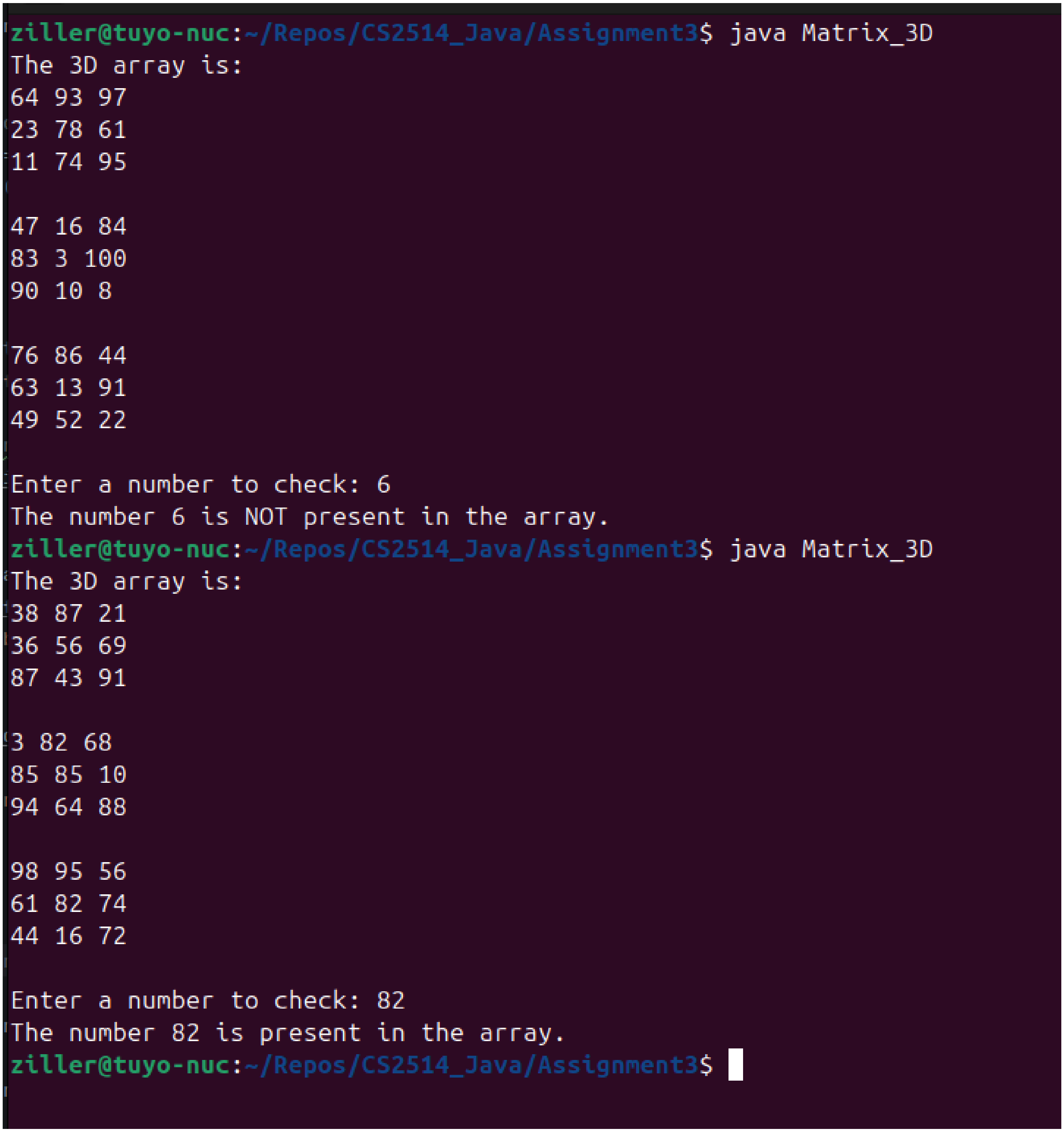
Program 1

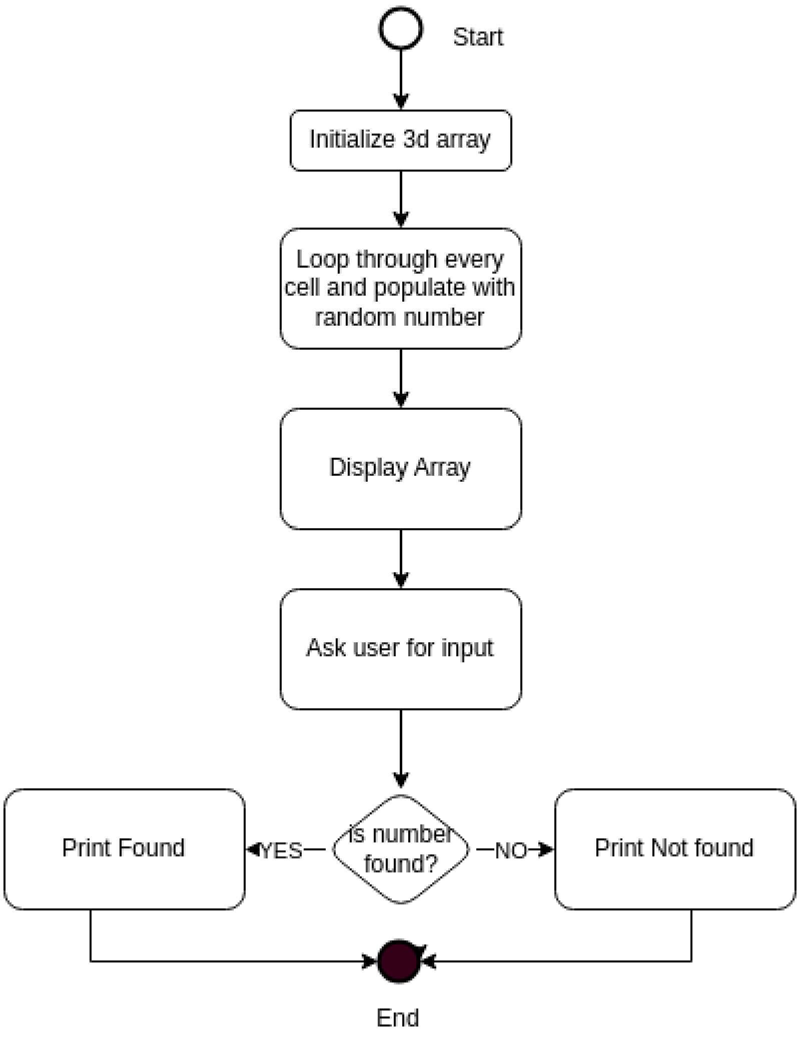
Write a program in JAVA to create a 3D array (containing integer values) and display it on the console. Then input a number from user and check whether it is present.

