C-DAC Mumbai

Date 25/09/2024

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. Armstrong Number
Problem: Write a Java program to check if a given number is an Armstrong number.

Test Cases:

Input: 153
Output: true
Input: 123
Output: false
Program code:

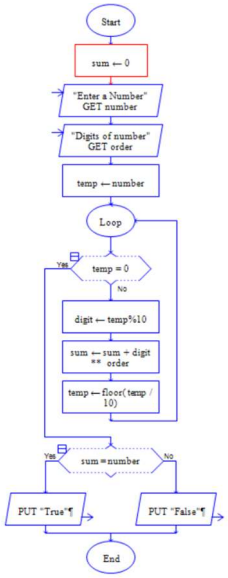
```
import java.util.Scanner;

public class Armstrong {
   public static void main(String[] args) {
      Scanner sc = new Scanner(System.in);
      System.out.println("Enter a Number:");
      int num = sc.nextInt();

      int n1 = num;
      int result = 0, rem, n = 0;

      while (num != 0) {
         num /= 10;
         n++;
      }
      num = n1;
      while (num != 0) {
         rem = num % 10;
         result += Math.pow(rem, n);
         num /= 10;
      }
      if (n1 == result) {
         System.out.println(n1 + " is an Armstrong number.");
      } else {
         System.out.println(n1 + " is not an Armstrong number.");
      }
```

```
        }
    }
```

Output:

```
C:\Users\rahul\OneDrive\Desktop\CDAC\Module 3 DSA\Assignments>java Armstrong.java
Enter a Number:
153
153 is an Armstrong number.

C:\Users\rahul\OneDrive\Desktop\CDAC\Module 3 DSA\Assignments>java Armstrong.java
Enter a Number:
123
123 is not an Armstrong number.
```

Flow Chart:



Code Explanation:

- The program prompts use to enter a number and stores it in num.
- It first counts the number of digits in the number (n) by repeatedly dividing num by 10.
- Then, it calculates the sum of each digit raised to the power of n using Math.pow().
- Finally, we checks if the sum is equal to the original number (n1). If true, it declares it as an Armstrong number; otherwise, it isn't.

Time complexity: Olog(n)
Space complexity: O(1)

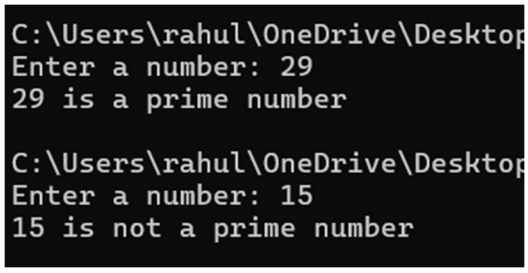
2. Prime Number
Problem: Write a Java program to check if a given number is prime.

Test Cases:

Input: 29
Output: true
Input: 15
Output: false
Program code:

```
import java.util.Scanner;

public class PrimeNumber{
	public static void main(String[] args){
		Scanner sc = new Scanner(System.in);

		System.out.print("Enter a number: ");
		int number = sc.nextInt();

		boolean isPrime = true;
		if(number <= 1){
			isPrime = false;
		}
		else{
			for(int i = 2; i<number;i++){
				if(number % i == 0){
					isPrime = false;
					break;
				}
			}
		}

		if(isPrime){
			System.out.println( number +" is a prime number");
		}
		else{
			System.out.println(number + " is not a prime number");
		}
		sc.close();
	}
}
```

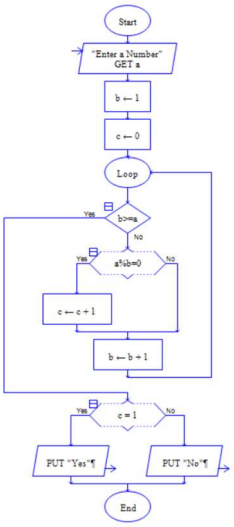
Output:



Code Explanation:

- we write a program for to check a given number is prime or not
- The function takes an integer n as input.
- It checks if the number is less than or equal to 1, marking it as not prime.
- If the number is greater than 1, it loops from 2 to number-1, checking if number is divisible by any value in this range.
- If any divisor is found, the number is marked as not prime; otherwise, it is prime.

