, output);
    }
```

Output



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);
}
```

Equivalence Partitioning:

Tester Action and Input Data	Expected Outcome
Test with v as a non-existent value and an empty array a[]	0
Test with v as a non-existent value and a non-empty array a[]	0
Test with v as an existent value and a non-empty array a[] where v exists multiple times	The number of occurrences of v in a[]
Test with v as an existent value and a non-empty array a[] where v exists only once	1

Boundary Value Analysis:

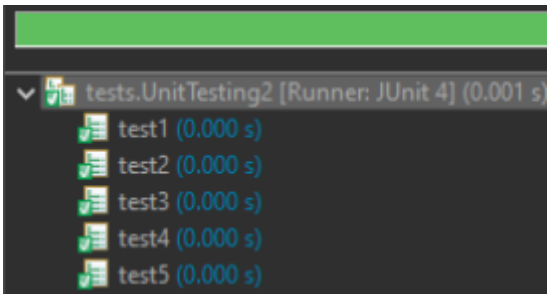
Tester Action and Input Data	Expected Outcome
Test with v as a non-existent value and an empty array a[]	0
Test with v as a non-existent value and a non-empty array a[]	0
Test with v as an existent value and an array a[] of length 1, where *v* exists	1
Test with v as an existent value and an array a[] of length 1, where *v* does not exist	0
Test with v as an existent value and an array a[] of length greater than 1, where v exists at the beginning of the array	The number of occurrences of v in a[]
Test with v as an existent value and an array a[] of length greater than 1, where v exists at the end of the array	The number of occurrences of v in a[]
Test with v as an existent value and an array a[] of length greater than 1, where v exists in the middle of the array	The number of occurrences of v in a[]

Test cases in Eclipse:

```
public class UnitTesting2 {
    @Test
    public void test1() {
        int arr[] = {};
        p2 program = new p2();
        int o = program.countItem(0, arr);

        assertEquals(o, 0);
    }

    @Test
    public void test2() {
        int arr[] = { 1, 1, 1 };
        p2 program = new p2();
        int o = program.countItem(1, arr);

        assertEquals(o, 3);
    }

    @Test
    public void test3() {
        int arr[] = { 2 };
        p2 program = new p2();
        int o = program.countItem(2, arr);

        assertEquals(o, 1);
    }
```

```
    @Test
    public void test4() {
        int arr[] = { 3, 1 };
        p2 program = new p2();
        int o = program.countItem(2, arr);

        assertEquals(o, 0);
    }

    @Test
    public void test5() {
        int arr[] = { 11, 2 };
        Programs program = new Programs();
        int o = program.countItem(11, arr);

        assertEquals(o, 1);
    }

}
```

Output:



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);
}
```

Equivalence Partitioning:

Tester Actions and Input Data	Expected Output
v=20, a=[20, 40, 60, 80, 100]	0
v=100, a=[20, 40, 60, 80, 100]	4
v=40, a=[20, 40, 60, 80, 100]	2
v=1, a=[20, 40, 60, 80, 100]	-1
v=12, a=[20, 40, 60, 80, 100]	-1

Boundary Value Analysis:

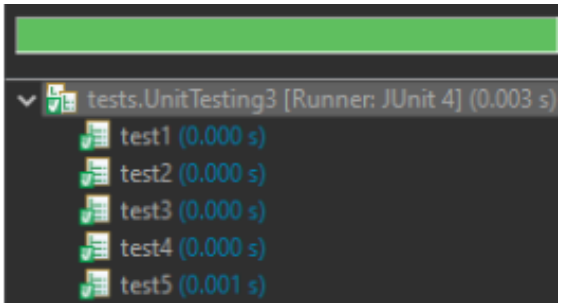
Tester Actions and Input Data	Expected Output
v=10, a=[10]	0
v=5, a=[]	-1
v=5, a=[5, 7, 9]	0 (smallest element in the array)
v=5, a=[1, 3, 5]	2 (largest element in the array)

Test cases in Eclipse:

```
public class UnitTesting3 {
    @Test
    public void test1() {
        int input[] = { 20, 40, 60, 80, 100 };
        Programs program = new Programs();
        int output = program.binarySearch(20, input);

        assertEquals(0, output);
    }

    @Test
    public void test2() {
        int input[] = { 20, 40, 60, 80, 100 };
        Programs program = new Programs();
        int output = program.binarySearch(100, input);

        assertEquals(4, output);
```

```
    }

    @Test
    public void test3() {
        int input[] = { 20, 40, 60, 80, 100  };
        Programs program = new Programs();
        int output = program.binarySearch(40, input);

        assertEquals(1, output);
    }

    @Test
    public void test4() {
        int input[] = { 20, 40, 60, 80, 100  };
        Programs program = new Programs();
        int output = program.binarySearch(1, input);

        assertEquals(-1, output);
    }

    @Test
    public void test5() {
        int input[] = { 20, 40, 60, 80, 100  };
        Programs program = new Programs();
        int output = program.binarySearch(12, input);

        assertEquals(-1, output);
    }

}
```

Output:



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);
}
```

Equivalence Partitioning:

Tester Actions and Input Data Input Format: (a, b, c)	Expected Output
(2, 2, 2)	0
(3, 3, 4)	1
(6, 5, 4)	2
(0, 0, 0)	3
(-1, -1, 5)	3
(2, 2, 1)	1
(0, 1, 1)	3
(1, 0, 1)	3
(1, 1, 0)	3

Boundary Value Analysis:

Tester Actions and Input Data	Expected Output
(0, 0, 0)	3
a + b = c or b + c = a or c + a = b (eg., (1, 2, 3))	3
(5, 5, 5)	0
a = b != c = 3	1
a != b = c = 3	1
a = c != b = 3	1
{a = b + c - 1} or {b = a + c - 1} or {c = a + b - 1}	2

(eg., (5, 4, 2))	
a = b = c = Integer.MAX_VALUE or a = b = c = Integer.MIN_VALUE	3

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;
}
```

Equivalence Partitioning:

Tester Actions and Input Data **Input Format: *(str1, str2)***	**Expected Output**
(“good”, “good morning”)	true
(“a”, “abc”)	true
(“”, “good morning”)	false
(“morning”, “good morning”)	false

Boundary Value Analysis:

Tester Actions and Input Data **Input Format: *(str1, str2)***	**Expected Output**
(“”, “software”)	false
(“soft”, “software”)	true
(“software”, “soft”)	false
(“a”, “ab”)	true
(“software”, “softwareeee”)	true

(“abc”, “abc”)	true
(“a”, “b”)	false
(“a”, “a”)	true
(“”, “”)	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:

a. Identify the equivalence classes for the system
b. Identify test cases to cover the identified equivalence classes. Also, explicitly mention which test case would cover which equivalence class. (Hint: you must need to be ensure that the identified set of test cases cover all identified equivalence classes)
c. For the boundary condition A + B > C case (scalene triangle), identify test cases to verify the boundary.
d. For the boundary condition A = C case (isosceles triangle), identify test cases to verify the
e. boundary.
f. For the boundary condition A = B = C case (equilateral triangle), identify test cases to verify the boundary.
g. For the boundary condition A2 + B2 = C2 case (right-angle triangle), identify test cases to verify the boundary.
h. For the non-triangle case, identify test cases to explore the boundary.
i. For non-positive input, identify test points.

Ans.

Equivalence Class:

Tester Action and Input Data(a,b,c)	Expected Output
(-1,2,3)	Invalid input
(1,1,1)	Equilateral triangle
(2,2,3)	Isosceles triangle
(3,4,5)	Scalene right-angled triangle
(3,5,4)	Scalene right-angled triangle
(5,3,4)	Scalene right-angled triangle
(3,4,6)	Not a triangle

Test Case:

Invalid inputs:

a = 0, b = 0, c = 0, a + b = c, b + c = a, c + a = b

Invalid inputs:

a = -1, b = 1, c = 1, a + b = c

Equilateral triangles:

a = b = c = 1, a = b = c = 100

Isosceles triangles:

a = b = 10, c = 5;
a = c = 10, b = 3;
b = c = 10,
a = 6

Scalene triangles:

a = 4, b = 5, c = 6;
a = 10, b = 11, c = 13

Right angled triangle:

a = 3, b = 4, c = 5;
a = 5, b = 12, c = 13

Non-triangle:

a = 1, b = 2, c = 3

Non-positive input:

a = -1, b = -2, c = -3

c) Boundary condition A + B > C:

a = Integer.MAX_VALUE, b = Integer.MAX_VALUE, c = 1
a = Double.MAX_VALUE, b = Double.MAX_VALUE, c = Double.MAX_VALUE

d) Boundary condition A = C:

a = Integer.MAX_VALUE,
b = 2,
c = Integer.MAX_VALUE
a = Double.MAX_VALUE,
b = 2.5,
c = Double.MAX_VALUE

e) Boundary condition A = B = C:

a = Integer.MAX_VALUE, b = Integer.MAX_VALUE, c = Integer.MAX_VALUE a = Double.MAX_VALUE, b = Double.MAX_VALUE, c = Double.MAX_VALUE

f) Boundary condition A^2 + B^2 = C^2:

a = Integer.MAX_VALUE,
b = Integer.MAX_VALUE,
c = Integer.MAX_VALUE
a = Double.MAX_VALUE,
b = Double.MAX_VALUE,

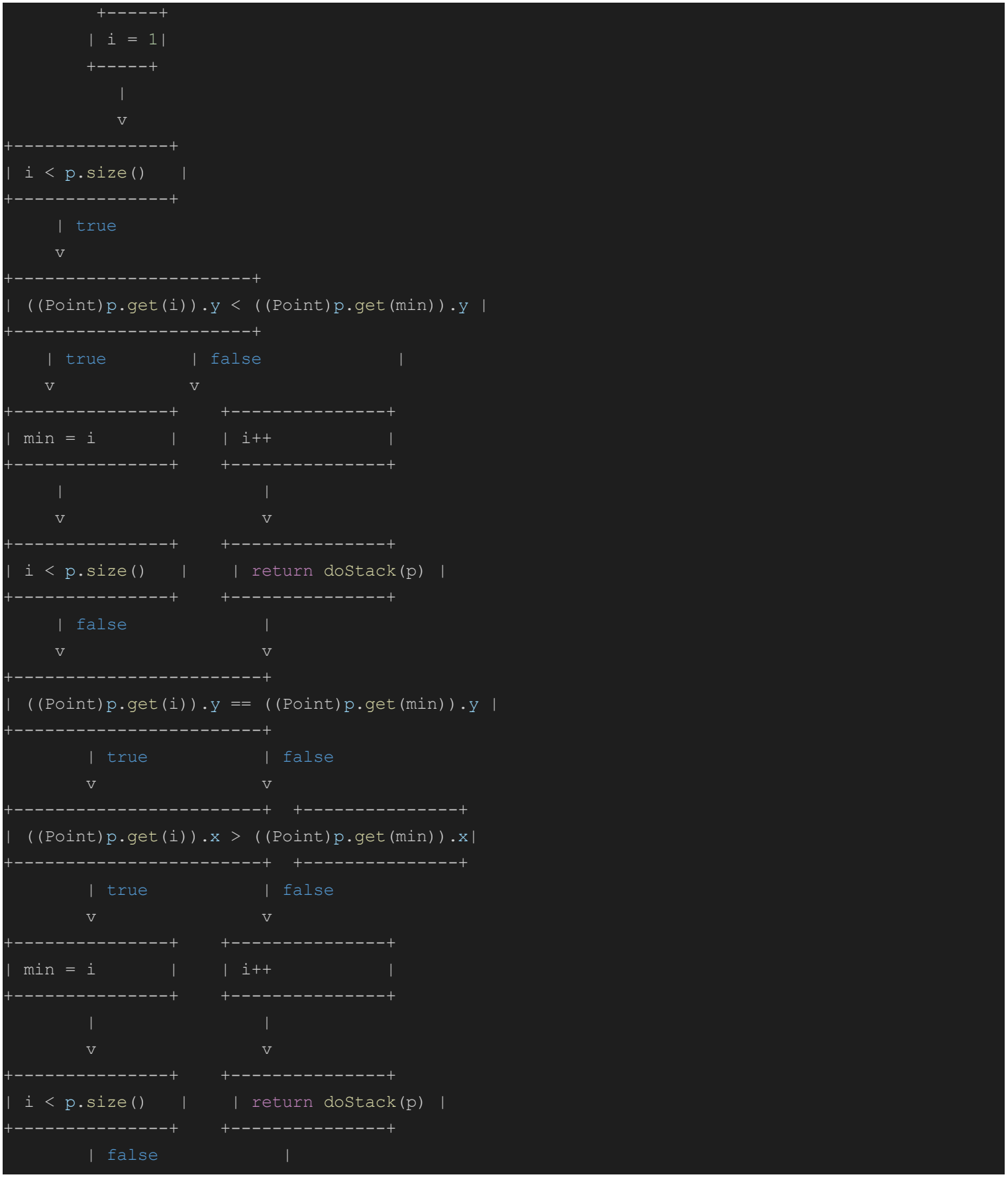
c = Math.sqrt(Math.pow(Double.MAX_VALUE, 2) + Math.pow(Double.MAX_VALUE, 2))

g) Non-triangle:

a = 1, b = 2, c = 4 a = 2, b = 4, c = 8

Section – B

1. **Control Flow Graph (CFG)**



Test sets for each coverage criterion:

a. Statement Coverage:
Test 1: p = {new Point(0, 0), new Point(1, 1)}
Test 2: p = {new Point(0, 0), new Point(1, 0), new Point(2, 0)}

b. Branch Coverage:
Test 1: p = {new Point(0, 0), new Point(1, 1)}
Test 2: p = {new Point(0, 0), new Point(1, 0), new Point(2, 0)}
Test 3: p = {new Point(0, 0), new Point(1, 0), new Point(1, 1)}

c. Basic Condition Coverage:
Test 1: p = {new Point(0, 0), new Point(1, 1)}
Test 2: p = {new Point(0, 0), new Point(1, 0), new Point(2, 0)}
Test 3: p = {new Point(0, 0), new Point(1, 0), new Point(1, 1)}
Test 4: p = {new Point(0, 0), new Point(1, 0), new Point(0, 1)}
Test 5: p = {new Point(0, 0), new Point(0, 1), new Point(1, 1)}