Terminal Out



```
ziller@tuyo-nuc:~/Repos/CS2514_Java/Assignment3$ java Matrix_3D
The 3D array is:
64 93 97
23 78 61
11 74 95

47 16 84
83 3 100
90 10 8

76 86 44
63 13 91
49 52 22

Enter a number to check: 6
The number 6 is NOT present in the array.
ziller@tuyo-nuc:~/Repos/CS2514_Java/Assignment3$ java Matrix_3D
The 3D array is:
38 87 21
36 56 69
87 43 91

3 82 68
85 85 10
94 64 88

98 95 56
61 82 74
44 16 72

Enter a number to check: 82
The number 82 is present in the array.
ziller@tuyo-nuc:~/Repos/CS2514_Java/Assignment3$ 
```

Flowchart



Source Code

```
import java.util.Random;
import java.util.Scanner;

// Class to create a random 3d array, then allow the user to check if a number exist in it.
public class Matrix_3D {
    public static void main(String[] args) {
        // x,y,z are the demsions of our array
        int x = 3, y = 3, z = 3;

        // Set up the matrix with the dimensions
        int[][][] array = new int[x][y][z];

        // To keep things interesting, going to use random numbers
        // to populate the array.
        Random random = new Random();

        // Initialize the array with random values between 1 and 100
        // 3 nested for loops, giving us an O(N^3)
        for (int i = 0; i < x; i++) {
            for (int j = 0; j < y; j++) {
                for (int k = 0; k < z; k++) {
                    array[i][j][k] = random.nextInt(100) + 1; // Random number between 1 and 100
                }
            }
        }

        // Similar style nested loops to print out the array we have so far.
        System.out.println("The 3D array is:");
        for (int i = 0; i < x; i++) {
            for (int j = 0; j < y; j++) {
                for (int k = 0; k < z; k++) {
                    System.out.print(array[i][j][k] + " ");
                }
                System.out.println();  // Newline for better readability
            }
            System.out.println();  // Add an extra line between 2D arrays
        }

        // The user now checks to see if their number is in the array...
        Scanner scanner = new Scanner(System.in);
        System.out.print("Enter a number to check: ");

        //
        int userNumber = scanner.nextInt();

        // Default to not found until we find it...
        boolean found = false;

        // Our familar tripple nested loop
        for (int i = 0; i < x; i++) {
            for (int j = 0; j < y; j++) {
                for (int k = 0; k < z; k++) {
                    if (array[i][j][k] == userNumber) {
                        found = true;   // we found the user's number, so we can
                        break;  // break out of the search loop.
                    }
                }
                if (found) break;  // cascade out
            }
            if (found) break;   // cascade out further.
                                // Note Java does seem to have an assembly style label/jump feature
                                // but not sure how OO that is , so avoiding.
        }

        // We're at the results section now.
        if (found) {
            System.out.println("The number " + userNumber + " is present in the array.");
        } else {
            System.out.println("The number " + userNumber + " is NOT present in the array.");
        }

        scanner.close();
    }
}
```

Program 2

Write a program in Java to implement a linked list containing 5 numbers <11, 22, 6, 89, 99> and then perform the following:

Then insert a number <50> in the third position of the linked list and print the new linked list <11, 22, 50, 6, 89, 99>

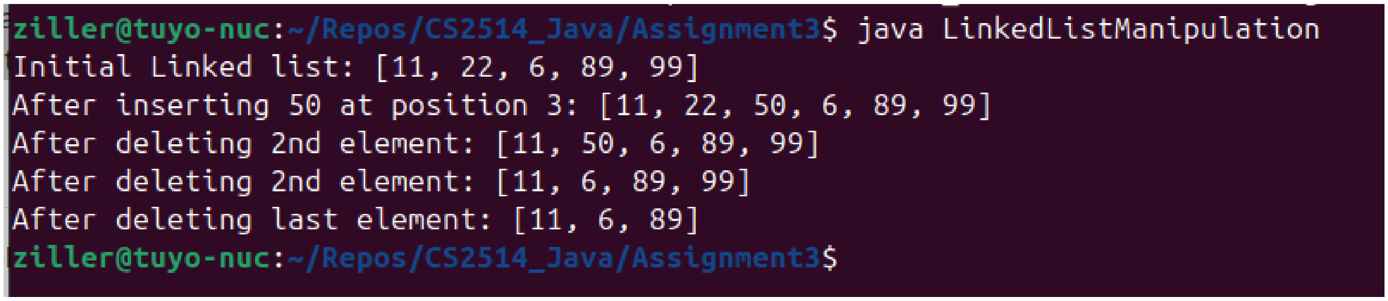
Delete the 2nd element of the linked list and print the remaining linked list <11, 50, 6, 89, 99>

Delete the 1st element of the linked list and print the remaining linked list <50, 6, 89, 99>

Delete the last element of the linked list and print the remaining linked list <50,6,89>

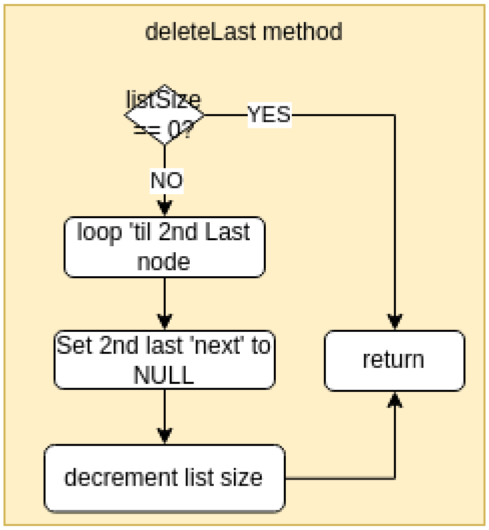
You are not allowed to use java.util.LinkedList