Flow chart:



Time Complexity:

- **Worst case:** O(N), where N is the input number. The for loop runs up to N-2 times, checking for divisors.
- **Best case:** O(1),

Space complexity: O(1)

3. Factorial
Problem: Write a Java program to compute the factorial of a given number.

Test Cases:

Input: 5
Output: 120
Input: 0
Output: 1

Program:

```
class Factorial{

   static int fact(int n) {
      if (n <= 1) {
         return 1;
      } else {
         return n * fact(n - 1);
      }
   }

   public static void main(String args[]) {
      System.out.println(fact(5));
   }
}
```

Output:

```
C:\Users\rahul\OneDrive\Des
120
```

Flow chart:

Code Explanation:

- We write a program for factorials using recursion method
- The fact() method is a recursive function that calculates the factorial of a given number n.
- The base case checks if n is less than or equal to 1, returning 1 as factorial of 0 and 1 is 1.
- Otherwise, the method recursively calls itself with n-1, multiplying n with the factorial of n-1 until it reaches the base case.
- In the main() method, the program calls fact(5) and prints the result (5! = 120).

Time complexity: O(n)

Space complexity: O(n)

4. Fibonacci Series
Problem: Write a Java program to print the first n numbers in the Fibonacci series.

Test Cases:

Input: n = 5
Output: [0, 1, 1, 2, 3]
Input: n = 8
Output: [0, 1, 1, 2, 3, 5, 8, 13]

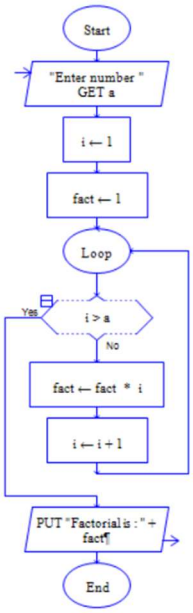
Programing code:

```
import  java.util.Scanner;
public class FibonacciSeries{
        public static void main(String[] arge){
                Scanner sc = new Scanner(System.in);
                System.out.println("Enter number for fibseq: ");
                int n = sc.nextInt();
                int a = 0;
                int b = 1;

                System.out.println(" fibonacci series: ");

                for(int i = 1; i<=n;i++){
                        System.out.println(a);
                        int c = a+b;
                        a = b;
                        b = c;
                }
        sc.close();
        }

}
```

Output:

```
Enter number for fibseq:
10
 fibonacci series:
0
1
1
2
3
5
8
13
21
34
```

Flowchart:



5. Find GCD
Problem: Write a Java program to find the Greatest Common Divisor (GCD) of two numbers.

Test Cases:

Input: a = 54, b = 24
Output: 6
Input: a = 17, b = 13
Output: 1

Program code:

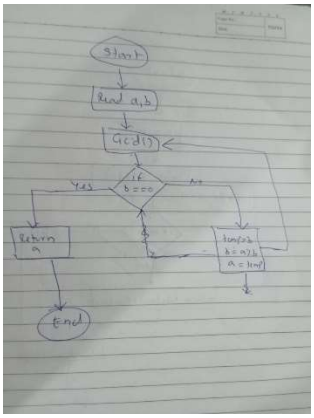
```
import java.util.Scanner;

public class GCD {
```

```
        // GCD using subtraction
    private static int findGCD(int a, int b) {
        while (a != b) {
            if (a > b) {
                a = a - b;
            } else {
                b = b - a;
            }
        }
        return a;
    }

    public static void main(String[] args) {
        Scanner sc = new Scanner(System.in);

        System.out.print("Enter the first number: ");
        int a = sc.nextInt();
        System.out.print("Enter the second number: ");
        int b = sc.nextInt();
        int gcd = findGCD(a, b);

        System.out.println("The GCD of " + a + " and " + b + " is: " + gcd);

        sc.close();
    }


}
```

Output:

```
C:\Users\rahul\OneDrive\Desktop\CD
Enter the first number: 125
Enter the second number: 105
The GCD of 125 and 105 is: 5
```

Flow chart:



Explaination:
1: Initialize Numbers
2: Check Base Case
3: Calculate Remainder
4: Recursive Replacement
5: return GCD

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

6. Find Square Root
Problem: Write a Java program to find the square root of a given number (using integer approximation).

