

Software Engineering

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Lab 7: Software Testing

Section A

Based on the input ranges, equivalence classes are given as follows

1. Valid dates: The input triple (day, month, year) that represents a valid date in the Gregorian calendar, such as (14, 11, 2002).
2. Invalid dates: The input triple (day, month, year) that represents an invalid date, such as (30, 2, 2002) or (29, 2, 1900).
- 3.
4. Out of range dates: The input triple (day, month, year) that are outside the allowed ranges, such as (0, 5, 200) or (15, 15, 2007).

Based on these equivalence classes, we can design the following test cases:

Valid dates:

Input	Expected output
29,09,2009	28,09,2009
1,1,2009	31,12,1999
31,5,1997	30,5,1997

Invalid dates:

Input	Expected output
30,02,2009	Invalid
31,11,2009	Invalid

Out of range dates:

Input	Expected output
0,12,2009	Invalid
15,15,2007	Invalid
31,12,1887	Invalid

Boundary value analysis:

- 1) Earliest possible date: (1,1,1900)
- 2) Latest possible date: (31,12,2015)
- 3) The earliest day of each month: (1, 1, 2000), (1, 2, 2000), (1, 3, 2000),..., (1, 12, 2000)
- 4) The latest day of each month: (31, 1, 2000), (28, 2, 2000), (31, 3, 2000),..., (31, 12, 2000)
- 5) Leap year day: (29, 2, 2004)
- 6) Invalid leap year day: (29, 2, 2001)
- 7) One day before earliest date: (31, 12, 1899)
- 8) One day after latest date: (1, 1, 2016)

Boundary test cases:

Input	Expected output
(1,1,1900)	Invalid
(31,12,2015)	(30,12,2015)
(1, 1, 2000)	(31,12,1999)
(31, 1, 2000)	(30,1,2000)

(29,2,2004)	(28,4,2004)
(29,2,2001)	Invalid

Program 1:

Equivalence class table

Test Case ID	Array value	target	output	Expected output
1	{1,2,3,4}	3	2	2
2	{1,2,3,4}	5	-1	-1
3	{}	1	-1	-1

Boundary class table

Case id	array	target	output	Expected output
1	{1,2,3,4}	1	0	0
2	{1,2,3,4,5}	5	4	4

Package ExplorerJUnit X

Finished after 0.012 seconds

Runs: 5/5Errors: 0Failures: 0

tests.linearSearch [Runner: JUnit 4] (0.001 s)

Failure Trace

UnitTesting.java

linearSearch.java X

countItem.java

```
4
5 import org.junit.Test;
6
7 public class linearSearch {
8     @Test
9     public void test1() {
10         UnitTesting obj1 = new UnitTesting();
11         int a[] = {1,2,3,4};
12         int output_f = obj1.linearSearch(3,a);
13         assertEquals(2, output_f);
14     }
15
16     @Test
17     public void test2() {
18         UnitTesting obj1 = new UnitTesting();
19         int a[] = {1,2,3,4};
20         int output_f = obj1.linearSearch(5,a);
21         assertEquals(-1, output_f);
22     }
23
24     @Test
25     public void test3() {
26         UnitTesting obj1 = new UnitTesting();
27         int a[] = {};
28         int output_f = obj1.linearSearch(1,a);
29         assertEquals(-1, output_f);
30     }
31
32     @Test
33     public void test4() {
34         UnitTesting obj1 = new UnitTesting();
35         int a[] = {1,2,3,4};
36         int output_f = obj1.linearSearch(1,a);
37         assertEquals(0, output_f);
38     }
39     @Test
40     public void test5() {
41         UnitTesting obj1 = new UnitTesting();
42         int a[] = {1,2,3,4,5};
43         int output_f = obj1.linearSearch(5,a);
44         assertEquals(4, output_f);
45     }
46
47 }
```

ProblemsJavadocDeclarationCoverage X

countItem (12-Apr-2023 4:28:20 pm)

Element	Coverage	Covered Instructio...	Missed Instructions	Total Instructions
> JunitTesting	38.4 %	163	261	424

Program 2:

Equivalence class table

Test Case ID	Array value	target	output	Expected output
1	{1,2,3,2,4}	2	2	2
2	{1,2,3,4}	5	0	0
3	{7}	1	0	0

Boundary class table

Case id	array	target	output	Expected output
1	{}	2	0	0
2	{1}	1	1	1

Package ExplorerJUnit X

Finished after 0.017 seconds

Runs: 5/5Errors: 0Failures: 0

> tests.countItem [Runner: JUnit 4] (0.002 s)

UnitTesting.java

linearSearch.java

countItem.java X

```
5 import org.junit.Test;
6
7 public class countItem {
8     @Test
9     public void test1() {
10         UnitTesting obj1 = new UnitTesting();
11         int a[] = {1,2,3,2,4};
12         int output_f = obj1.countItem(2,a);
13         assertEquals(2, output_f);
14     }
15
16     @Test
17     public void test2() {
18         UnitTesting obj1 = new UnitTesting();
19         int a[] = {1,2,3,4};
20         int output_f = obj1.countItem(5,a);
21         assertEquals(0, output_f);
22     }
23
24     @Test
25     public void test3() {
26         UnitTesting obj1 = new UnitTesting();
27         int a[] = {7};
28         int output_f = obj1.countItem(1,a);
29         assertEquals(0, output_f);
30     }
31
32     @Test
33     public void test4() {
34         UnitTesting obj1 = new UnitTesting();
35         int a[] = {};
36         int output_f = obj1.countItem(2,a);
37         assertEquals(0, output_f);
38     }
39
40     @Test
41     public void test5() {
42         UnitTesting obj1 = new UnitTesting();
43         int a[] = {1};
44         int output_f = obj1.countItem(1,a);
45         assertEquals(1, output_f);
46     }
47 }
48
```

Failure Trace

ProblemsJavadocDeclarationCoverage X

countItem (12-Apr-2023 4:43:24 pm)

Element	Coverage	Covered Instructio...	Missed Instructions	Total Instructions
> JunitTesting	37.3 %	165	277	442

Program 3:

Equivalence class table

Test Case ID	Array value	target	output	Expected output
1	{1,2,2,3,4}	3	3	3
2	{1,2,3,4}	5	-1	-1
3	{}	1	-1	-1

Boundary class table

Case id	array	target	output	Expected output
1	{1,2,3,4,5}	5	4	4
2	{6,7,8,9}	6	0	0

Package Explorer
JUnit X

Finished after 0.013 seconds

Runs: 5/5
Errors: 0
Failures: 0

> tests.binarySearch [Runner: JUnit 4] (0.000 s)

JUnitTesting.java
linearSearch.java
countItem.java
binarySearch.java X

```

5 import org.junit.Test;
6
7 public class binarySearch {
8     @Test
9     public void test1() {
10         UnitTesting obj1 = new UnitTesting();
11         int a[] = {1,2,3,2,4};
12         int output_f = obj1.binarySearch(3,a);
13         assertEquals(2, output_f);
14     }
15
16     @Test
17     public void test2() {
18         UnitTesting obj1 = new UnitTesting();
19         int a[] = {1,2,3,4};
20         int output_f = obj1.binarySearch(5,a);
21         assertEquals(-1, output_f);
22     }
23
24     @Test
25     public void test3() {
26         UnitTesting obj1 = new UnitTesting();
27         int a[] = {};
28         int output_f = obj1.binarySearch(1,a);
29         assertEquals(-1, output_f);
30     }
31     @Test
32     public void test4() {
33         UnitTesting obj1 = new UnitTesting();
34         int a[] = {1,2,3,4,5};
35         int output_f = obj1.binarySearch(5,a);
36         assertEquals(4, output_f);
37     }
38
39     @Test
40     public void test5() {
41         UnitTesting obj1 = new UnitTesting();
42         int a[] = {6,7,8,9};
43         int output_f = obj1.binarySearch(6,a);
44         assertEquals(0, output_f);
45     }
46 }
47
48

```

Failure Trace

Problems
Javadoc
Declaration
Coverage X

countItem (12-Apr-2023 4:43:24 pm)

Element	Coverage	Covered Instructio...	Missed Instructions	Total Instructions
> JUnitTesting	37.3 %	165	277	442

Program 4

Equivalence class table

Test Case ID	Array value	output	Expected output
1	3,3,3	0	0
2	4,4,6	1	1
3	3,4,5	2	2

Boundary class table

Case id	array	output	Expected output
1	10,2,4	3	3
2	0,0,0	3	3
3	-1,-2,-3	3	3
4	1235478945,999 999999,1000000 000	3	3

Package Explorer JUnit X

Finished after 0.012 seconds

Runs: 7/7 Errors: 0 Failures: 0

> tests.triangle [Runner: JUnit 4] (0.001 s)

Failure Trace

```
1 package tests;
2
3 import static org.junit.Assert.assertEquals;
4
5 import org.junit.Test;
6
7 public class triangle {
8     @Test
9     public void test1() {
10         UnitTesting obj1 = new UnitTesting();
11         int output_f = obj1.triangle(3,3,3);
12         assertEquals(0, output_f);
13     }
14
15     @Test
16     public void test2() {
17         UnitTesting obj1 = new UnitTesting();
18         int output_f = obj1.triangle(4,4,6);
19         assertEquals(1, output_f);
20     }
21
22     @Test
23     public void test3() {
24         UnitTesting obj1 = new UnitTesting();
25         int output_f = obj1.triangle(3,4,5);
26         assertEquals(2, output_f);
27     }
28     @Test
29     public void test4() {
30         UnitTesting obj1 = new UnitTesting();
31         int output_f = obj1.triangle(10,2,4);
32         assertEquals(3, output_f);
33     }
34
35     @Test
36     public void test5() {
37         UnitTesting obj1 = new UnitTesting();
38         int output_f = obj1.triangle(0,0,0);
39         assertEquals(3, output_f);
40     }
41
42     @Test
43     public void test6() {
44         UnitTesting obj1 = new UnitTesting();
45         int output_f = obj1.triangle(-1,2,3);
46         assertEquals(3, output_f);
47     }
48
49     @Test
50     public void test7() {
51         UnitTesting obj1 = new UnitTesting();
52         int output_f = obj1.triangle(1235478945,999999999,1000000000);
53         assertEquals(3, output_f);
54     }
55 }
```

Problems Javadoc Declaration Coverage X

triangle (12-Apr-2023 4:54:03 pm)

Element	Coverage	Covered Instruction...	Missed Instructions	Total Instructions
> JUnitTesting	17.7 %	126	584	710

Program 5:

Equivalence class table

Test case	Strings	output	Expected output
1	“” , “”	true	true
2	“” , “Software”	true	true
3	“Software” , “Software”	true	true
4	“Software” , “Softwere”	false	false
5	“Softwares” , “Software”	false	false

Boundary class tables

Test case	strings	output	Expected output
1	“” , “”	true	true
2	“” , “Software”	true	true
3	“Software” , “Softwere”	False	false
4	“Softwares” , “Software”	false	false

Package ExplorerJUnit ×

Finished after 0.022 seconds

Runs: 5/5Errors: 0Failures: 0

> tests.prefix [Runner: JUnit 4] (0.000 s)

Failure Trace

UnitTesting.javaprefix.java ×

```
9  @Test
10 public void test1() {
11     UnitTesting obj1 = new UnitTesting();
12     boolean output_f = obj1.prefix("", "");
13     assertEquals(true, output_f);
14 }
15
16 @Test
17 public void test2() {
18     UnitTesting obj1 = new UnitTesting();
19     boolean output_f = obj1.prefix("", "Software");
20     assertEquals(true, output_f);
21 }
22
23 @Test
24 public void test3() {
25     UnitTesting obj1 = new UnitTesting();
26     boolean output_f = obj1.prefix("Software", "Software");
27     assertEquals(true, output_f);
28 }
29
30 @Test
31 public void test4() {
32     UnitTesting obj1 = new UnitTesting();
33     boolean output_f = obj1.prefix("Software", "Softwere");
34     assertEquals(false, output_f);
35 }
36
37 @Test
38 public void test5() {
39     UnitTesting obj1 = new UnitTesting();
40     boolean output_f = obj1.prefix("Softwares", "Software");
41     assertEquals(false, output_f);
42 }
43
```

ProblemsJavadocDeclarationCoverage ×

prefix (Apr 12, 2023 10:17:55 PM)

Element	Coverage	vered Instructions	lised Instructions	Total Instructions
> junitTesting	93.1 %	108	8	116

Program 6:

a) Equivalence classes for the system

EC1: All sides are positive, real numbers.

EC2: One or more sides are negative or zero.

EC3: The sum of the lengths of any two sides is less than or equal to the length of the remaining side (impossible lengths).

EC4: The sum of the lengths of any two sides is greater than the length of the remaining side (possible lengths).

b) Test cases to cover equivalence classes

TC1 (EC1): A=3, B=4, C=5 (right-angled triangle)

TC2 (EC1): A=5, B=5, C=5 (equilateral triangle)

TC3 (EC1): A=5, B=6, C=7 (scalene triangle)

TC4 (EC1): A=5, B=5, C=7 (isosceles triangle)

TC5 (EC2): A=-2, B=4, C=5 (invalid input)

TC6 (EC2): A=0, B=4, C=5 (invalid input)

c) Test cases for boundary condition $A+B>C$

TC7 (EC4): A=4, B=3, C=6 (sum of A and B > C)

d) Test case for boundary condition $A=C$

TC8 (EC4): A=5, B=6, C=5 (A equals to C)

e) Test case for the boundary condition $A=B=C$

TC9 (EC4): A=5, B=5, C=5 (all sides are equal)

f) Test case for the boundary condition $A^2 + B^2 = C^2$

TC10 (EC4): A=3, B=4, C=5 (right-angled triangle)

g) Test cases for the boundary condition of non-triangle case:

TC11 (EC3): A=2, B=2, C=4 (sum of A and B is equal to C)

h) For non-positive input, identify test points.

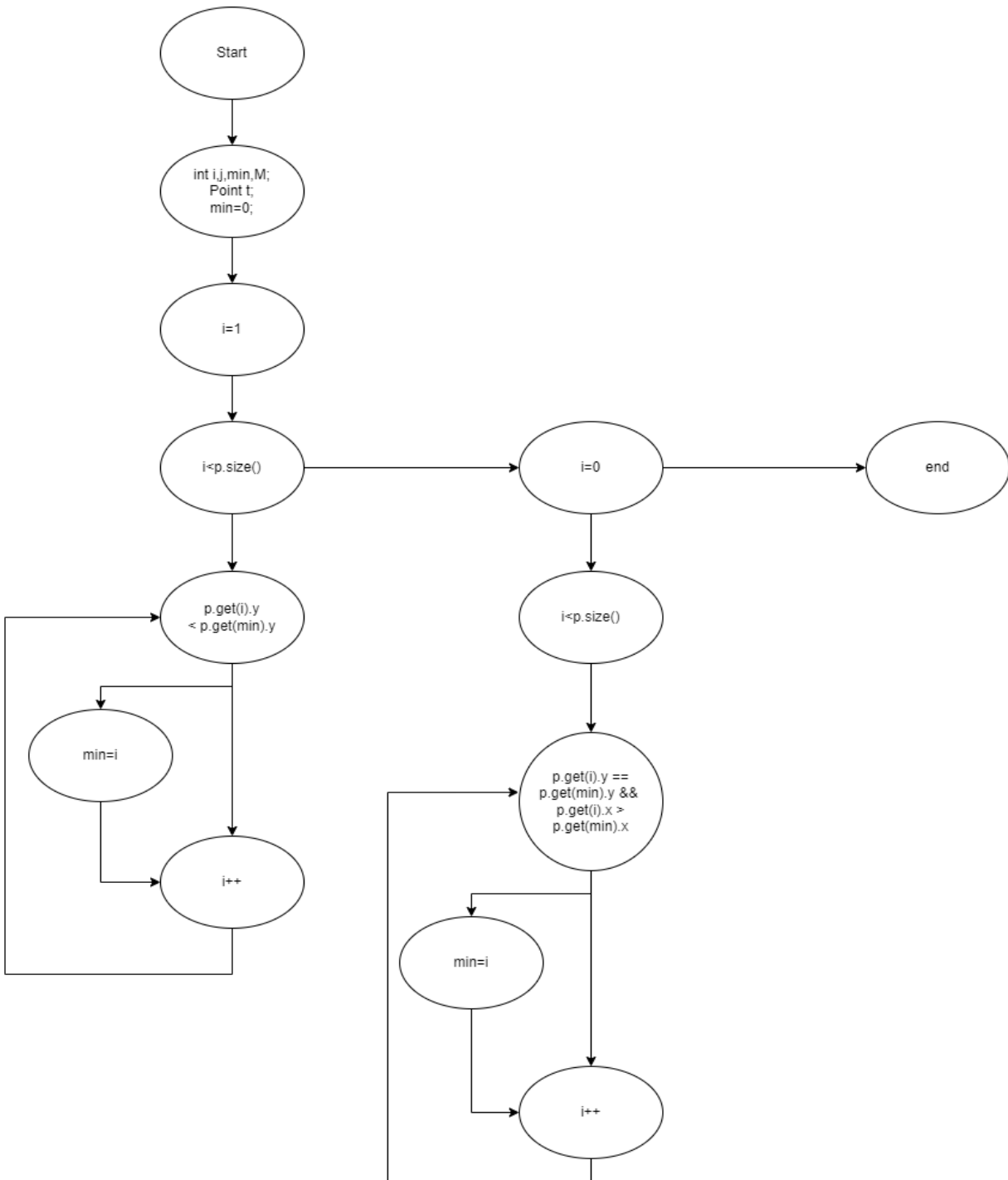
TP1 (EC2): A=0, B=4, C=5 (invalid input)

TP2 (EC2): A=-2, B=4, C=5 (invalid input)

The Test cases TC1 to TC10 covers all identified equivalence classes.

Section B

Control flow graph of doGraham method



Statement coverage test cases: every statement in code is executed at least once

Test 1: p = empty vector

Test 2: p = vector with one point

Test 3: p = vector with two points with the same y component

Test 4: p = vector with two points with different y components

Test 5: p = vector with three or more points with different y components

Test 6: p = vector with three or more points with the same y component

Branch coverage test sets: every branch in code is executed at least once

Test 1: p = empty vector

Test 2: p = vector with one point

Test 3: p = vector with two points with the same y component

Test 4: p = vector with two points with different y components

Test 5: p = vector with three or more points with different y components, and none of them have the same x component

Test 6: p = vector with three or more points with the same y component, and some of them have the same x

component

Test 7: p = vector with three or more points with the same y component, and all of them have the same x component

Basic condition coverage test sets: every boolean expression is executed at least once

Test 1: p = empty vector

Test 2: p = vector with one point

Test 3: p = vector with two points with the same y component, and the first point has a smaller x component

Test 4: p = vector with two points with the same y component, and the second point has a smaller x component

Test 5: p = vector with two points with different y components

Test 6: p = vector with three or more points with different y components, and none of them have the same x component

Test 7: p = vector with three or more points with the same y component, and some of them have the same x component

Test 8: p = vector with three or more points with the same y component, and all of them have the same x component.

Examples of such test cases

Test cases :

- 1) $p=[(x=2,y=2),(x=2,y=3),(x=1,y=3),(x=1,y=4)]$
- 2) $p=[(x=2,y=3),(x=3,y=4),(x=1,y=2),(x=5,y=6)]$
- 3) $p=[(x=1,y=5),(x=2,y=7),(x=3,y=5),(x=4,y=5),(x=5,y=6)]$
- 4) $p=[(x=1,y=2)]$
- 5) $p=[]$

These 5 test cases cover all the tests discussed above.