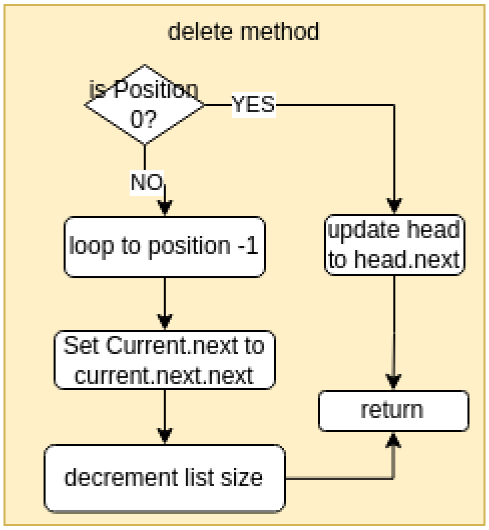
Terminal Out

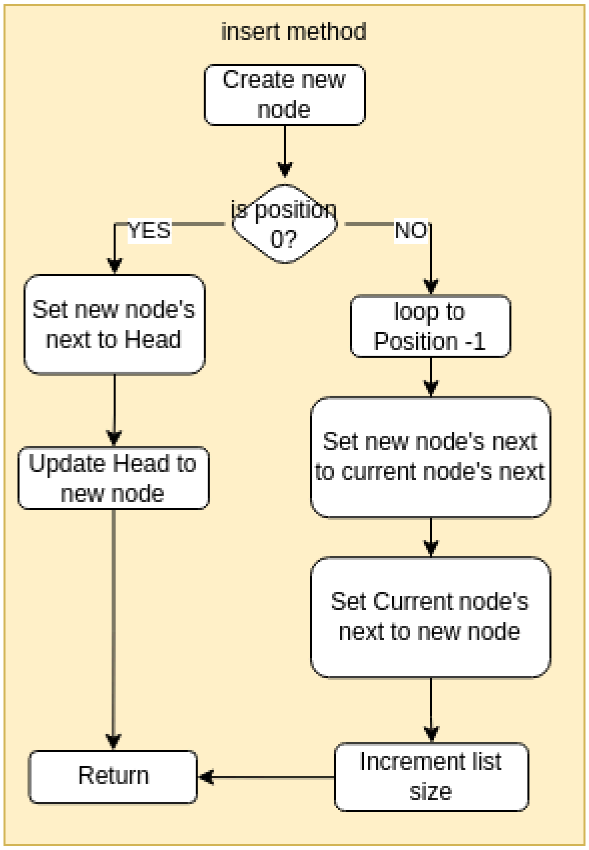


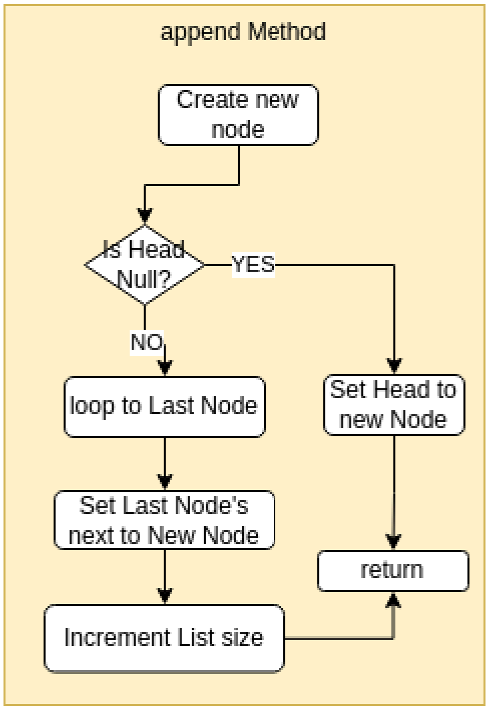
```
ziller@tuyo-nuc:~/Repos/CS2514_Java/Assignment3$ java LinkedListManipulation
Initial Linked list: [11, 22, 6, 89, 99]
After inserting 50 at position 3: [11, 22, 50, 6, 89, 99]
After deleting 2nd element: [11, 50, 6, 89, 99]
After deleting 2nd element: [11, 6, 89, 99]
After deleting last element: [11, 6, 89]
ziller@tuyo-nuc:~/Repos/CS2514_Java/Assignment3$
```

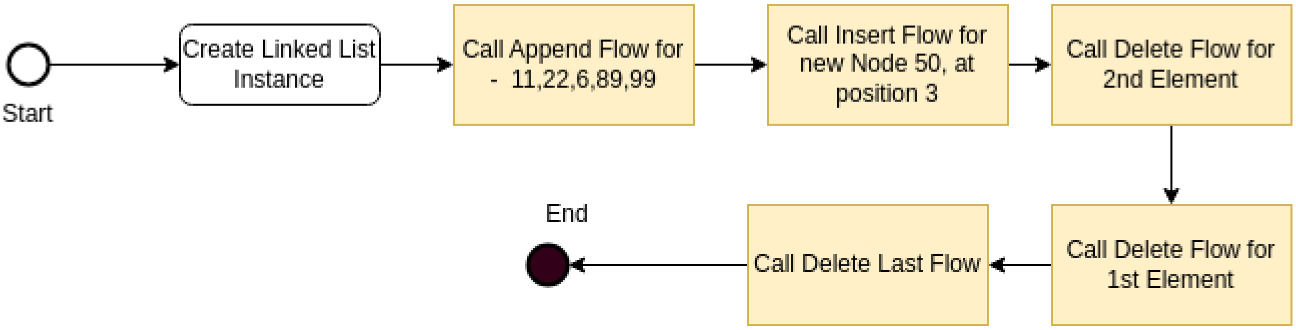
Flowchart


deleteLast method
listSize == 0?
YES
NO
loop 'til 2nd Last node
Set 2nd last 'next' to NULL
decrement list size
return


delete method
is Position 0?
YES
NO
loop to position -1
Set Current.next to current.next.next
decrement list size
update head to head.next
return


insert method
Create new node
is position 0?
YES
NO
Set new node's next to Head
Update Head to new node
Return
loop to Position -1
Set new node's next to current node's next
Set Current node's next to new node
Increment list size


append Method
Create new node
Is Head Null?
YES
NO
loop to Last Node
Set Last Node's next to New Node
Increment List size
Set Head to new Node
return