Test Cases:

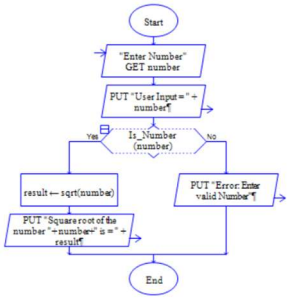
Input: x = 16
Output: 4
Input: x = 27
Output: 5
Program code:

```
import java.util.*;
 public class SquareRoot {
        public static void main (String args[]) {
        Scanner sc = new Scanner (System.in);
        System.out.println("Enter the number whose square root you want: ");
        double x = sc.nextDouble();
        double ans = (int) Math.sqrt(x);  //narrowing conversion - data type
        System.out.println(ans);
        }
}
```

Output:

```
C:\Users\rahul\OneDrive\Desktop\CDAC\Module 3 DS
Enter the number whose square root you want:
16
4.0

C:\Users\rahul\OneDrive\Desktop\CDAC\Module 3 DS
Enter the number whose square root you want:
27
5.0
```

Flow chart:



Code Explanation:
1: Input Number
2: Calculate Square Root
3: Data Type Conversion (Narrowing)
4: Store Result

5: Display Result

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

7. Find Repeated Characters in a String
Problem: Write a Java program to find all repeated characters in a string.

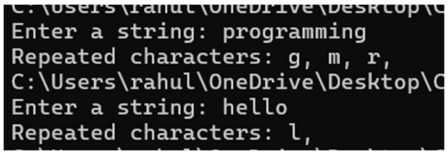
Test Cases:

Input: "programming"
Output: ['r', 'g', 'm']
Input: "hello"
Output: ['l']

Program code:

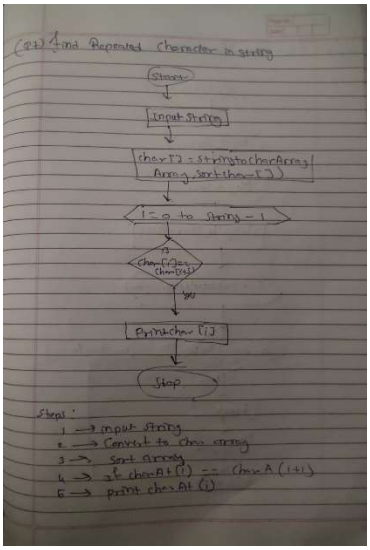
```
import java.util.Scanner;
public class RepeatedCharacters{
   public static void main(String[] args) {
      Scanner scanner = new Scanner(System.in);
      System.out.print("Enter a string: ");
      String input = scanner.nextLine();

      int[] charCount = new int[26];

      for (int i = 0; i < input.length(); i++) {
         charCount[input.charAt(i) - 'a']++;
      }

      System.out.print("Repeated characters: ");
      for (int i = 0; i < charCount.length; i++) {
         if (charCount[i] > 1) {
            System.out.print((char) ('a' + i) + ", ");
         }
      }
   }
}
```

Output:



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

Flow chart:



Code Explanation:

1. First we take string as input.
2. It initializes an integer array charCount[26] to store the count of each character from 'a' to 'z'.
3. The for loop iterates over the string, converting each character to its corresponding index in the charCount array and incrementing the count for that character.
4. It then checks which characters have been repeated (count > 1) and prints them.

8. First Non-Repeated Character
Problem: Write a Java program to find the first non-repeated character in a string.

Test Cases:

Input: "stress"
Output: 't'
Input: "aabbcc"
Output: null

Program code:

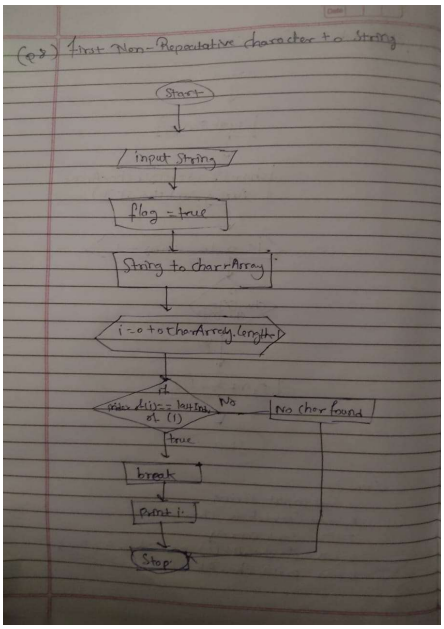
```
import java.util.Scanner;
public class NonRepeatedCharacter{
    public static void main(String[] args){
        Scanner sc = new Scanner(System.in);
        System.out.print("Enter String: ");
        String str = sc.nextLine();
        char[] arr = str.toCharArray();

        for(int i=0; i<arr.length; i++)
        {
```

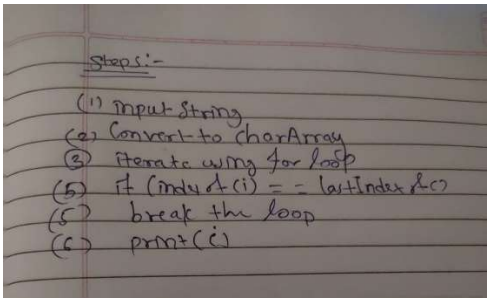
```
                    for(int j=i+1; j<arr.length; j++)
                    {
                        if(arr[i] != arr[j])
                        {
                            System.out.println(arr[j]);
                            System.exit(0);

                        }
                        else
                        {
                            System.out.println("null");
                            System.exit(0);
                        }
                    }
                }

            }
        }
```

Output:

```
C:\Users\rahul\OneDrive\De
Enter String: stress
t

C:\Users\rahul\OneDrive\De
Enter String: aabbcc
null
```

Flow chart:





Code Explanation:

1. First we set string and converts the string to a character array (arr).
2. It uses two nested loops to compare each character with the subsequent ones in the array.
3. If the character at index i is not equal to the character at index j (first non-repeated), it prints the character and exits.
4. If the characters are equal (repeated), it prints "null" and exits the program immediately.

Time complexity: $O(n^2)$
Space complexity: $O(1)$

9. Integer Palindrome
Problem: Write a Java program to check if a given integer is a palindrome.

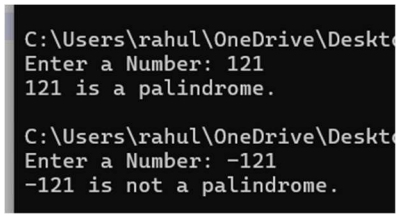
Test Cases:

Input: 121
Output: true
Input: -121
Output: false
Program code:

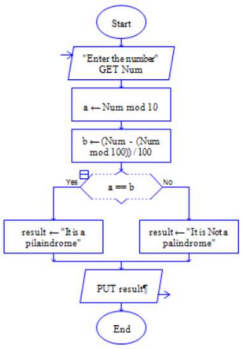
```
import java.util.Scanner;
public class IntegerPalindrome {
   public static void main(String[] args) {
      Scanner sc = new Scanner(System.in);
      System.out.print("Enter a word: ");
      String input = sc.nextLine();

      boolean isPalindrome = true;
      int left = 0;
      int right = input.length() - 1;

      while (left < right) {
         if (input.charAt(left) != input.charAt(right)) {
            isPalindrome = false;
            break;
         }
         left++;
         right--;
      }
```

```
            if (isPalindrome) {
                System.out.println(input + " is a palindrome.");
            } else {
                System.out.println(input + " is not a palindrome.");
            }
        }
    }
```

Output:



Flow chart:



Algorithm:
1: Initialize Variables
2: Compare Characters from Both Ends
3. Increment left and decrement right
4. Repeat steps 2-3 until left pointer meets or crosses right
5.print result.

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

10. Leap Year
Problem: Write a Java program to check if a given year is a leap year.

Test Cases:

Input: 2020
Output: true
Input: 1900
Output: false
Program code:

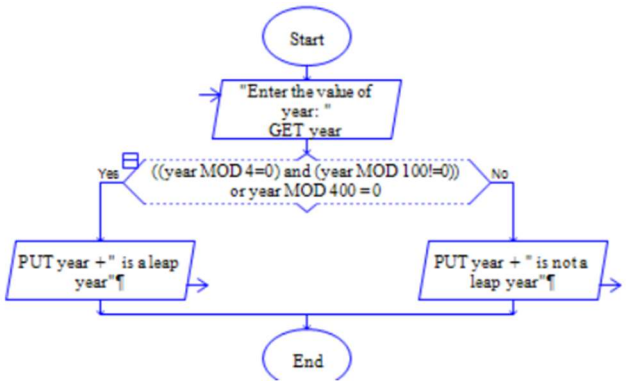
```
        import java.util.*;
        class LeapYear{
```

```
        public static void main(String args[]) {
                Scanner sc = new Scanner(System.in);
                System.out.print("Enter the year you want to choose: ");
                int year = sc.nextInt();
                if (year % 4 == 0 && year %100 != 0 || year % 400 == 0)
                {
                        System.out.println(true);
                }
                else
                {
                        System.out.println(false);
                }
        }
}
```

Output:

```
C:\Users\rahul\OneDrive\Desktop\CDAC\Module
Enter the year you want to choose: 2020
true

C:\Users\rahul\OneDrive\Desktop\CDAC\Module
Enter the year you want to choose: 1900
false
```

Flow chart:



Explaination:

1: Get User Input

2: Check Divisibility by 4

3: If year is divisible by 100, it must also be divisible by 400 to be a leap year

4:If year is divisible by 100 but not 400, it's not a leap year (goto Step 6)

5:If year passes Step 2 and Step 3 checks, it's a leap year

6:Display leap year or not

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