Dhirubhai Ambani
Institute of Information and Communication Technology

Lab 8

Functional Testing (Black-Box)

Name: Parjanya Rajput

S.ID: 202201115

Q.1. 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?

Write a set of test cases (i.e., test suite) – specific set of data – to properly test the programs. Your test suite should include both correct and incorrect inputs.

1. Enlist which set of test cases have been identified using Equivalence Partitioning and Boundary Value Analysis separately.

==========

No	Equivalence Class	Validity
1	Day Value is alphabetic	Invalid
2	Day Value is numeric	Valid
3	Day Value is Decimal	Invalid
4	Day Value is empty	Invalid
5	Day Value < 1	Invalid
6	1 <= Day Value <= 31	Valid
7	Day Value > 31	Invalid
8	Month Value is alphabetic	Invalid
9	Month value is numeric	Valid

10	Month Value is Decimal	Invalid
11	Month Value is empty	Invalid
12	Month Value < 1	Invalid
13	1 <= Month Value <= 12	Valid
14	Month Value > 12	Invalid
15	Year Value is alphabetic	Invalid
16	Year Value is numeric	Valid
17	Year Value is Decimal	Invalid
18	Year Value is empty	Invalid
19	Year Value < 1900	Invalid
20	1900<= Year Value <= 2015	Valid
21	Year Value > 2015	Invalid

Test Case	Input(Day, Month, Year)	Class Covered	Expected Output	Validity	Remarks
1	(1,1,2000)	E2, E6,E9, E13, E16, E20	(31,12,1999)	Valid	
2	(32, 1, 2000)	E7	Error Message	Invalid	Invalid Day
3	(15, 1, 2000)	E2, E6,E9, E13, E16, E20	(14, 1, 2000)	Valid	
4	(1, 1, 1899)	E19	Error Message	Invalid	Invalid Year
5	(1, 1, 2016)	E19	Error Message	Invalid	Invalid Year
6	(0, 1, 2000)	E5	Error Message	Invalid	Invalid Day
7	(1, 0, 2000)	E12	Error Message	Invalid	Invalid Month
8	(1, 13, 2000)	E14	Error Message	Invalid	Invalid Month

9	(a, 12,2001)	E1	Error Message	Invalid	Invalid Day
10	(‘ ’, 11, 2005)	E4	Error Message	Invalid	Invalid Day
11	(5.6, 12, 2010)	E3	Error Message	Invalid	Invalid Day
12	(5, 6.6, abc)	E5, E10	Error Message	Invalid	Invalid Month and Year
13	(5,’ ‘, 2010.1)	E11, E17	Error Message	Invalid	Invalid Month and Year
14	(10, abc, ‘ ‘)	E8, E18	Error Message	Invalid	Invalid Month and Year

2. Modify your programs such that it runs, and then execute your test suites on the program.

While executing your input data in a program, check whether the identified expected outcome (mentioned by you) is correct or not

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.

==========

Code:

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

Equivalence Class Partitioning:

- E1: Element exists somewhere in the middle of the array
- E2: Element does not exist in the array
- E3: The array is empty
- E4: Element occurs more than once in the array

Tester Action and Input Data	Expected Outcome	Classes Covered
v = 12, a[] = [5, 9, 12, 18, 22]	2	E1
v = 20, a[] = [3, 8, 15, 21, 27]	-1	E2
v = 10, a[] = []	-1	E3
v = 18, a[] = [12, 18, 7, 18, 5]	2	E4

Boundary Value Analysis:

- C1: Element exists in a single-element array
- C2: Element does not exist in a single-element array
- C3: Element occurs at the first position in the array
- C4: Element occurs at the last position in the array

Tester Action and Input Data	Expected Outcome	Cases Covered
v = 7, a[] = [7]	0	C1
v = 8, a[] = [1]	-1	C2
v = 14, a[] = [14, 20, 25, 30, 35]	0	C3
v = 42, a[] = [10, 20, 30, 35, 42]	4	C4

Modified Code –

```
public class SearchFunctions {
```

```
    // Modified linearSearch function to handle null arrays
    public static int linearSearch(int v, int[] a) {
        if (a == null || a.length == 0) {
            return -1; // Return -1 if the array is null or empty
        }

        for (int i = 0; i < a.length; i++) {
            if (a[i] == v) {
                return i; // Return the index if the value is found
            }
        }
        return -1; // Return -1 if the value is not found
    }
}
```

After executing the test suite on the modified program, the identified expected outcome turns out to be correct.

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 Class Partitioning:

- E1: Element appears multiple times in the array
- E2: Element does not appear in the array
- E3: The array is empty

Tester Action and Input Data	Expected Outcome	Classes Covered
v = 5, a[] = [5, 1, 5, 7, 5, 8]	3	E1
v = 9, a[] = [2, 4, 6, 8, 10]	0	E2

v = 12, a[] = []	0	E3
v = -3, a[] = [-1, -2, -3, -4, -5]	0	E2

Boundary Value Analysis:

- C1: Element appears in a single-element array
- C2: Element does not exist in a single-element array
- C3: Element occurs at the first position in the array
- C4: Element occurs at the last position in the array

Tester Action and Input Data	Expected Outcome	Cases Covered
v = 7, a[] = [7]	1	C1
v = 2, a[] = [1]	0	C2
v = 5, a[] = [5, 9, 12, 15, 18]	1	C3
v = 20, a[] = [10, 15, 17, 19, 20	1	C4

Modified Code:

```
public class CountItem {

    public static void main(String[] args) {
        int[] array = {1, 2, 3, 2, 4, 2};
        int valueToCount = 2;
        int count = countItem(valueToCount, array);
        System.out.println("Count of " + valueToCount + ": " + count);
    }

    // Modified countItem method to handle null or empty arrays
    public static int countItem(int v, int[] a) {
        if (a == null || a.length == 0) {
            return 0; // Return 0 for null or empty arrays
        }

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

```
        }
        return count;
    }
}
```

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

Code:

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

Equivalence Class Partitioning:

- E1: Element exists in the array
- E2: Element does not exist in the array
- E3: The array is empty
- E4: Element occurs more than once in the array

Tester Action and Input Data	Expected Outcome	Classes Covered
v = 8, a[] = [2, 4, 6, 8, 10, 12, 14]	4	E1
v = 1, a[] = [3, 5, 7, 9, 11]	-1	E2
v = 4, a[] = []	-1	E3
v = 6, a[] = [1, 3, 6, 6, 7, 9, 10]	3	E4

Boundary Value Analysis:

- C1: Element exists in a single-element array
- C2: Element does not exist in a single-element array
- C3: Element occurs at the first position in the array
- C4: Element occurs at the last position in the array
- C5: Element is greater than the greatest element in the array
- C6: Element is smaller than the smallest element in the array

Tester Action and Input Data	Expected Outcome	Cases Covered
v = 4, a[] = [4]	0	C1
v = 2, a[] = [5]	-1	C2
v = 7, a[] = [7, 8, 9, 10]	0	C3
v = 15, a[] = [5, 7, 9, 11, 15]	4	C4
v = 20, a[] = [2, 4, 6, 8, 10]	-1	C5
v = -5, a[] = [0, 2, 4, 6, 8]	-1	C6

Code Modified

```
public class BinarySearchExample {

    public static void main(String[] args) {
        int[] array = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10}; // Must be sorted
        int valueToFind = 5;

        int result = binarySearch(valueToFind, array);
        if (result != -1) {
            System.out.println("Value " + valueToFind + " found at index: " + result);
        } else {
            System.out.println("Value " + valueToFind + " not found in the array.");
        }
    }

    // Modified binarySearch method to handle array size
    public static int binarySearch(int v, int[] a) {
        if (a == null || a.length == 0) {
```

```
            return -1; // Return -1 for null or empty arrays
        }

        int lo = 0;
        int hi = a.length - 1;
        int mid;

        while (lo <= hi) {
            mid = lo + (hi - lo) / 2;

            if (v == a[mid]) {
                return mid; // Value found
            } else if (v < a[mid]) {
                hi = mid - 1; // Search in the left half
            } else {
                lo = mid + 1; // Search in the right half
            }
        }
        return -1; // Value not found
    }
}
```

After executing the test suite on the modified program, the identified expected outcome turns out to be correct.

P4 – Triangle Type Function

The function triangle takes three integer parameters as side lengths of a triangle. It returns:

- 0 (EQUILATERAL) if all three sides are equal.
- 1 (ISOSCELES) if two sides are equal.
- 2 (SCALENE) if all three sides are different.
- 3 (INVALID) if the given sides do not form a valid triangle.

Code:

```
public class TriangleType {

    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) {
        // Check for invalid triangles: non-positive sides or triangle inequality
        violation if (a <= 0 || b <= 0 || c <= 0 || a >= b + c || b >= a + c || c >= a +
        b) {
            return INVALID;
        }
        // Check if the triangle is equilateral
        if (a == b && b == c) {
            return EQUILATERAL;
        }
        // Check if the triangle is isosceles
        if (a == b || a == c || b == c) {
            return ISOSCELES;
        }
        // Otherwise, it must be scalene
        return SCALENE;
    }
}
```

Equivalence Class Partitioning:

- E1: All three sides are equal (Equilateral triangle).
- E2: Exactly two sides are equal (Isosceles triangle).
- E3: All three sides are different (Scalene triangle).
- E4: One or more negative sides (Invalid triangle).
- E5: One side length is zero (Invalid triangle).
- E6: Valid side lengths for a valid triangle.
- E7: Sum of two sides is not greater than the third side (Invalid triangle).

Tester Action and Input Data	Expected Outcome	Classes Covered
a = 7, b = 7, c = 7	EQUILATERAL (0)	E1, E6
a = 5, b = 5, c = 9	ISOSCELES (1)	E2, E6
a = 3, b = 4, c = 5	SCALENE (2)	E3, E6
a = 10, b = 5, c = 3	INVALID (3)	E7
a = 0, b = 6, c = 6	INVALID (3)	E5
a = -1, b = 3, c = 4	INVALID (3)	E5

Boundary Value Analysis:

- C1: Smallest valid triangle (all sides = 1).
- C2: Sum of two sides equals the third.
- C3: One side is very close to zero but valid.

Tester Action and Input Data	Expected Outcome	Cases Covered
a = 1, b = 1, c = 1	EQUILATERAL (0)	C1
a = 2, b = 2, c = 4	INVALID (3)	C2
a = 1000, b = 1, c = 1	INVALID (3)	C3

Modified Code:

```
public class TriangleType {

  // Constants representing different triangle types

  public static final int EQUILATERAL = 0;

  public static final int ISOSCELES = 1;

  public static final int SCALENE = 2;

  public static final int INVALID = 3;


  public int triangle(int a, int b, int c) {
```

```
    // Check for invalid triangles: non-positive sides or invalid triangle
    inequality if (a <= 0 || b <= 0 || c <= 0 || a >= b + c || b >= a + c || c >= a +
    b) {
        return INVALID;
    }

    // Check if the triangle is equilateral
    if (a == b && b == c) {
        return EQUILATERAL;
    }

    // Check if the triangle is isosceles
    if (a == b || a == c || b == c) {
        return ISOSCELES;
    }

    // If it's neither equilateral nor isosceles, it must be
    scalene return SCALENE;
}

public static void main(String[] args) {
    TriangleType triangleType = new TriangleType();

    // Example test cases
    System.out.println(triangleType.triangle(7, 7, 7)); // Output: 0
```

```
    (Equilateral) System.out.println(triangleType.triangle(5, 5, 9)); //
    Output: 1 (Isosceles) System.out.println(triangleType.triangle(3, 4,
    5)); // Output: 2 (Scalene)
    System.out.println(triangleType.triangle(10, 5, 3)); // Output: 3
    (Invalid) System.out.println(triangleType.triangle(-1, 3, 4)); //
    Output: 3 (Invalid) }
}
```

After executing the test suite on the modified program, the identified expected outcome turns out to be correct.

P5 –Function Specification: Prefix Check

Code:

```
public class StringPrefix {
    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 Class Partitioning

1. E1: s1 is a valid prefix of s2.
2. E2: s1 is not a valid prefix of s2.
3. E3: s1 exceeds the length of s2.
4. E4: s1 is an empty string.
5. E5: s2 is an empty string.

Tester Action and Input Data	Expected Outcome	Classes Covered
s1 = "hello" s2 = "hello world"	True	E1
s1 = "xyz" s2 = "abcdef"	False	E2
s1 = "abcdefgh" s2 = "abc"	False	E3
s1 = "" s2 = "test"	True	E4
s1 = "abc" s2 = ""	False	E5

Boundary Value Analysis

1. C1: Both strings are of equal length.
2. C2: s1 is nearly a prefix of s2, differing only at the last character.
3. C3: s1 is a single character that matches the beginning of s2.
4. C4: s1 is a single character that does not match the start of s2.
5. C5: Both strings are empty.

Tester Action and Input Data	Expected Outcome	Cases Covered
s1 = "test" s2 = "test"	True	C1
s1 = "test1" s2 = "test2"	False	C2
s1 = "t" s2 = "test"	True	C3

s1 = "x" s2 = "test"	False	C4
s1 = "" s2 = ""	True	C5

P6 – Triangle Classification Program
The program reads floating-point values from the standard input, interpreting them as the lengths of the sides of a triangle. It then prints a message indicating whether the triangle can be formed and its type: scalene, isosceles, equilateral, or right-angled.

a) Equivalence Classes Identification

The identified Equivalence Classes are:

- E1: All sides are positive (Valid)
- E2: One or more sides are negative (Invalid)
- E3: Valid triangle inequality (sum of two sides greater than the third) (Valid)
- E4: Invalid triangle inequality (Invalid)
- E5: All sides equal, forming an Equilateral triangle (Valid)
- E6: Two sides equal, forming an Isosceles triangle (Valid)
- E7: All sides unequal, forming a Scalene triangle (Valid)
- E8: Sides form a Right-angled triangle (Valid)
- E9: One of the sides has length 0 (Invalid)

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)
The Test Cases are –

Test Case No.	Input Values Expected Outcome	Covered Equivalence Class
1	3, 4, 5 Right-angled Triangle	E1, E3, E8
2	3, 3, 3 Equilateral Triangle	E1, E3, E5
3	4, 5, 4 Isosceles Triangle	E1, E3, E6
4	2, 3, 4 Scalene Triangle	E1, E3, E7
5	1, 2, 3 Invalid Triangle	E1, E4

6	0, 2, 3 Invalid Input	E9
7	-1, 2, 3 Invalid Input	E2

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

➔ The Test Case are –

➔

Test Case No.	Input Values	Expected Outcome
1	2.9999, 4, 7	Scalene Triangle
2	2 3, 4, 7.0001	ScaleneTriangle

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

➔ The Test Case are –

Test Case No.	Input Values	Expected Outcome
1	5, 7.12, 5	Isosceles Triangle
2	7, 7, 13,2	Isosceles Triangle

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

➔ The Test Case are –

Test Case No.	Input Values	Expected Outcome
1	8, 8, 8	Equilateral Triangle
2	2.0, 2.0, 2.0	Equilateral Triangle

f) For the boundary condition A2 + B2 = C2 case (right-angle triangle), identify test cases to verify the boundary.

➔ The Test Case are –

Test Case No.	Input Values	Expected Outcome
1	5, 12, 13	Right-angled Triangle
2	6, 8, 10	Right-angled Triangle

g) For the non-triangle case, identify test cases to explore the boundary.

➔ The Test Case are –

Test Case No.	Input Values	Expected Outcome
1	1, 2, 3	Invalid Triangle
2	4, 4, 8	Invalid Triangle

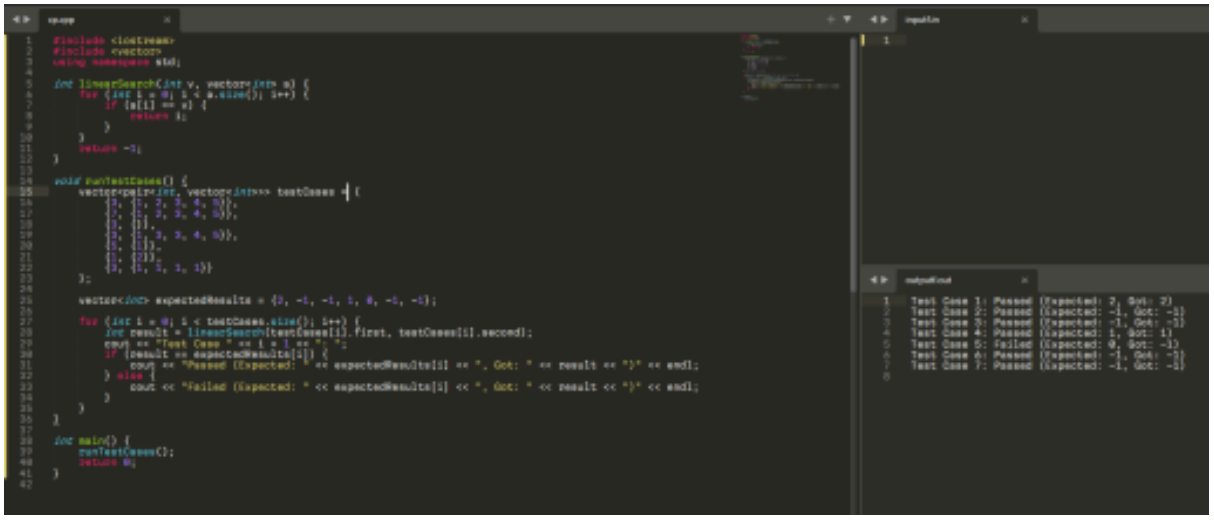
h) For non-positive input, identify test points.

➔ The Test Case are –

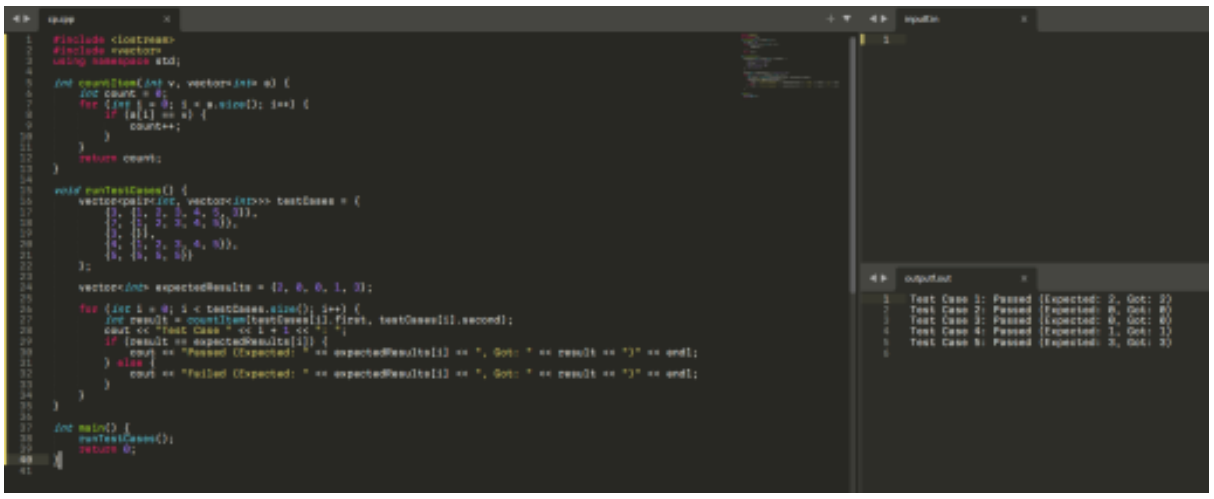
Test Case No.	Input Values	Expected Outcome
1	0, 5, 3	Invalid Input
2	-1, -5, 3	Invalid Input

C++ Code Output (Java Codes above are corresponding to it)

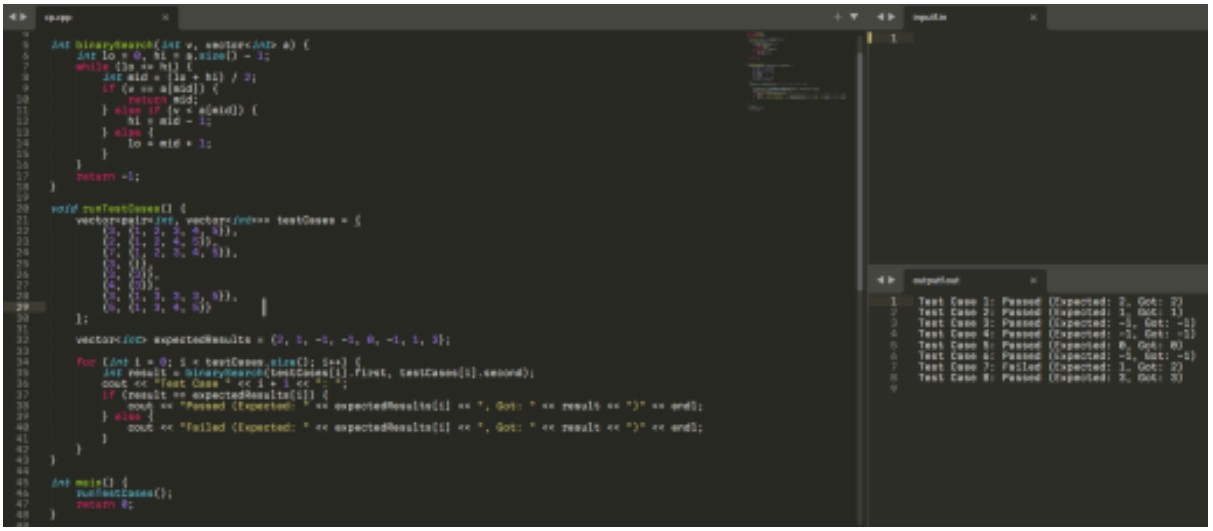
1.



2.



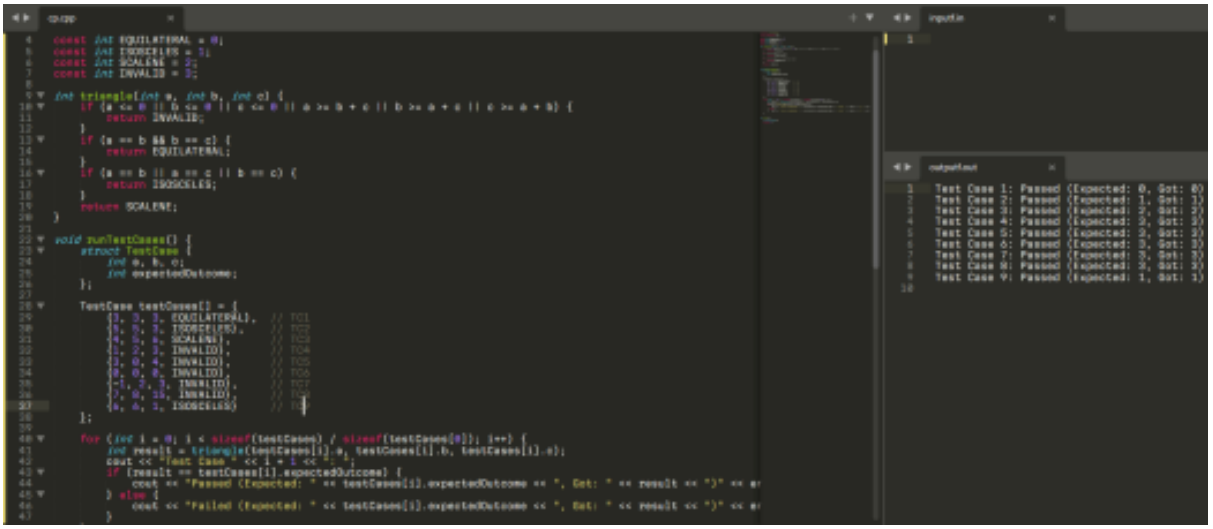
3.



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

void runTestCases() {
    vector<pair<int, vector<int>>> testCases = {
        {3, {1, 2, 3, 4, 5}},
        {1, {1, 2, 3, 4, 5}},
        {7, {1, 2, 3, 4, 5}},
        {8, {}},
        {8, {8}},
        {4, {8}},
        {3, {1, 3, 3, 3, 5}},
        {5, {1, 3, 4, 5}}
    };

    vector<int> expectedResults = {2, 1, -1, -1, 0, -1, 1, 3};

    for (int i = 0; i < testCases.size(); i++) {
        int result = binarySearch(testCases[i].first, testCases[i].second);
        cout << "Test Case " << i + 1 << ": ";
        if (result == expectedResults[i]) {
            cout << "Passed (Expected: " << expectedResults[i] << ", Got: " << result << ")" << endl;
        } else {
            cout << "Failed (Expected: " << expectedResults[i] << ", Got: " << result << ")" << endl;
        }
    }
}

int main() {
    runTestCases();
    return 0;
}
```

```
Test Case 1: Passed (Expected: 2, Got: 2)
Test Case 2: Passed (Expected: 1, Got: 1)
Test Case 3: Passed (Expected: -1, Got: -1)
Test Case 4: Passed (Expected: -1, Got: -1)
Test Case 5: Passed (Expected: 0, Got: 0)
Test Case 6: Passed (Expected: -1, Got: -1)
Test Case 7: Failed (Expected: 1, Got: 2)
Test Case 8: Passed (Expected: 3, Got: 3)
```

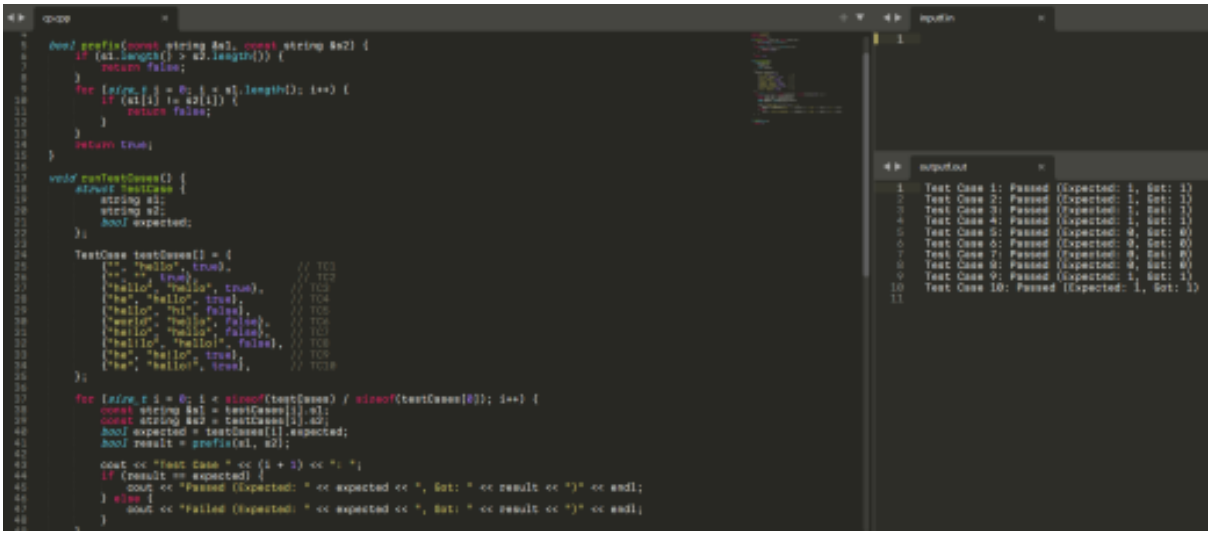
4.



```
const int EQUILATERAL = 0;
const int ISOSCELES = 1;
const int SCALENE = 2;
const int INVALID = 3;

int triangle(int a, int b, int c) {
    if (a <= 0 || b <= 0 || c <= 0 || 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;
}

void runTestCases() {
    struct TestCase {
        int a, b, c;
        int expectedOutcome;
    };

    TestCase testCases[] = {
        {3, 3, 3, EQUILATERAL},  // TC1
        {0, 0, 3, ISOSCELES},    // TC2
        {4, 5, 6, SCALENE},      // TC3
        {1, 2, 3, INVALID},      // TC4
        {0, 0, 4, INVALID},      // TC5
        {0, 0, 0, INVALID},      // TC6
        {-1, 2, 3, INVALID},     // TC7
        {7, 0, 15, INVALID},     // TC8
        {0, 4, 1, ISOSCELES}     // TC9
    };

    for (int i = 0; i < sizeof(testCases) / sizeof(testCases[0]); i++) {
        int result = triangle(testCases[i].a, testCases[i].b, testCases[i].c);
        cout << "Test Case " << i + 1 << ": ";
        if (result == testCases[i].expectedOutcome) {
            cout << "Passed (Expected: " << testCases[i].expectedOutcome << ", Got: " << result << ")" << e
        } else {
            cout << "Failed (Expected: " << testCases[i].expectedOutcome << ", Got: " << result << ")" << e
        }
```

```
Test Case 1: Passed (Expected: 0, Got: 0)
Test Case 2: Passed (Expected: 1, Got: 1)
Test Case 3: Passed (Expected: 2, Got: 2)
Test Case 4: Passed (Expected: 3, Got: 3)
Test Case 5: Passed (Expected: 3, Got: 3)
Test Case 6: Passed (Expected: 3, Got: 3)
Test Case 7: Passed (Expected: 3, Got: 3)
Test Case 8: Passed (Expected: 3, Got: 3)
Test Case 9: Passed (Expected: 1, Got: 1)
```

5.



```
bool prefix(const string &s1, const string &s2) {
    if (s1.length() > s2.length()) {
        return false;
    }
    for (size_t i = 0; i < s1.length(); i++) {
        if (s1[i] != s2[i]) {
            return false;
        }
    }
    return true;
}

void runTestCases() {
    struct TestCase {
        string s1;
        string s2;
        bool expected;
    };

    TestCase testCases[] = {
        {"", "hello", true},          // TC1
        {"", "", true},               // TC2
        {"hello", "hello", true},     // TC3
        {"he", "hello", true},        // TC4
        {"hello", "hi", false},       // TC5
        {"world", "hello", false},    // TC6
        {"hello", "hello", false},    // TC7
        {"hello", "hello!", false},   // TC8
        {"he", "hello", true},        // TC9
        {"he", "hello!", true},       // TC10
    };

    for (size_t i = 0; i < sizeof(testCases) / sizeof(testCases[0]); i++) {
        const string &s1 = testCases[i].s1;
        const string &s2 = testCases[i].s2;
        bool expected = testCases[i].expected;
        bool result = prefix(s1, s2);

        cout << "Test Case " << (i + 1) << ": ";
        if (result == expected) {
            cout << "Passed (Expected: " << expected << ", Got: " << result << ")" << endl;
        } else {
            cout << "Failed (Expected: " << expected << ", Got: " << result << ")" << endl;
        }
```

```
Test Case 1: Passed (Expected: 1, Got: 1)
Test Case 2: Passed (Expected: 1, Got: 1)
Test Case 3: Passed (Expected: 1, Got: 1)
Test Case 4: Passed (Expected: 1, Got: 1)
Test Case 5: Passed (Expected: 0, Got: 0)
Test Case 6: Passed (Expected: 0, Got: 0)
Test Case 7: Passed (Expected: 0, Got: 0)
Test Case 8: Passed (Expected: 0, Got: 0)
Test Case 9: Passed (Expected: 1, Got: 1)
Test Case 10: Passed (Expected: 1, Got: 1)
```