Start
Create Linked List Instance
Call Append Flow for - 11,22,6,89,99
Call Insert Flow for new Node 50, at position 3
Call Delete Flow for 2nd Element
Call Delete Flow for 1st Element
Call Delete Last Flow
End

Source Code

```java
// Custom Single Linked-List Class diagram.
public class CustomLinkedList{

        Node head;      // Reference to head of the list
        private int size; // Size of linked list


        // Node class for the Single linked list...
        static class Node{
                int data; // Node's data payload
                Node next; // pointer to next downstream on the list

                // Constructor
                public Node(int data){
                        this.data = data;
                        this.next = null; // default to null - don't know yet where we place it.
                }
        }

        // Constructor.
        public CustomLinkedList() {
                this.head = null;
                this.size = 0;
        }

        // Method to add node to end.
        public void append(int data){

                // wrap the data in its node instance.
                Node newNode = new Node(data);

                // If this is the first to be added to the list
                if (head == null) {
                        head = newNode; // then it becomes the head.
                }
                else {
                        // need to walk down the list to the last Node.
                        Node current = head;
                        while (current.next != null) {
                                current = current.next;
                        }
                        // when we get to end of list, we append by requiring
                        // the current list's last node to point its next from
                        // null to this new node. Note the new node is point to null
                        current.next = newNode;
                }
                // increment the list size as we have added a new node.
                size++;
        }

        // Method to insert at a specific position
        // position is where we want to place it - the i'th location
        // data is the new data we want to store in our list
        public void insert(int position, int data){
                // basic error checking to ensure position is valid
                if (position < 0 || position > size){
                        throw new IndexOutOfBoundsException("Invalid position");
                }

                // wrap the data in its new Node's instance.
                Node newNode = new Node(data);

                // Check do we want this new Node to be head?
                if (position == 0){
                        // if so, we update our head pointer
                        newNode.next = head;
                        head = newNode;
                }else{
                        // walk down the list until the node just before the
                        // desired position
                        Node current = head;
                        for (int i = 0; i<position - 1; i++){
                                current = current.next;
                        }
                        // rewire the linked list - setting the new node's next
                        // to the position -1 's next
                        // and then the position -1's next to this new node.
                        newNode.next = current.next;
                        current.next = newNode;
                }
                // new node means we increment the list size.
                size++;
        }

        // Deleting a node from the list at position
        public void delete(int position){
                // basic error checking to ensure position is valid
                if (position < 0 || position >= size){
                        throw new IndexOutOfBoundsException("Invalid position");
                }

                // Special case if we are removing the head?
                // for example if this was a queue.
                if (position == 0){
                        head = head.next;
                } else {
                        // walk down the list to the node before the element to be removed.
                        Node current = head;
                        // wire the element out of the list
                        for (int i = 0; i < position - 1; i++){
                                current = current.next;
                        }
                        current.next = current.next.next;
                }
                // deleted element - so we need to reduce list size.
                size--;
        }
        public void deleteLast() {
                        // If no elements we still succeeded
                if (size == 0) return;
                        // if we have 1, then we are getting rid of head.
                if (size == 1) {
                        head = null;
                } else {
                                        // walk down the list.
                                        // and point second from last to null.
```

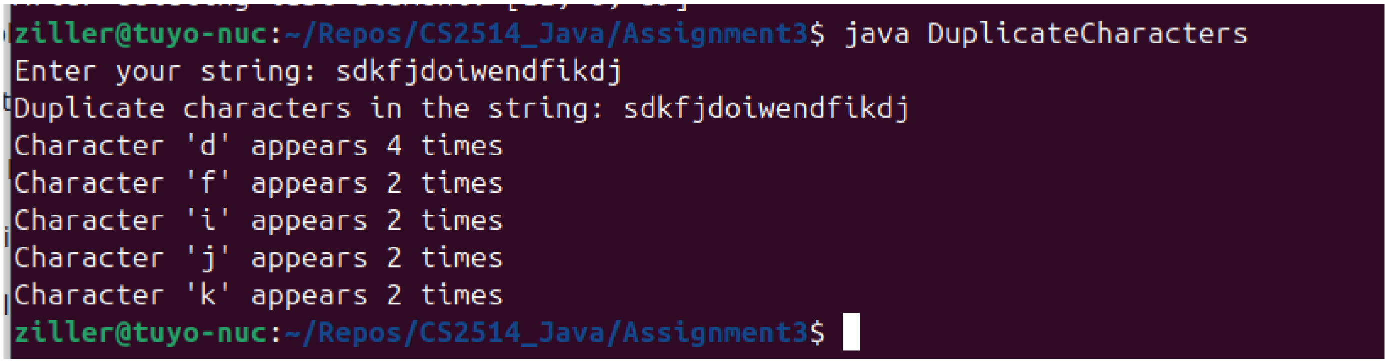
```
                    // garbage collection will take care of the last one.
            Node current = head;
            while (current.next.next != null) {
                current = current.next;
            }
            current.next = null;
        }
        // deleted element - so we need to reduce list size.
        size--;
    }

    // Method to print the list
    public void printList() {
        // Prity print of our list

        Node current = head;
        System.out.print("[");

            // Walk down the list, printing as we go.
        while (current != null) {
            System.out.print(current.data);
            if (current.next != null) {
                System.out.print(", ");
            }
            current = current.next;
        }
        System.out.println("]");
    }

    public static void main(String[] args) {

            // list instance.
        CustomLinkedList list = new CustomLinkedList();

        // Add initial elements
        list.append(11);
        list.append(22);
        list.append(6);
        list.append(89);
        list.append(99);

        System.out.print("Initial linked list: ");
        list.printList();

        // Insert 50 at position 2 (third position)
        list.insert(2, 50);
        System.out.print("After inserting 50 at position 3: ");
        list.printList();

        // Delete the 2nd element (position 1)
        list.delete(1);
        System.out.print("After deleting 2nd element: ");
        list.printList();

        // Delete the 1st element (position 0)
        list.delete(0);
        System.out.print("After deleting 1st element: ");
        list.printList();

        // Delete the last element
        list.deleteLast();
```

```
                System.out.print("After deleting last element: ");
                list.printList();
    }
}
```

Program 3

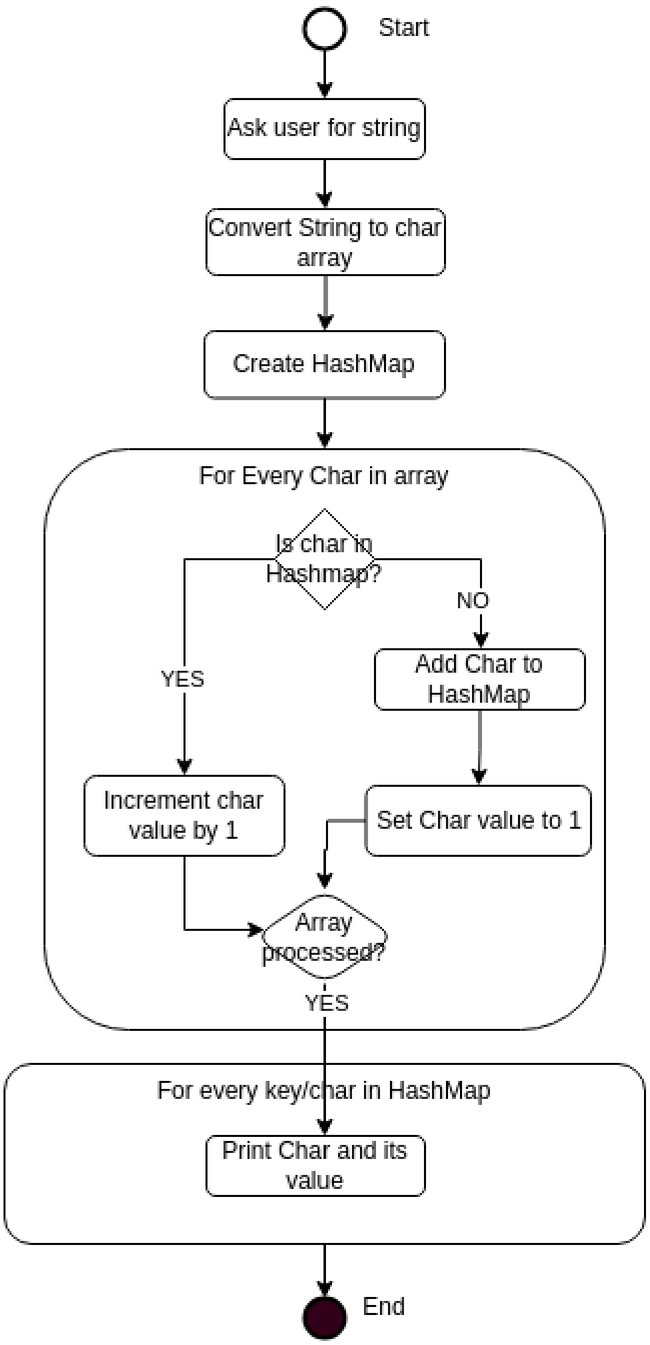
Write a program in Java to find duplicate characters in an user defined input sting

Terminal Out



```
ziller@tuyo-nuc:~/Repos/CS2514_Java/Assignment3$ java DuplicateCharacters
Enter your string: sdkfjdoiwendfikdj
Duplicate characters in the string: sdkfjdoiwendfikdj
Character 'd' appears 4 times
Character 'f' appears 2 times
Character 'i' appears 2 times
Character 'j' appears 2 times
Character 'k' appears 2 times
ziller@tuyo-nuc:~/Repos/CS2514_Java/Assignment3$
```

Flowchart



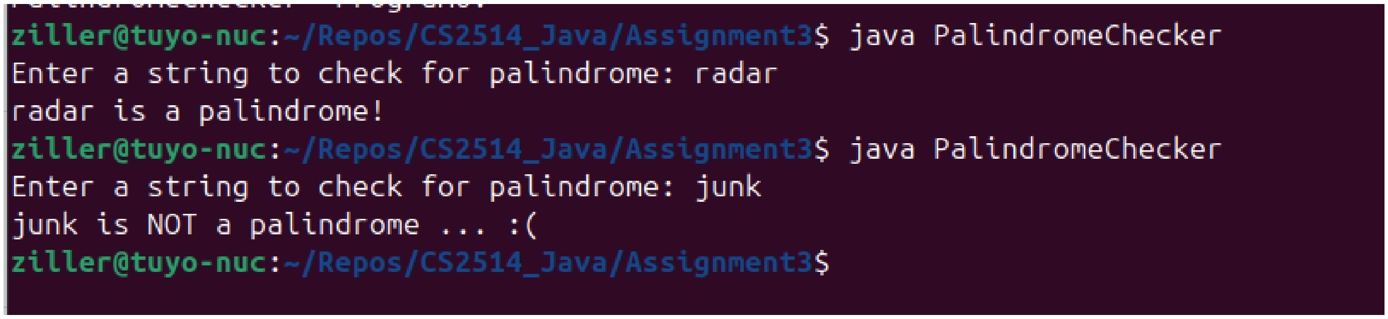
Source Code

```
import java.util.HashMap;
import java.util.Map;
import java.util.Scanner;

// Class to interrogate a user inputted string
// and find duplicate characters
public class DuplicateCharacters {
        public static void main(String[] args){

                Scanner scanner = new Scanner(System.in);
                System.out.print("Enter your string: ");
                String input = scanner.nextLine();

                // Find and print duplicate characters from user string.
                findDuplicateCharacters(input);

                scanner.close();
        }

        public static void findDuplicateCharacters(String str){

                // Useing a HashMap as a mechanism to collect character frequency info
                // [Char, charount]
                Map<Character, Integer> charCountMap = new HashMap<>();

                // Convert the string to character array
                char[] chars = str.toCharArray();

                // Count occurences of each character
                for (char c : chars) {
                        // Was this character seen/stored before?
                        if (charCountMap.containsKey(c)) {
                                // if so, increment the count value by 1
                                charCountMap.put(c, charCountMap.get(c) + 1);
                        } else {
                                // new observed char, so set count value to 1
                                charCountMap.put(c,1);
                        }
                }

                // Print Duplicate characters
                System.out.println("Duplicate characters in the string: " + str );
                boolean duplicatesFound = false;

                // Loop through the hashmap
                for (Map.Entry<Character, Integer> entry : charCountMap.entrySet()){
                        // if a char is seen more than once, print out.
                        if (entry.getValue() > 1){
                                System.out.println("Character '" + entry.getKey() + "' appears " + ent

                        }
                        duplicatesFound = true;
                }
        }
}
```

Program 4

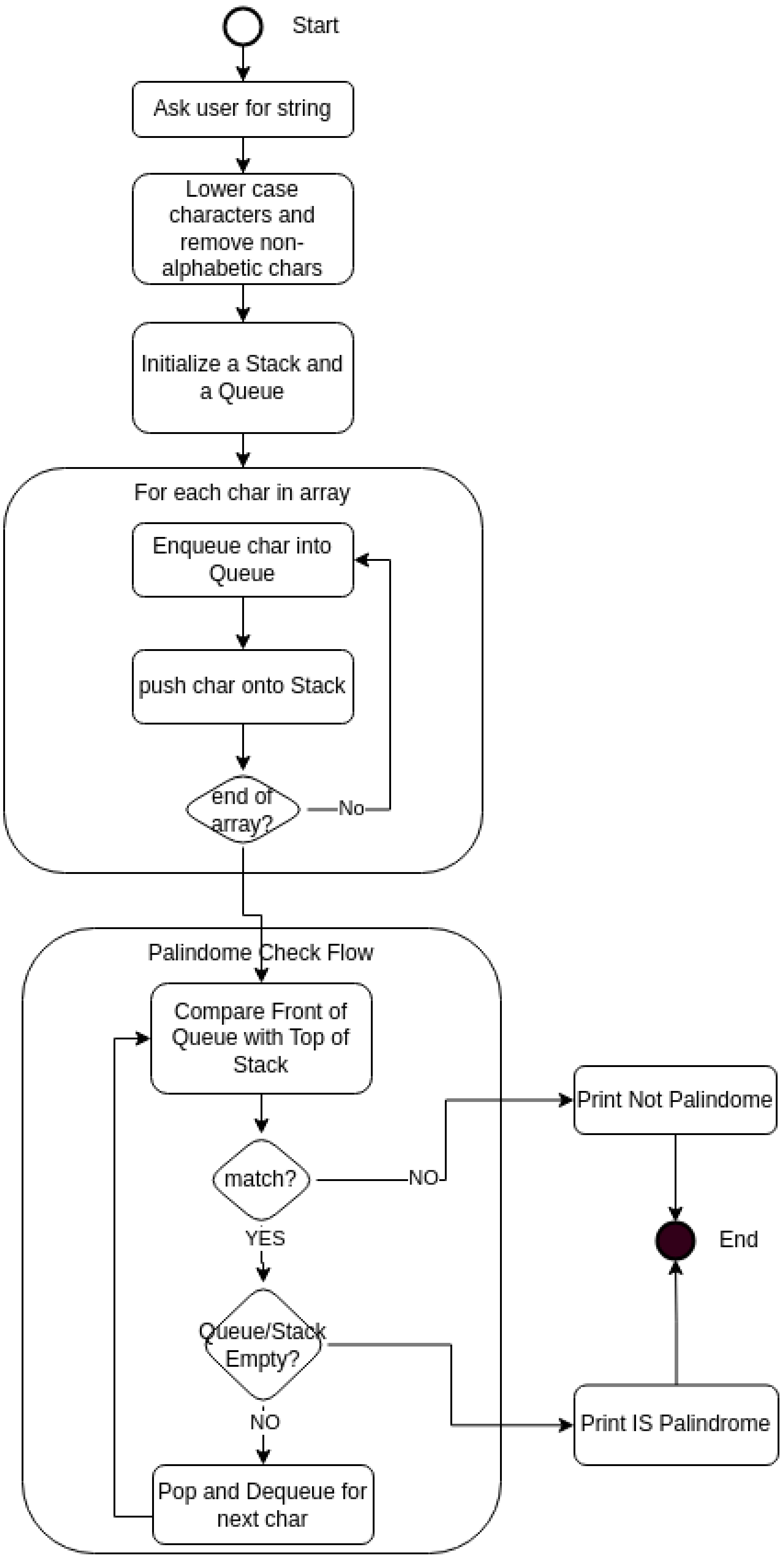
Write a program in Java to check palindrome string using data types queue and stack

Terminal Out



```
ziller@tuyo-nuc:~/Repos/CS2514_Java/Assignment3$ java PalindromeChecker
Enter a string to check for palindrome: radar
radar is a palindrome!
ziller@tuyo-nuc:~/Repos/CS2514_Java/Assignment3$ java PalindromeChecker
Enter a string to check for palindrome: junk
junk is NOT a palindrome ... :(
ziller@tuyo-nuc:~/Repos/CS2514_Java/Assignment3$
```

Flowchart


Start
Ask user for string
Lower case characters and remove non-alphabetic chars
Initialize a Stack and a Queue
For each char in array
Enqueue char into Queue
push char onto Stack
end of array?
No
Palindome Check Flow
Compare Front of Queue with Top of Stack
match?
NO
YES
Print Not Palindome
End
Queue/Stack Empty?
NO
Print IS Palindrome
Pop and Dequeue for next char

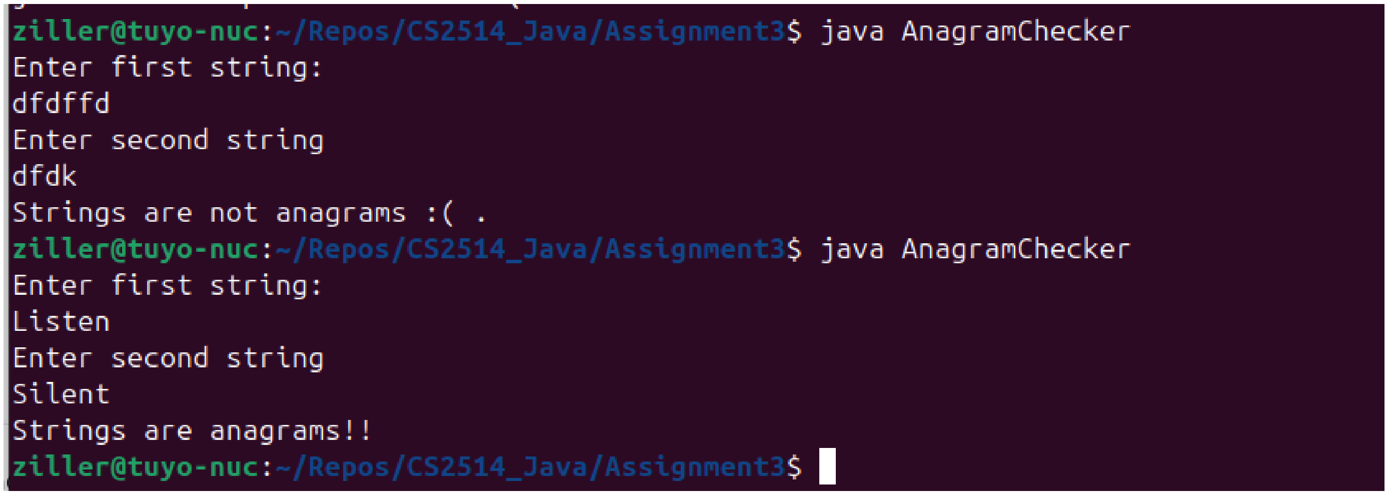
Source Code

```java
import java.util.LinkedList;
import java.util.Scanner;
import java.util.Stack;
import java.util.Queue;

// Class to check if a string is a palindrome.
public class PalindromeChecker {

        public static void main(String[] args){

                Scanner scanner = new Scanner(System.in);

                System.out.print("Enter a string to check for palindrome: ");

                // process the input string.
                // first lower the case.
                // then a simple regex to recognize Palindomes should only work with letters and digit
                // so if we see anything else strange, we mask out.
                String input = scanner.nextLine().toLowerCase().replaceAll("[^a-z0-9]", "");

                if (isPalindrome(input)){
                        System.out.println(input + " is a palindrome!");
                } else {
                        System.out.println(input + " is NOT a palindrome ... :(");
                }

                scanner.close();
        }

        public static boolean isPalindrome(String str) {

                // Using the classical Stack and Queue from Algo class
                // inserting the string into both results the string getting inverted
                // which means we can do a simple compare of each entry
                Stack<Character> stack = new Stack<>();
                Queue<Character> queue = new LinkedList<>();

                // Push characters onto the stack and queue
                for (int i = 0; i < str.length(); i++){
                        char c = str.charAt(i);
                        stack.push(c);
                        queue.add(c);
                }


                // This is where we leverage the string pushed to a stack and enqueued in a queue
                // popping and removing each in parallel should tell us if we have a palindorme or not
                while (!stack.isEmpty()){
                        if (stack.pop() != queue.remove()){
                                return false;
                        }
                }
                return true;
        }
}
```

Program 5

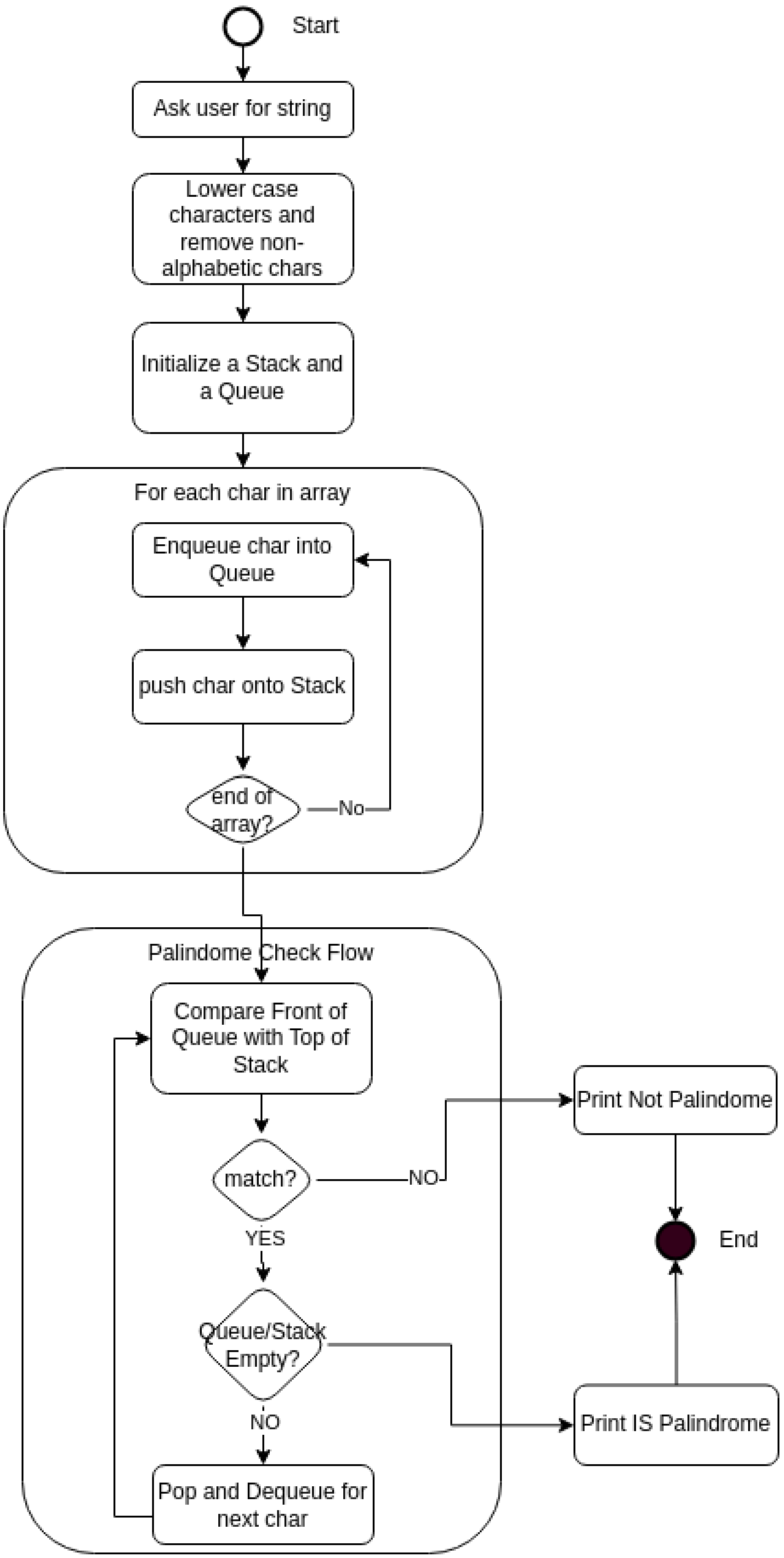
Write a program in Java to check two strings are anagram or not

Terminal Out



```
ziller@tuyo-nuc:~/Repos/CS2514_Java/Assignment3$ java AnagramChecker
Enter first string:
dfdffd
Enter second string
dfdk
Strings are not anagrams :( .
ziller@tuyo-nuc:~/Repos/CS2514_Java/Assignment3$ java AnagramChecker
Enter first string:
Listen
Enter second string
Silent
Strings are anagrams!!
ziller@tuyo-nuc:~/Repos/CS2514_Java/Assignment3$ 
```

Flowchart


Start
Ask user for string
Lower case characters and remove non-alphabetic chars
Initialize a Stack and a Queue
For each char in array
Enqueue char into Queue
push char onto Stack
end of array?
No
Palindome Check Flow
Compare Front of Queue with Top of Stack
match?
NO
YES
Queue/Stack Empty?
NO
Pop and Dequeue for next char
Print Not Palindome
End
Print IS Palindrome

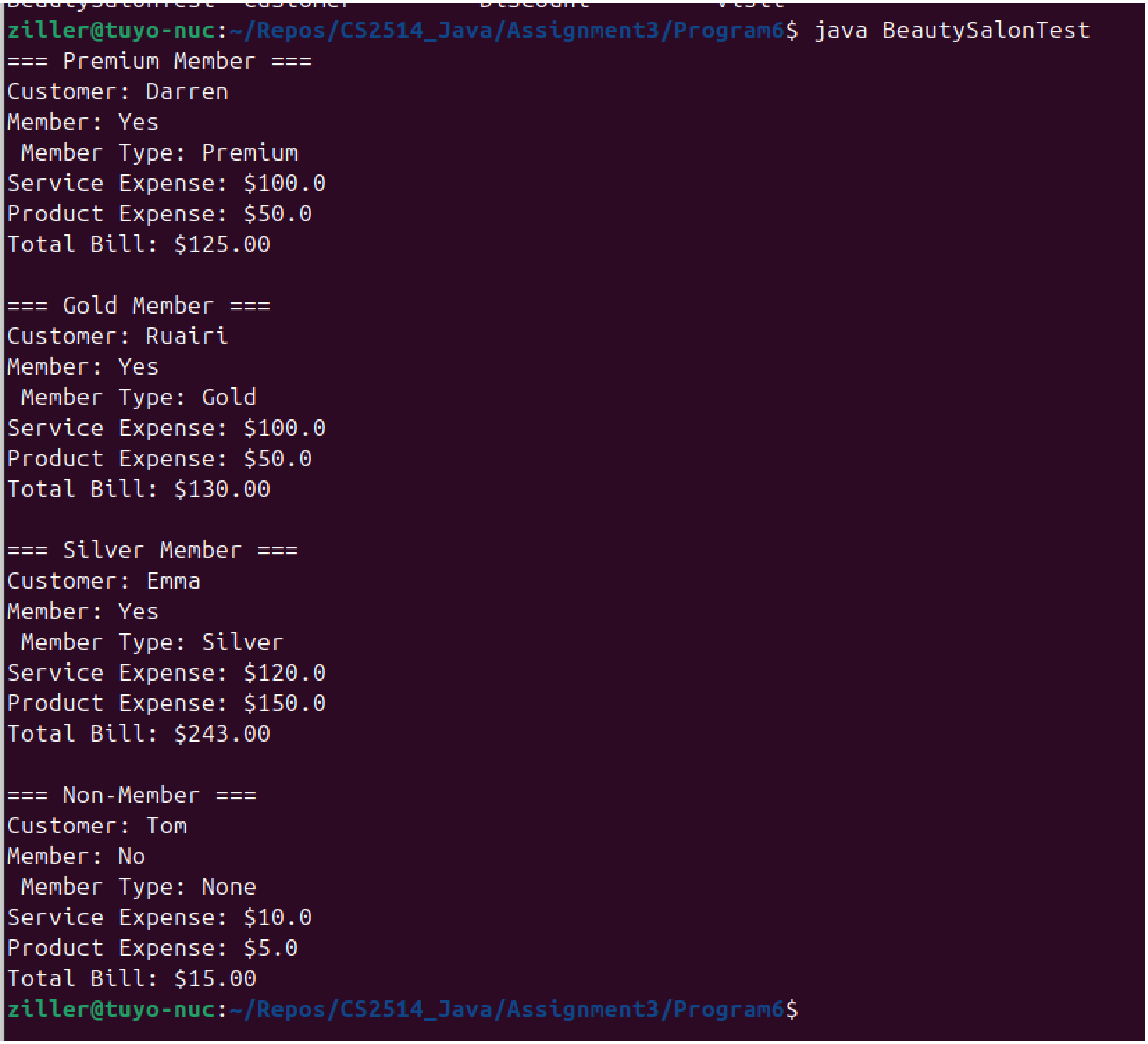
Source Code

```
import java.util.*;

// Anangram Checker checks to see if 2 strings given
// by a user are anagrams.
public class AnagramChecker{
        public static void main(String[] args){

                // Create scanner object
                Scanner scanner = new Scanner(System.in);

                // Take the two strings from user.
                System.out.println("Enter first string: ");
                String str1 = scanner.nextLine();

                System.out.println("Enter second string");
                String str2 = scanner.nextLine();

                // Check if they are anagrams
                if (areAnagrams(str1, str2)){
                        System.out.println("Strings are anagrams!!");
                }
                else {
                        System.out.println("Strings are not anagrams :( .");
                }
                scanner.close();
        }

        // Takes two strings and returns true or false if they are an anagram of each other.
        public static boolean areAnagrams(String str1, String str2){

                // Normalize the string - drop all to lower case
                // and remove all tabs/spaces/newlines
                String s1 = str1.replaceAll("\\s", "").toLowerCase();
                String s2 = str2.replaceAll("\\s", "").toLowerCase();

                // