C-DAC Mumbai

Date 26/09/2024

Subject: Algorithm and Data Structure
Assignment 1

Solve the assignment with following thing to be added in each question.

-Program
-Flow chart
-Explanation
-Output
-Time and Space complexity

1. Printing Patterns
Problem: Write a Java program to print patterns such as a right triangle of stars.

Test Cases:

Input: n = 3
Output:

```
*
**
***
```

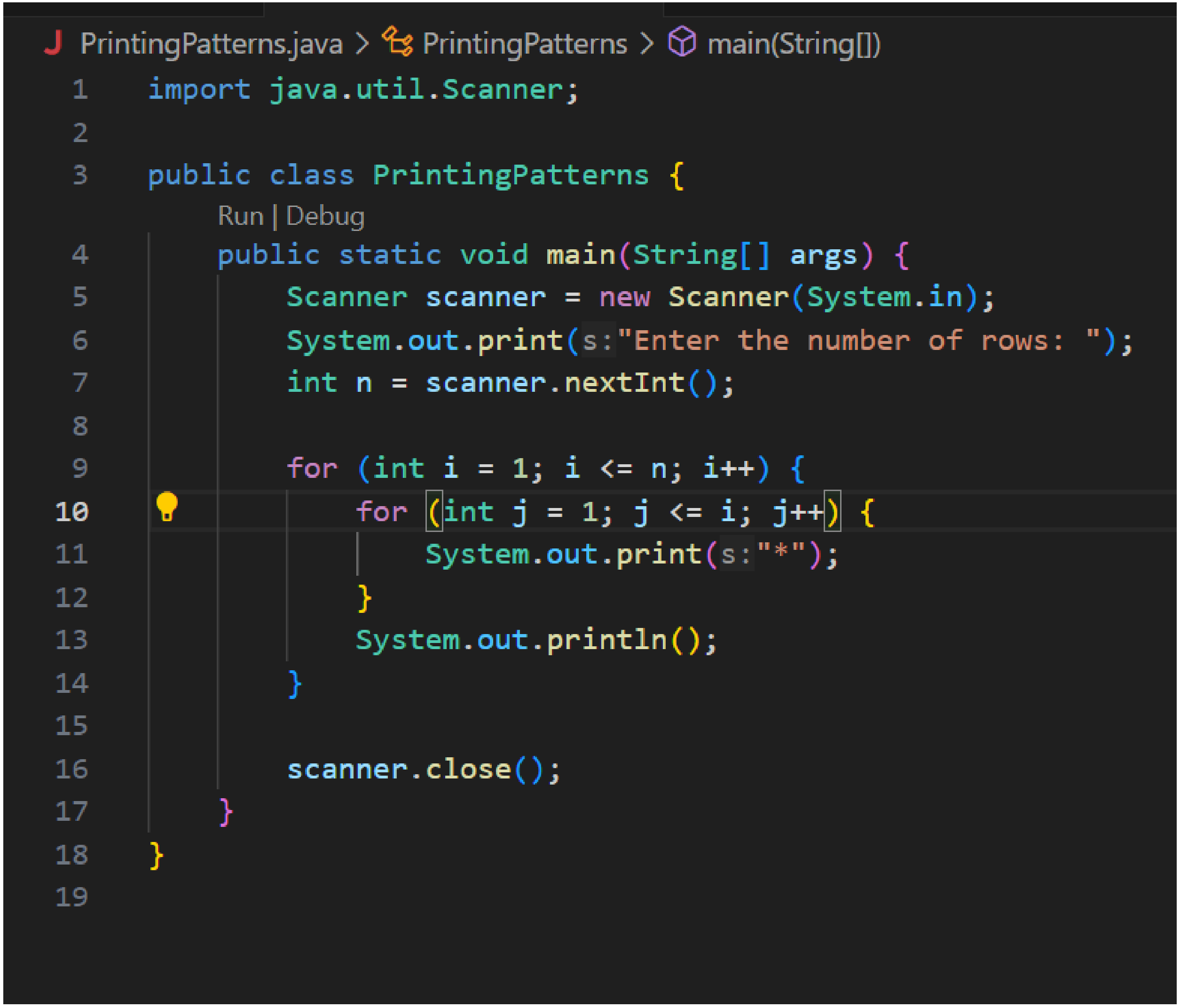
Input: n = 5
Output:

```
*
**
***
****
*****
```

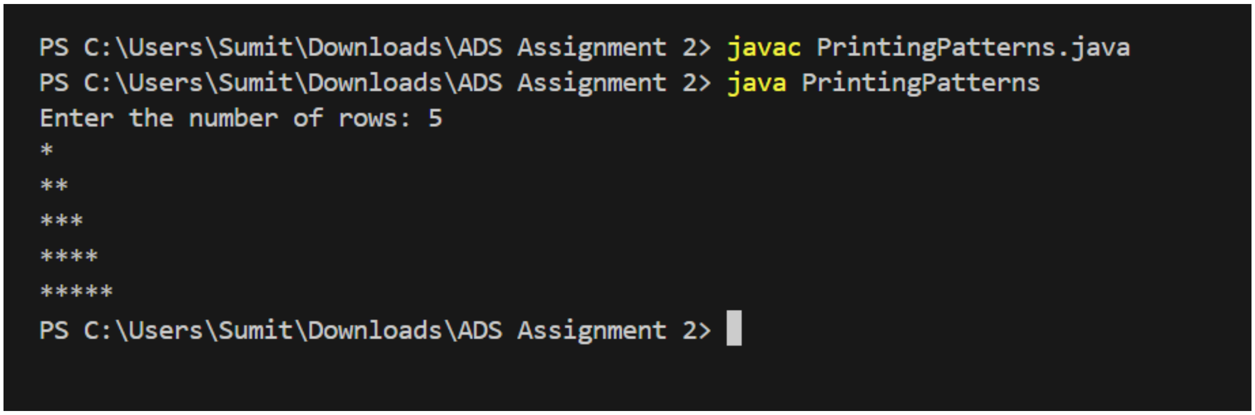
Ans:

```
import java.util.Scanner;

public class PrintingPatterns {
  public static void main(String[] args) {
    Scanner scanner = new Scanner(System.in);
    System.out.print("Enter the number of rows: ");
    int n = scanner.nextInt();

    for (int i = 1; i <= n; i++) {
      for (int j = 1; j <= i; j++) {
        System.out.print("*");
      }
      System.out.println();
    }

    scanner.close();
  }
```

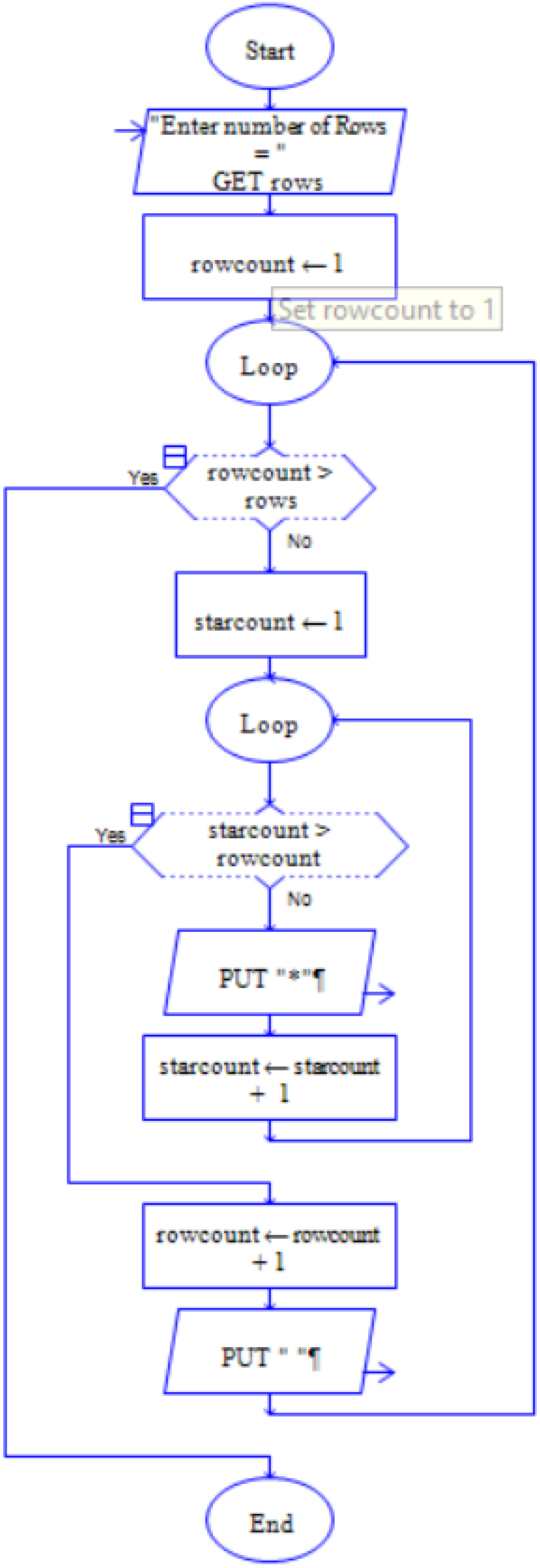
}



```java
import java.util.Scanner;

public class PrintingPatterns {
    public static void main(String[] args) {
        Scanner scanner = new Scanner(System.in);
        System.out.print(s:"Enter the number of rows: ");
        int n = scanner.nextInt();

        for (int i = 1; i <= n; i++) {
            for (int j = 1; j <= i; j++) {
                System.out.print(s:"*");
            }
            System.out.println();
        }

        scanner.close();
    }
}

```



```
PS C:\Users\Sumit\Downloads\ADS Assignment 2> javac PrintingPatterns.java
PS C:\Users\Sumit\Downloads\ADS Assignment 2> java PrintingPatterns
Enter the number of rows: 5
*
**
***
****
*****
PS C:\Users\Sumit\Downloads\ADS Assignment 2> 
```


Start
"Enter number of Rows = "
GET rows
rowcount ← 1
Set rowcount to 1
Loop
Yes
rowcount > rows
No
starcount ← 1
Loop
Yes
starcount > rowcount
No
PUT "*"¶
starcount ← starcount + 1
rowcount ← rowcount + 1
PUT " "¶
End

Time Complexity: (O(n^2))
Space Complexity: (O(1))

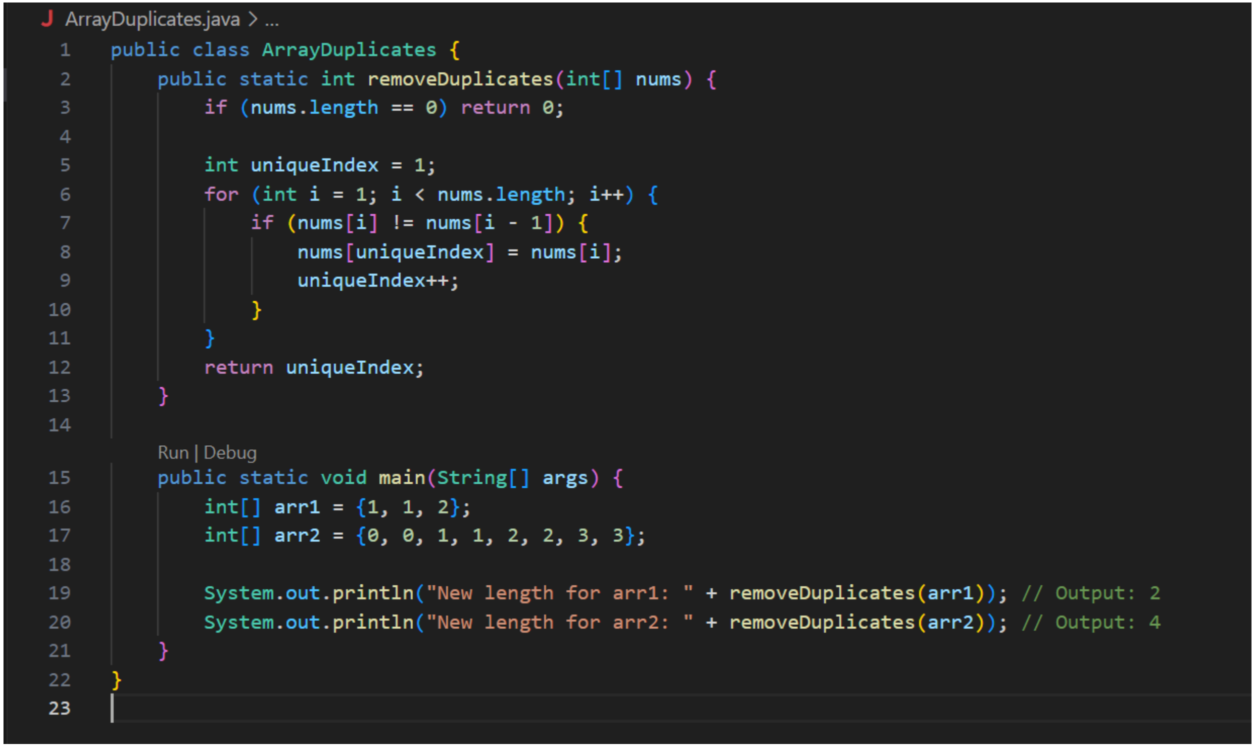
2. Remove Array Duplicates
Problem: Write a Java program to remove duplicates from a sorted array and return the new length of the array.

Test Cases:

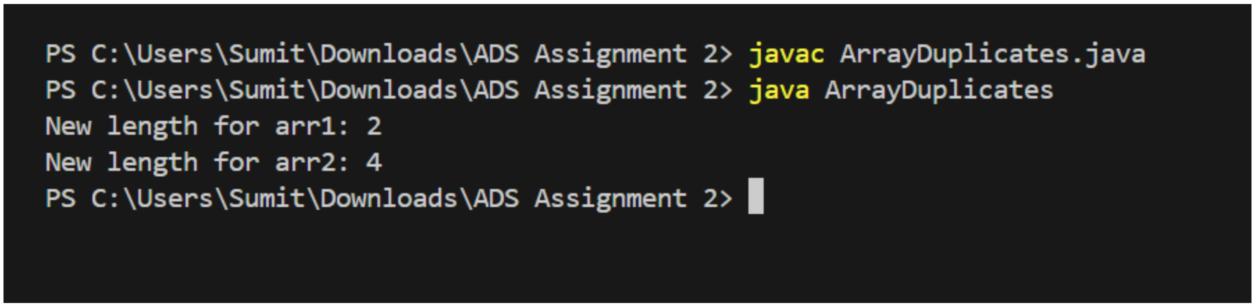
Input: arr = [1, 1, 2]
Output: 2
Input: arr = [0, 0, 1, 1, 2, 2, 3, 3]
Output: 4
Ans:

```
public class RemoveDuplicates {
  public static int removeDuplicates(int[] nums) {
    if (nums.length == 0) return 0;

    int uniqueIndex = 1;
    for (int i = 1; i < nums.length; i++) {
      if (nums[i] != nums[i - 1]) {
        nums[uniqueIndex] = nums[i];
        uniqueIndex++;
      }
    }
    return uniqueIndex;
  }

  public static void main(String[] args) {
    int[] arr1 = {1, 1, 2};
    int[] arr2 = {0, 0, 1, 1, 2, 2, 3, 3};

    System.out.println("New length for arr1: " + removeDuplicates(arr1)); // Output: 2
    System.out.println("New length for arr2: " + removeDuplicates(arr2)); // Output: 4
  }
```

- }



```java
public class ArrayDuplicates {
    public static int removeDuplicates(int[] nums) {
        if (nums.length == 0) return 0;

        int uniqueIndex = 1;
        for (int i = 1; i < nums.length; i++) {
            if (nums[i] != nums[i - 1]) {
                nums[uniqueIndex] = nums[i];
                uniqueIndex++;
            }
        }
        return uniqueIndex;
    }

    public static void main(String[] args) {
        int[] arr1 = {1, 1, 2};
        int[] arr2 = {0, 0, 1, 1, 2, 2, 3, 3};

        System.out.println("New length for arr1: " + removeDuplicates(arr1)); // Output: 2
        System.out.println("New length for arr2: " + removeDuplicates(arr2)); // Output: 4
    }
}

```



```
PS C:\Users\Sumit\Downloads\ADS Assignment 2> javac ArrayDuplicates.java
PS C:\Users\Sumit\Downloads\ADS Assignment 2> java ArrayDuplicates
New length for arr1: 2
New length for arr2: 4
PS C:\Users\Sumit\Downloads\ADS Assignment 2> 
```

Time Complexity: (O(n))
Space Complexity: (O(1))

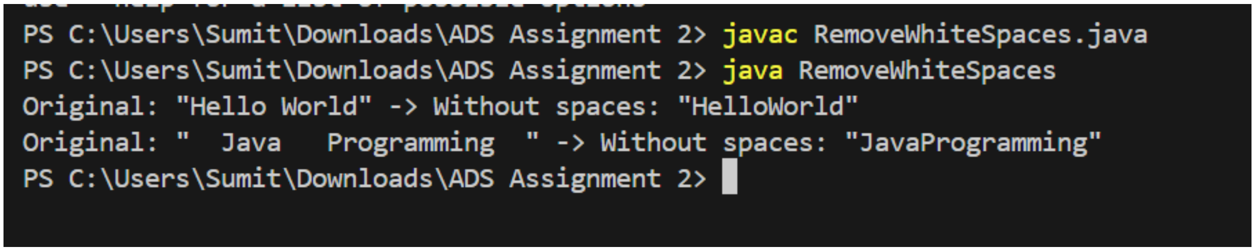
3. Remove White Spaces from String
Problem: Write a Java program to remove all white spaces from a given string.

Test Cases:

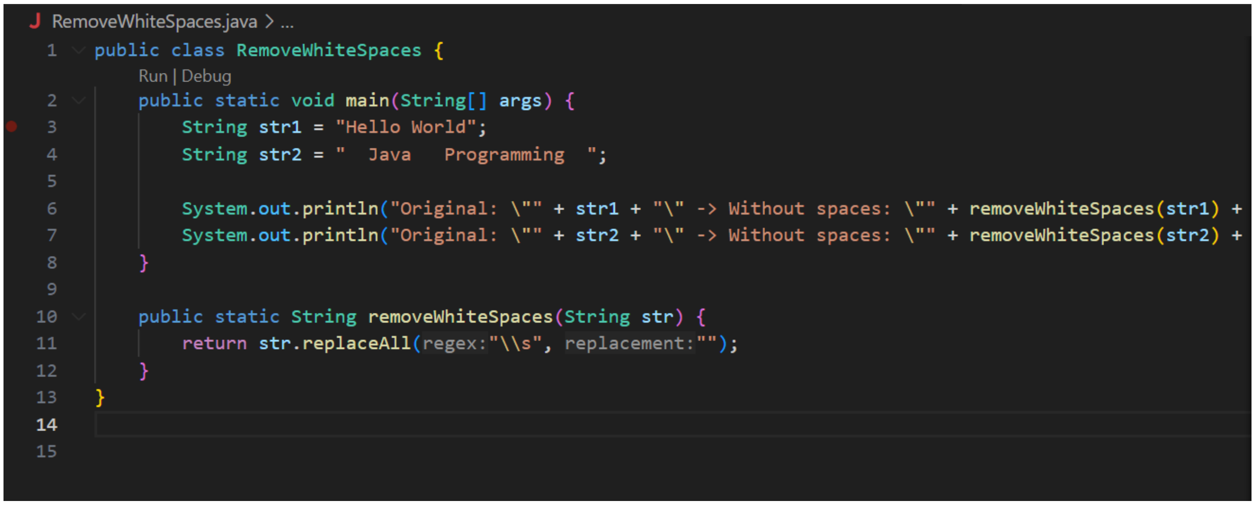
Input: "Hello World"
Output: "HelloWorld"
Input: " Java   Programming "
Output: "JavaProgramming"

Ans:

```
public class RemoveWhiteSpaces {
  public static void main(String[] args) {
    String str1 = "Hello World";
    String str2 = "  Java   Programming  ";

    System.out.println("Original: \"" + str1 + "\" -> Without spaces: \"" + removeWhiteSpaces(str1) + "\"");
    System.out.println("Original: \"" + str2 + "\" -> Without spaces: \"" + removeWhiteSpaces(str2) + "\"");
  }

  public static String removeWhiteSpaces(String str) {
    return str.replaceAll("\\s", "");
  }
}
```



```
PS C:\Users\Sumit\Downloads\ADS Assignment 2> javac RemoveWhiteSpaces.java
PS C:\Users\Sumit\Downloads\ADS Assignment 2> java RemoveWhiteSpaces
Original: "Hello World" -> Without spaces: "HelloWorld"
Original: "  Java   Programming  " -> Without spaces: "JavaProgramming"
PS C:\Users\Sumit\Downloads\ADS Assignment 2>
```



```java
public class RemoveWhiteSpaces {
    public static void main(String[] args) {
        String str1 = "Hello World";
        String str2 = "  Java   Programming  ";

        System.out.println("Original: \"" + str1 + "\" -> Without spaces: \"" + removeWhiteSpaces(str1) +
        System.out.println("Original: \"" + str2 + "\" -> Without spaces: \"" + removeWhiteSpaces(str2) +
    }

    public static String removeWhiteSpaces(String str) {
        return str.replaceAll(regex:"\\s", replacement:"");
    }
}


```

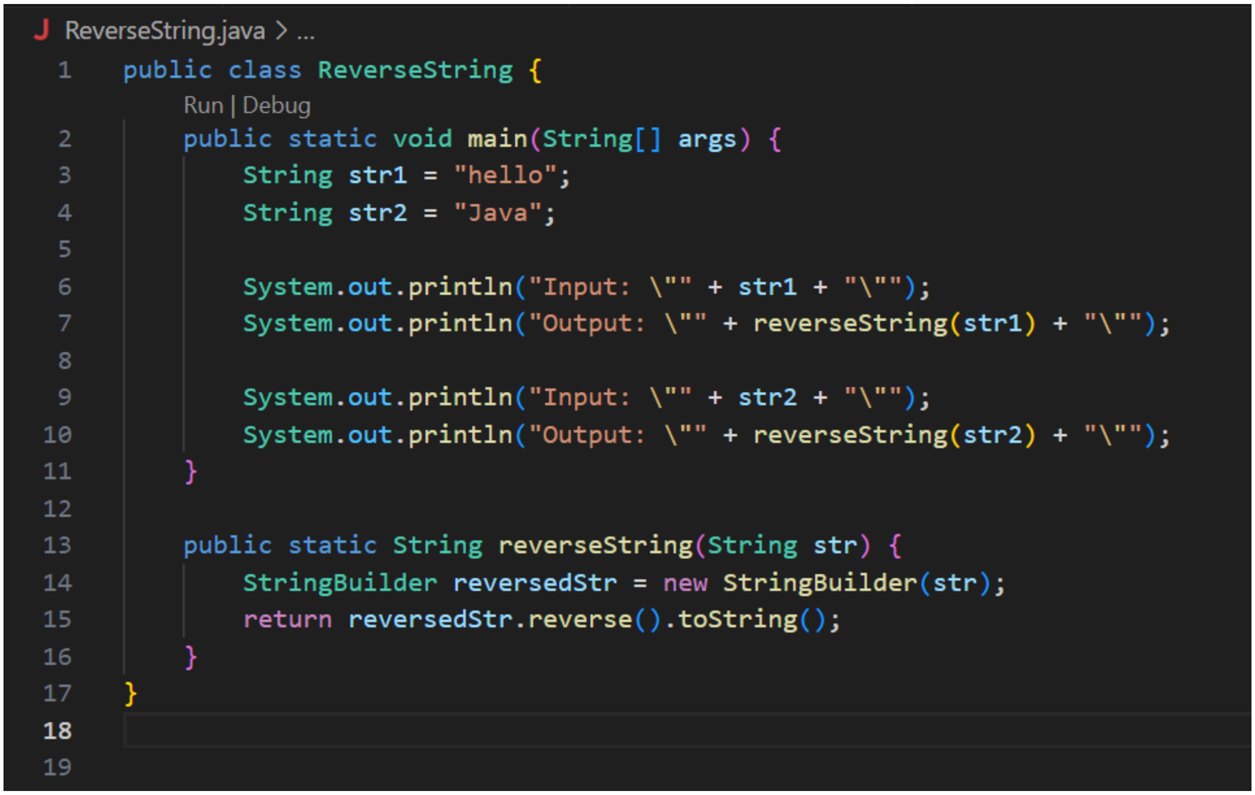
Time Complexity: (O(n))
Space Complexity: (O(n))

4. Reverse a String
Problem: Write a Java program to reverse a given string.

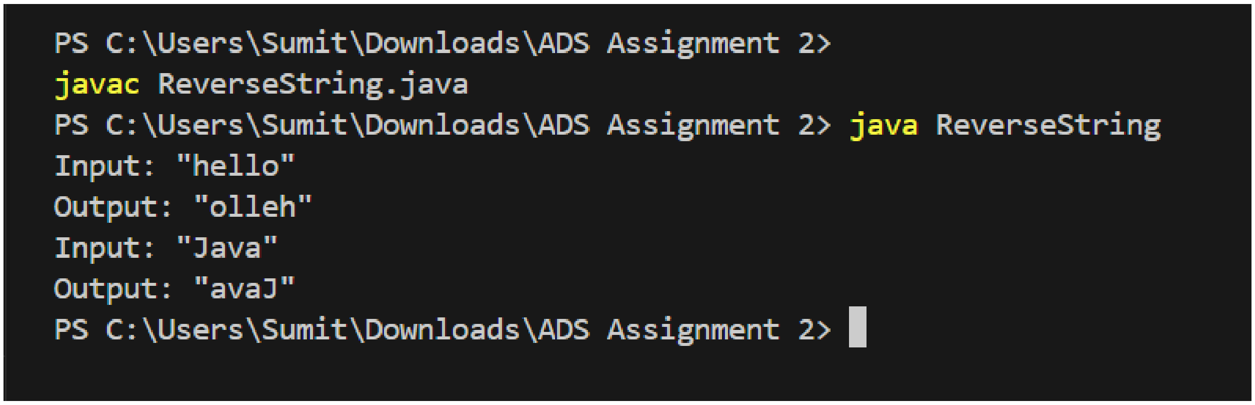
Test Cases:

Input: "hello"
Output: "olleh"
Input: "Java"
Output: "avaJ"
Ans:

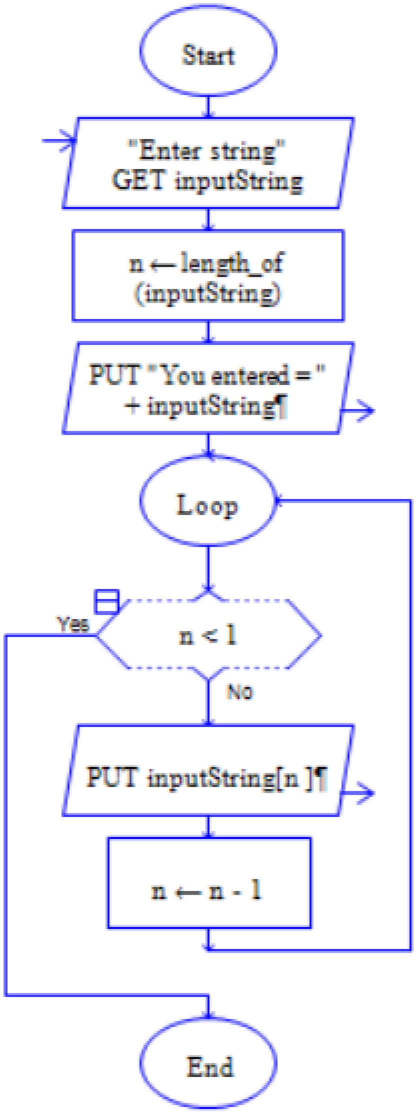
```java
public class ReverseString {
   public static void main(String[] args) {
      String str1 = "hello";
      String str2 = "Java";

      System.out.println("Input: \"" + str1 + "\"");
      System.out.println("Output: \"" + reverseString(str1) + "\"");

      System.out.println("Input: \"" + str2 + "\"");
      System.out.println("Output: \"" + reverseString(str2) + "\"");
   }

   public static String reverseString(String str) {
      StringBuilder reversedStr = new StringBuilder(str);
      return reversedStr.reverse().toString();
   }
}
```



```java
public class ReverseString {
    public static void main(String[] args) {
        String str1 = "hello";
        String str2 = "Java";

        System.out.println("Input: \"" + str1 + "\"");
        System.out.println("Output: \"" + reverseString(str1) + "\"");

        System.out.println("Input: \"" + str2 + "\"");
        System.out.println("Output: \"" + reverseString(str2) + "\"");
    }

    public static String reverseString(String str) {
        StringBuilder reversedStr = new StringBuilder(str);
        return reversedStr.reverse().toString();
    }
}
```



```
PS C:\Users\Sumit\Downloads\ADS Assignment 2>
javac ReverseString.java
PS C:\Users\Sumit\Downloads\ADS Assignment 2> java ReverseString
Input: "hello"
Output: "olleh"
Input: "Java"
Output: "avaJ"
PS C:\Users\Sumit\Downloads\ADS Assignment 2>
```



Time Complexity: (O(n))
Space Complexity: (O(n))

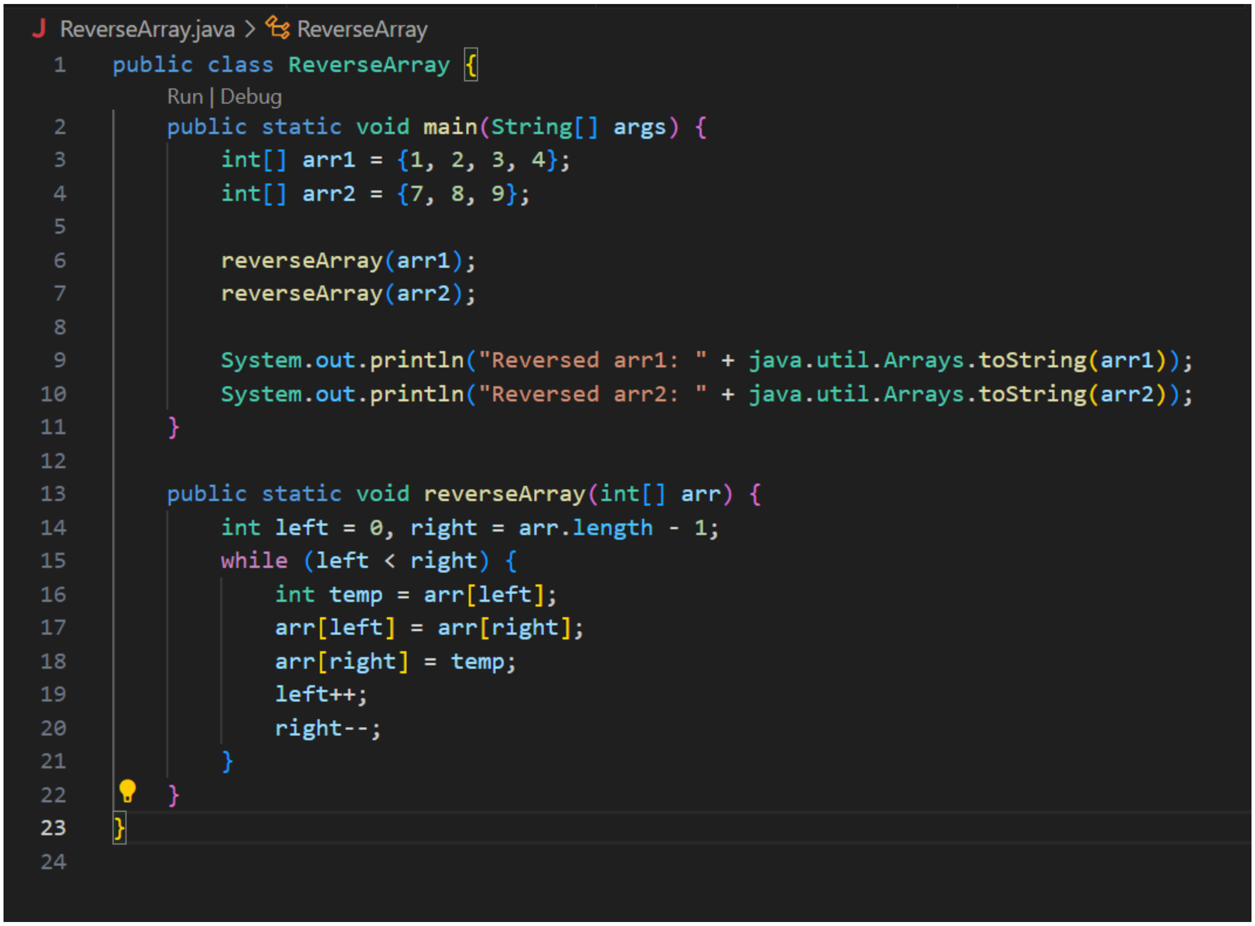
5. Reverse Array in Place
Problem: Write a Java program to reverse an array in place.

Test Cases:

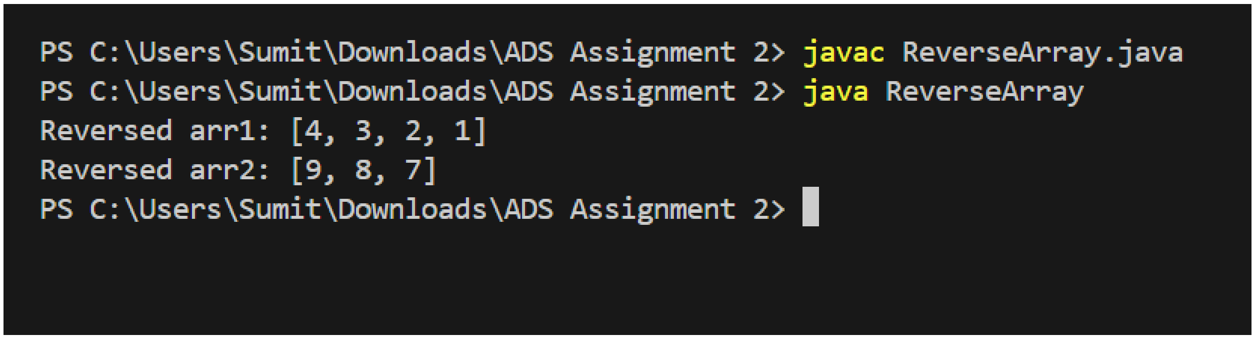
Input: arr = [1, 2, 3, 4]
Output: [4, 3, 2, 1]
Input: arr = [7, 8, 9]
Output: [9, 8, 7]
Ans:

```
public class ReverseArray {
    public static void main(String[] args) {
        int[] arr1 = {1, 2, 3, 4};
        int[] arr2 = {7, 8, 9};

        reverseArray(arr1);
        reverseArray(arr2);

        System.out.println("Reversed arr1: " + java.util.Arrays.toString(arr1));
        System.out.println("Reversed arr2: " + java.util.Arrays.toString(arr2));
    }

    public static void reverseArray(int[] arr) {
        int left = 0, right = arr.length - 1;
        while (left < right) {
            int temp = arr[left];
            arr[left] = arr[right];
            arr[right] = temp;
            left++;
            right--;
        }
    }
```

}



```java
public class ReverseArray {
    public static void main(String[] args) {
        int[] arr1 = {1, 2, 3, 4};
        int[] arr2 = {7, 8, 9};

        reverseArray(arr1);
        reverseArray(arr2);

        System.out.println("Reversed arr1: " + java.util.Arrays.toString(arr1));
        System.out.println("Reversed arr2: " + java.util.Arrays.toString(arr2));
    }

    public static void reverseArray(int[] arr) {
        int left = 0, right = arr.length - 1;
        while (left < right) {
            int temp = arr[left];
            arr[left] = arr[right];
            arr[right] = temp;
            left++;
            right--;
        }
    }
}

```



```
PS C:\Users\Sumit\Downloads\ADS Assignment 2> javac ReverseArray.java
PS C:\Users\Sumit\Downloads\ADS Assignment 2> java ReverseArray
Reversed arr1: [4, 3, 2, 1]
Reversed arr2: [9, 8, 7]
PS C:\Users\Sumit\Downloads\ADS Assignment 2> 
```

Time Complexity: (O(n))
Space Complexity: (O(1))

6. Reverse Words in a String

Problem: Write a Java program to reverse the words in a given sentence.

Test Cases:

Input: "Hello World"

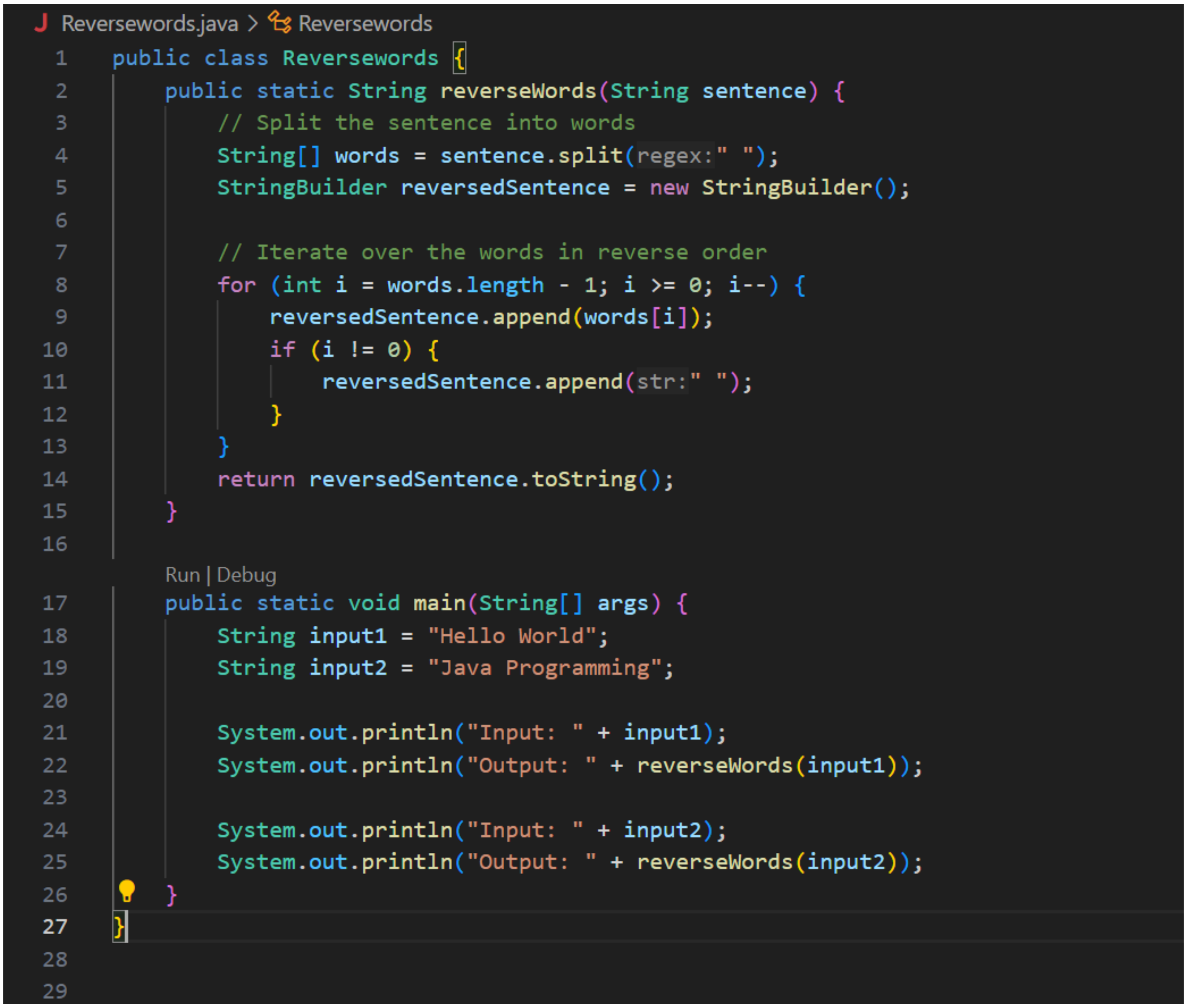
Output: "World Hello"

Input: "Java Programming"

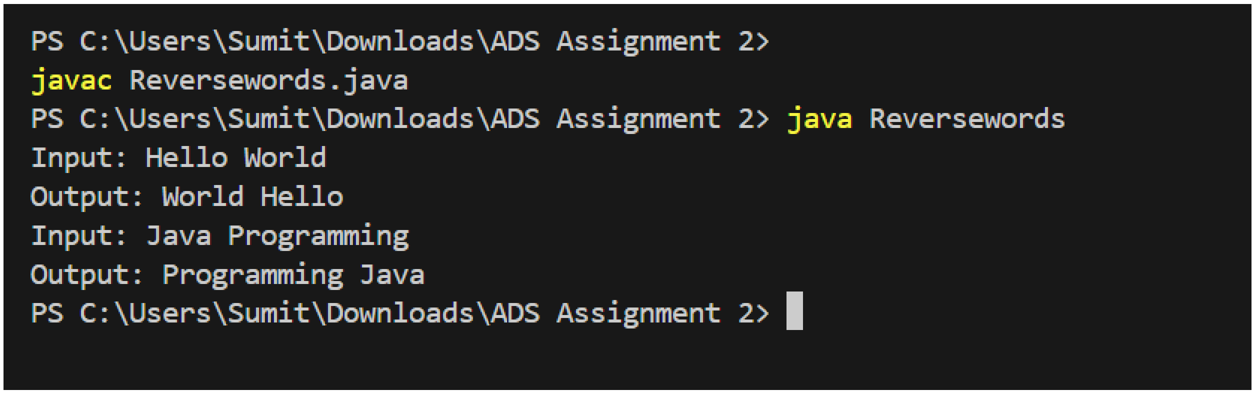
Output: "Programming Java"

Ans:

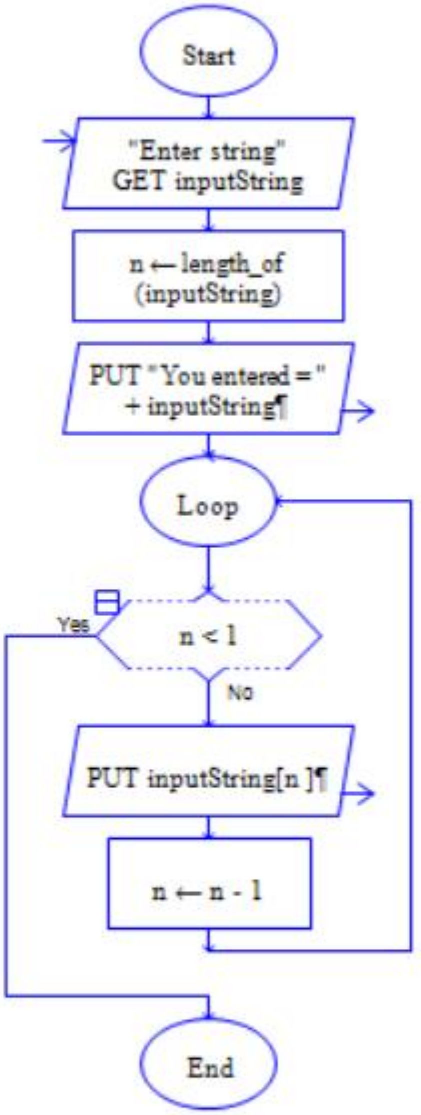
```
public class Reversewords {
    public static String reverseWords(String sentence) {
        // Split the sentence into words
        String[] words = sentence.split(" ");
        StringBuilder reversedSentence = new StringBuilder();

        // Iterate over the words in reverse order
        for (int i = words.length - 1; i >= 0; i--) {
            reversedSentence.append(words[i]);
            if (i != 0) {
                reversedSentence.append(" ");
            }
        }
        return reversedSentence.toString();
    }

    public static void main(String[] args) {
        String input1 = "Hello World";
        String input2 = "Java Programming";

        System.out.println("Input: " + input1);
        System.out.println("Output: " + reverseWords(input1));

        System.out.println("Input: " + input2);
        System.out.println("Output: " + reverseWords(input2));
    }
}
```



```java
public class Reversewords {
    public static String reverseWords(String sentence) {
        // Split the sentence into words
        String[] words = sentence.split(regex:" ");
        StringBuilder reversedSentence = new StringBuilder();

        // Iterate over the words in reverse order
        for (int i = words.length - 1; i >= 0; i--) {
            reversedSentence.append(words[i]);
            if (i != 0) {
                reversedSentence.append(str:" ");
            }
        }
        return reversedSentence.toString();
    }

    Run | Debug
    public static void main(String[] args) {
        String input1 = "Hello World";
        String input2 = "Java Programming";

        System.out.println("Input: " + input1);
        System.out.println("Output: " + reverseWords(input1));

        System.out.println("Input: " + input2);
        System.out.println("Output: " + reverseWords(input2));
    }
}
```



```
PS C:\Users\Sumit\Downloads\ADS Assignment 2>
javac Reversewords.java
PS C:\Users\Sumit\Downloads\ADS Assignment 2> java Reversewords
Input: Hello World
Output: World Hello
Input: Java Programming
Output: Programming Java
PS C:\Users\Sumit\Downloads\ADS Assignment 2>
```



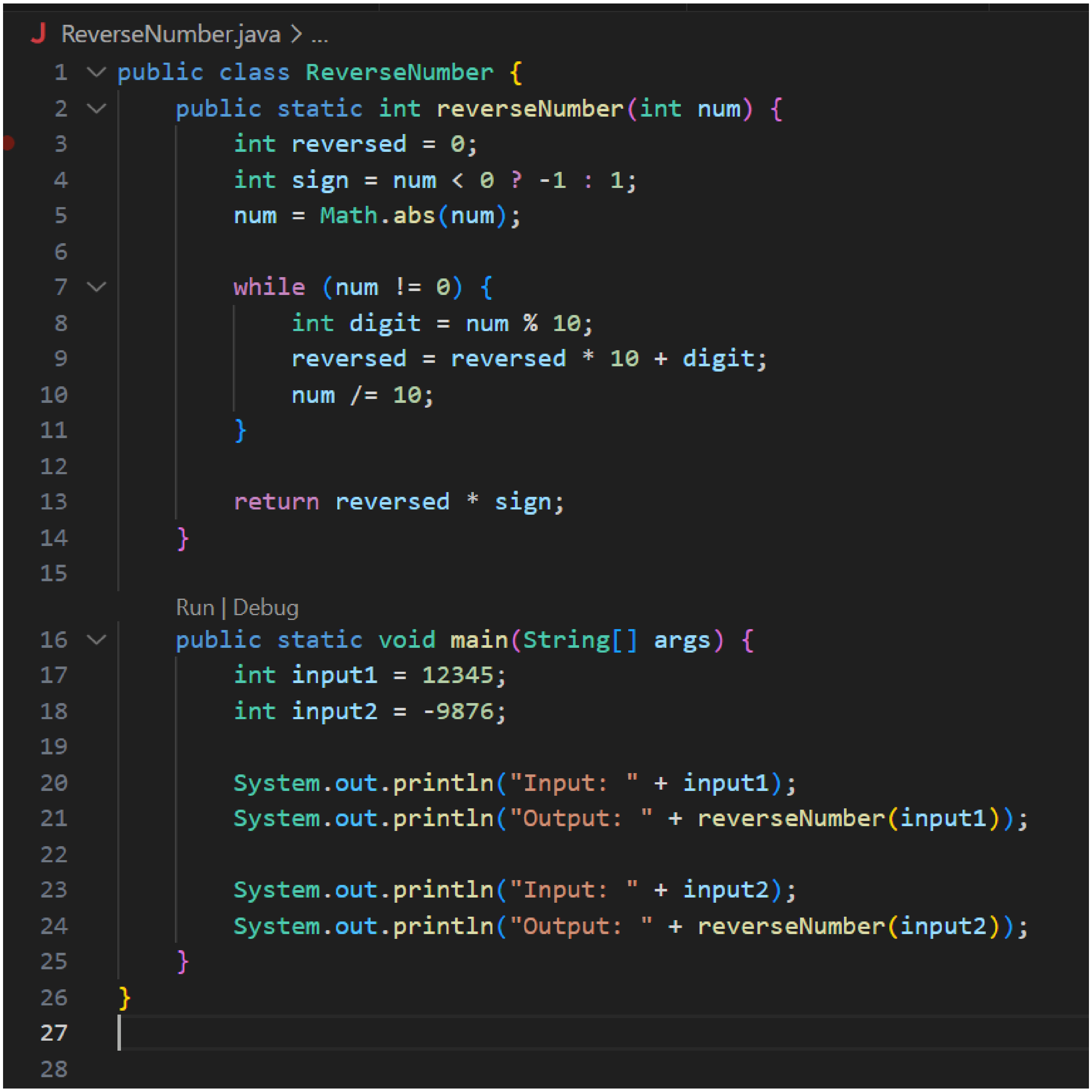
Time Complexity: O(n)
Space Complexity: O(n)

7. Reverse a Number
Problem: Write a Java program to reverse a given number.

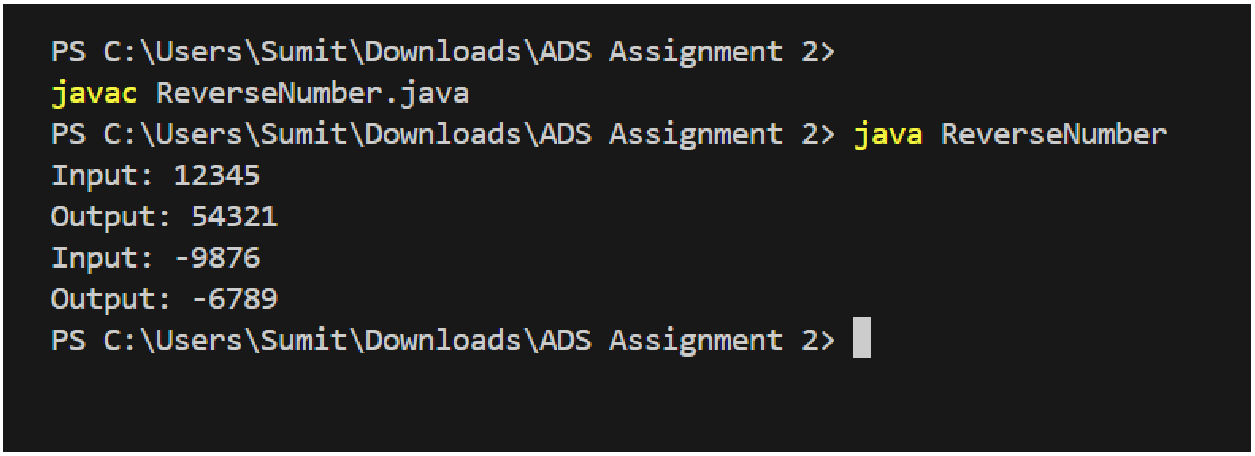
Test Cases:

Input: 12345
Output: 54321
Input: -9876
Output: -6789
Ans:

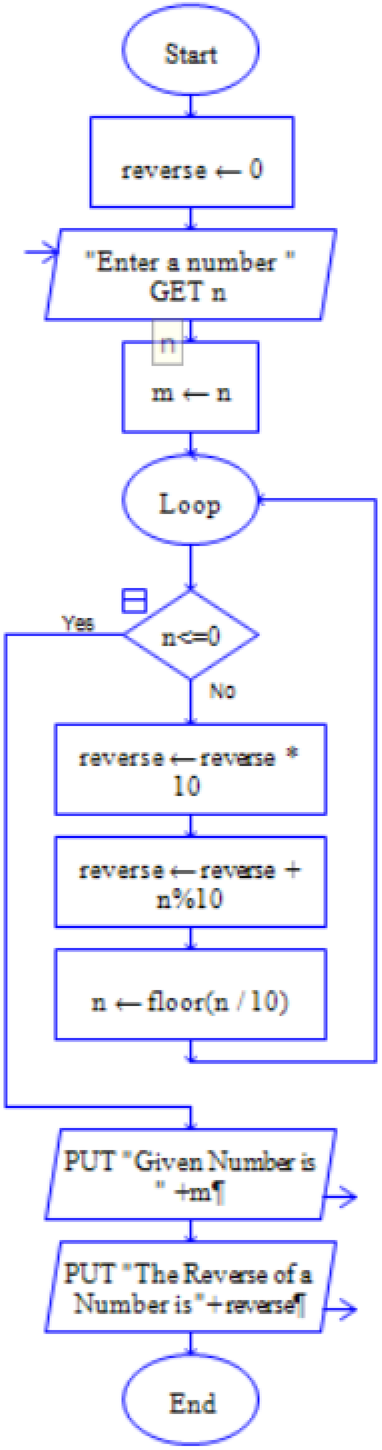
```
public class ReverseNumber {
    public static int reverseNumber(int num) {
        int reversed = 0;
        int sign = num < 0 ? -1 : 1;
        num = Math.abs(num);

        while (num != 0) {
            int digit = num % 10;
            reversed = reversed * 10 + digit;
            num /= 10;
        }

        return reversed * sign;
    }

    public static void main(String[] args) {
        int input1 = 12345;
        int input2 = -9876;

        System.out.println("Input: " + input1);
        System.out.println("Output: " + reverseNumber(input1));

        System.out.println("Input: " + input2);
        System.out.println("Output: " + reverseNumber(input2));
    }
}
```



```java
public class ReverseNumber {
    public static int reverseNumber(int num) {
        int reversed = 0;
        int sign = num < 0 ? -1 : 1;
        num = Math.abs(num);

        while (num != 0) {
            int digit = num % 10;
            reversed = reversed * 10 + digit;
            num /= 10;
        }

        return reversed * sign;
    }

    public static void main(String[] args) {
        int input1 = 12345;
        int input2 = -9876;

        System.out.println("Input: " + input1);
        System.out.println("Output: " + reverseNumber(input1));

        System.out.println("Input: " + input2);
        System.out.println("Output: " + reverseNumber(input2));
    }
}
```



```
PS C:\Users\Sumit\Downloads\ADS Assignment 2>
javac ReverseNumber.java
PS C:\Users\Sumit\Downloads\ADS Assignment 2> java ReverseNumber
Input: 12345
Output: 54321
Input: -9876
Output: -6789
PS C:\Users\Sumit\Downloads\ADS Assignment 2>
```



Time Complexity: O(d)
Space Complexity: O(1)

8. Array Manipulation

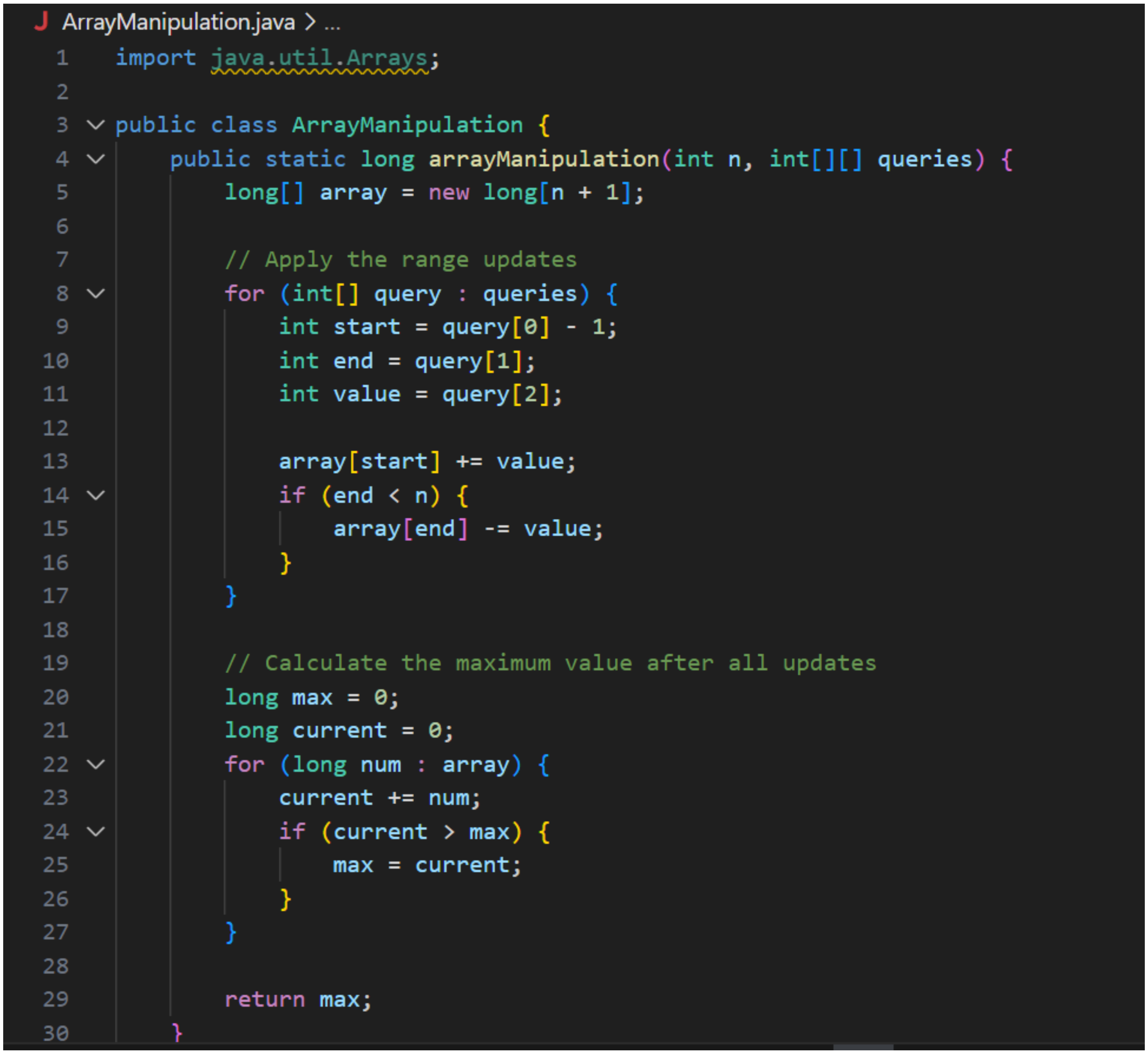
Problem: Perform a series of operations to manipulate an array based on range update queries. Each query adds a value to a range of indices.

Test Cases:

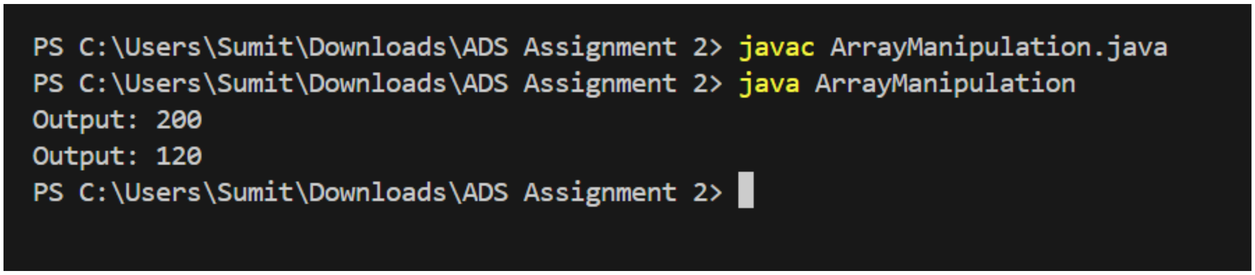
Input: n = 5, queries = [[1, 2, 100], [2, 5, 100], [3, 4, 100]]
Output: 200
Input: n = 4, queries = [[1, 3, 50], [2, 4, 70]]
Output: 120

Ans:

```
import java.util.Arrays;

public class ArrayManipulation {
    public static long arrayManipulation(int n, int[][] queries) {
        long[] array = new long[n + 1];

        // Apply the range updates
        for (int[] query : queries) {
            int start = query[0] - 1;
            int end = query[1];
            int value = query[2];

            array[start] += value;
            if (end < n) {
                array[end] -= value;
            }
        }

        // Calculate the maximum value after all updates
        long max = 0;
        long current = 0;
        for (long num : array) {
            current += num;
            if (current > max) {
                max = current;
            }
        }

        return max;
    }

    public static void main(String[] args) {
        int n1 = 5;
        int[][] queries1 = {{1, 2, 100}, {2, 5, 100}, {3, 4, 100}};
        System.out.println("Output: " + arrayManipulation(n1, queries1)); // Output: 200
        int n2 = 4;
        int[][] queries2 = {{1, 3, 50}, {2, 4, 70}};
        System.out.println("Output: " + arrayManipulation(n2, queries2)); // Output: 120
    }
}
```



```
import java.util.Arrays;

public class ArrayManipulation {
    public static long arrayManipulation(int n, int[][] queries) {
        long[] array = new long[n + 1];

        // Apply the range updates
        for (int[] query : queries) {
            int start = query[0] - 1;
            int end = query[1];
            int value = query[2];

            array[start] += value;
            if (end < n) {
                array[end] -= value;
            }
        }

        // Calculate the maximum value after all updates
        long max = 0;
        long current = 0;
        for (long num : array) {
            current += num;
            if (current > max) {
                max = current;
            }
        }

        return max;
    }
```



```
PS C:\Users\Sumit\Downloads\ADS Assignment 2> javac ArrayManipulation.java
PS C:\Users\Sumit\Downloads\ADS Assignment 2> java ArrayManipulation
Output: 200
Output: 120
PS C:\Users\Sumit\Downloads\ADS Assignment 2> 
```

Time Complexity: O(n + m)
Space Complexity: O(n)

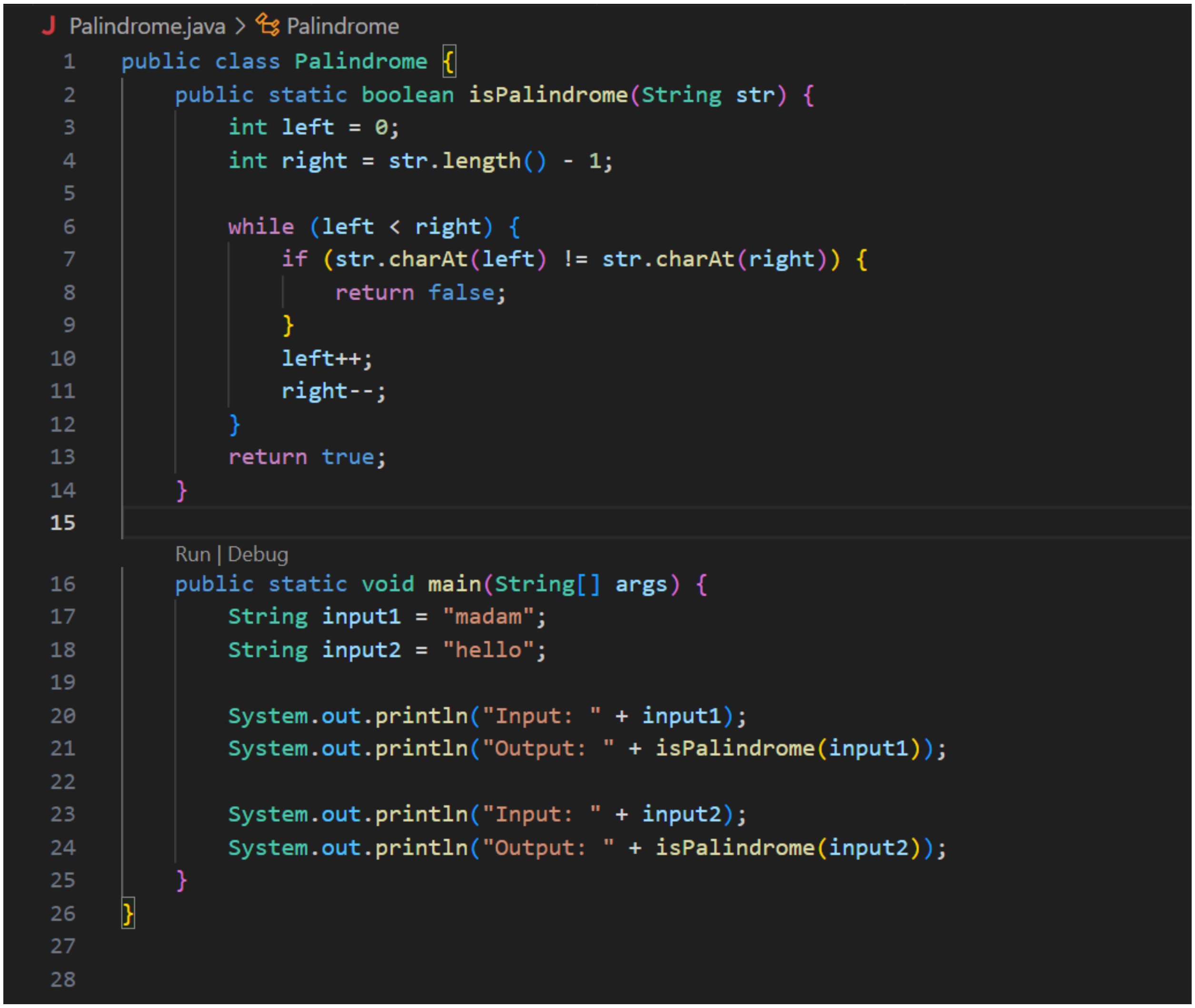
9. String Palindrome
Problem: Write a Java program to check if a given string is a palindrome.

Test Cases:

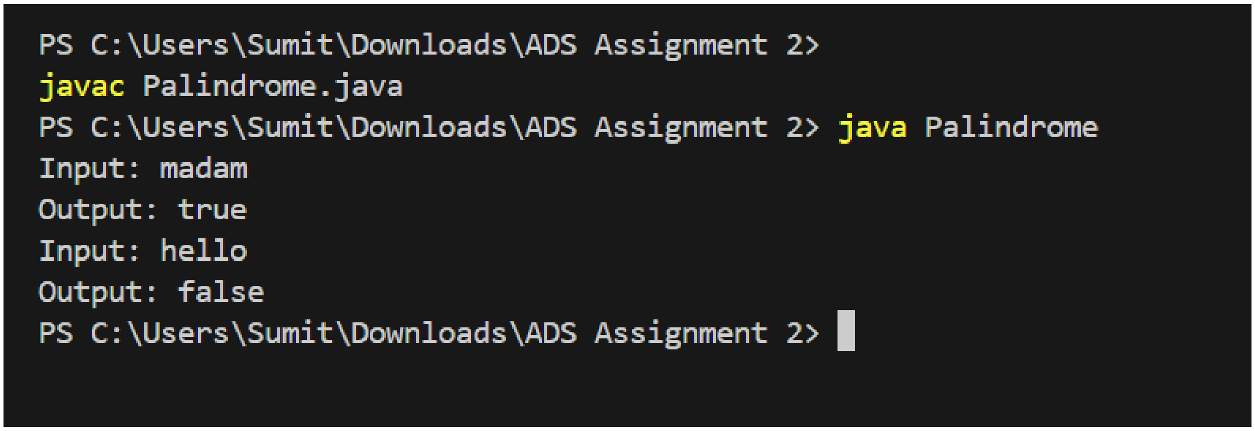
Input: "madam"
Output: true
Input: "hello"
Output: false
Ans:

```
public class Palindrome {
  public static boolean isPalindrome(String str) {
    int left = 0;
    int right = str.length() - 1;

    while (left < right) {
      if (str.charAt(left) != str.charAt(right)) {
        return false;
      }
      left++;
      right--;
    }
    return true;
  }

  public static void main(String[] args) {
    String input1 = "madam";
    String input2 = "hello";

    System.out.println("Input: " + input1);
    System.out.println("Output: " + isPalindrome(input1));

    System.out.println("Input: " + input2);
    System.out.println("Output: " + isPalindrome(input2));
  }
```

}



```java
public class Palindrome {
    public static boolean isPalindrome(String str) {
        int left = 0;
        int right = str.length() - 1;

        while (left < right) {
            if (str.charAt(left) != str.charAt(right)) {
                return false;
            }
            left++;
            right--;
        }
        return true;
    }

    public static void main(String[] args) {
        String input1 = "madam";
        String input2 = "hello";

        System.out.println("Input: " + input1);
        System.out.println("Output: " + isPalindrome(input1));

        System.out.println("Input: " + input2);
        System.out.println("Output: " + isPalindrome(input2));
    }
}
```



```
PS C:\Users\Sumit\Downloads\ADS Assignment 2>
javac Palindrome.java
PS C:\Users\Sumit\Downloads\ADS Assignment 2> java Palindrome
Input: madam
Output: true
Input: hello
Output: false
PS C:\Users\Sumit\Downloads\ADS Assignment 2>
```

Time Complexity: O(n)
Space Complexity: O(1)

10. Array Left Rotation

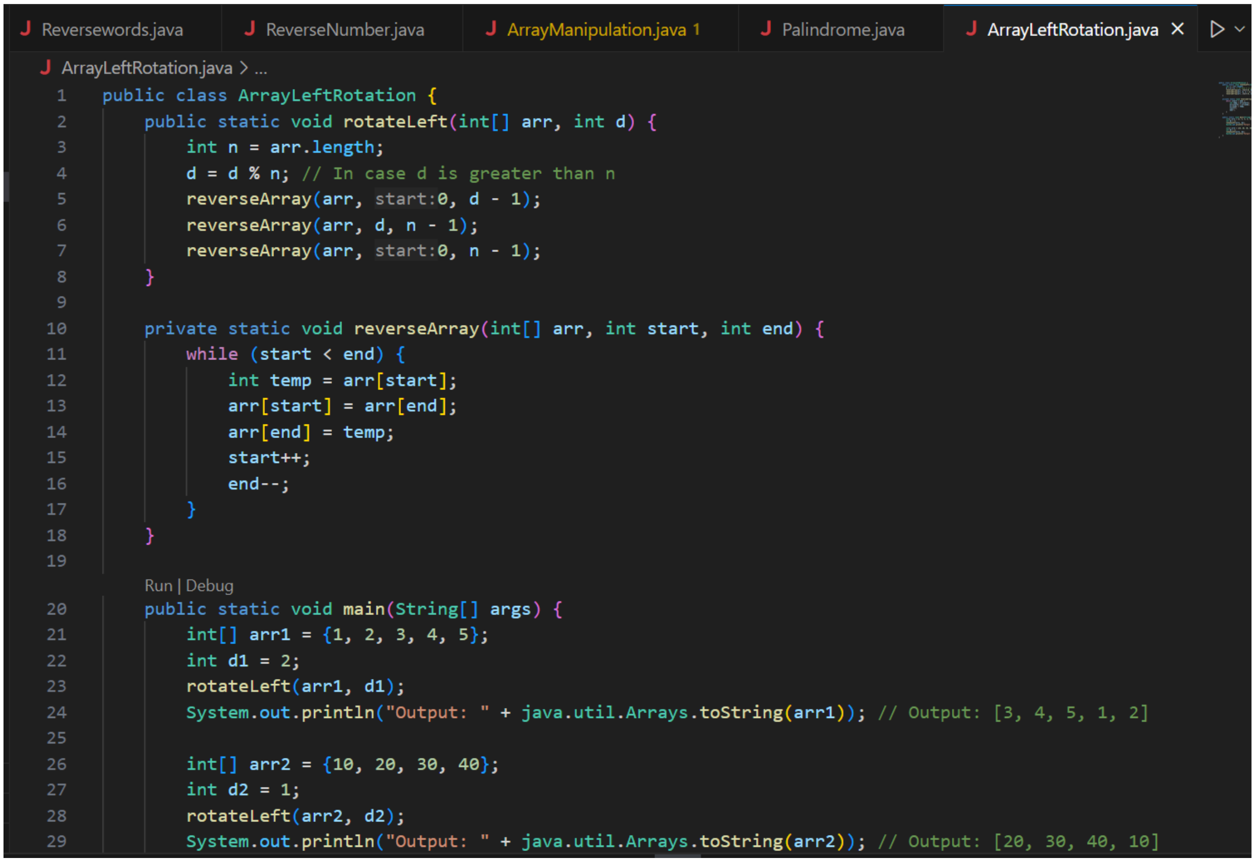
Problem: Write a Java program to rotate an array to the left by d positions.

Test Cases:

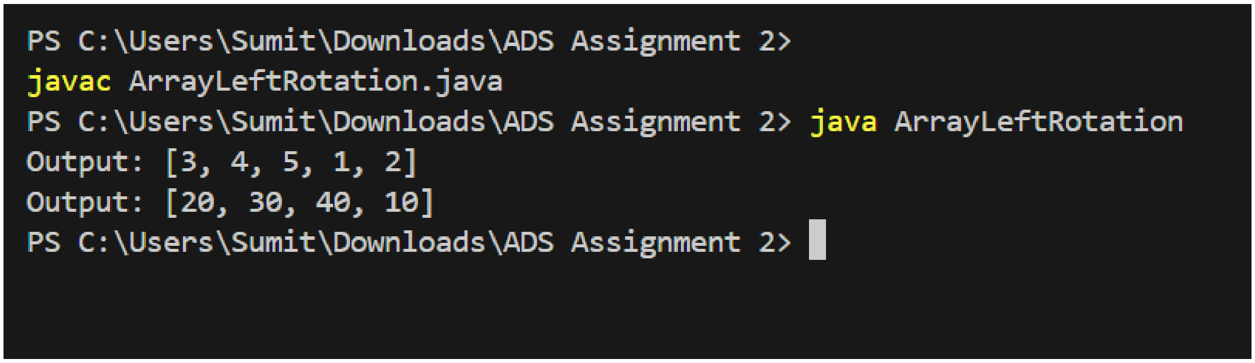
Input: arr = [1, 2, 3, 4, 5], d = 2
Output: [3, 4, 5, 1, 2]
Input: arr = [10, 20, 30, 40], d = 1
Output: [20, 30, 40, 10]

Ans:

```java
public class ArrayLeftRotation {
    public static void rotateLeft(int[] arr, int d) {
        int n = arr.length;
        d = d % n; // In case d is greater than n
        reverseArray(arr, 0, d - 1);
        reverseArray(arr, d, n - 1);
        reverseArray(arr, 0, n - 1);
    }

    private static void reverseArray(int[] arr, int start, int end) {
        while (start < end) {
            int temp = arr[start];
            arr[start] = arr[end];
            arr[end] = temp;
            start++;
            end--;
        }
    }

    public static void main(String[] args) {
        int[] arr1 = {1, 2, 3, 4, 5};
        int d1 = 2;
        rotateLeft(arr1, d1);
        System.out.println("Output: " + java.util.Arrays.toString(arr1)); // Output: [3, 4, 5, 1, 2]

        int[] arr2 = {10, 20, 30, 40};
        int d2 = 1;
        rotateLeft(arr2, d2);
        System.out.println("Output: " + java.util.Arrays.toString(arr2)); // Output: [20, 30, 40, 10]
    }
}
```



```java
public class ArrayLeftRotation {
    public static void rotateLeft(int[] arr, int d) {
        int n = arr.length;
        d = d % n; // In case d is greater than n
        reverseArray(arr, start:0, d - 1);
        reverseArray(arr, d, n - 1);
        reverseArray(arr, start:0, n - 1);
    }

    private static void reverseArray(int[] arr, int start, int end) {
        while (start < end) {
            int temp = arr[start];
            arr[start] = arr[end];
            arr[end] = temp;
            start++;
            end--;
        }
    }

    public static void main(String[] args) {
        int[] arr1 = {1, 2, 3, 4, 5};
        int d1 = 2;
        rotateLeft(arr1, d1);
        System.out.println("Output: " + java.util.Arrays.toString(arr1)); // Output: [3, 4, 5, 1, 2]

        int[] arr2 = {10, 20, 30, 40};
        int d2 = 1;
        rotateLeft(arr2, d2);
        System.out.println("Output: " + java.util.Arrays.toString(arr2)); // Output: [20, 30, 40, 10]
```



```
PS C:\Users\Sumit\Downloads\ADS Assignment 2>
javac ArrayLeftRotation.java
PS C:\Users\Sumit\Downloads\ADS Assignment 2> java ArrayLeftRotation
Output: [3, 4, 5, 1, 2]
Output: [20, 30, 40, 10]
PS C:\Users\Sumit\Downloads\ADS Assignment 2>
```

Time Complexity: O(n)
Space Complexity: O(1)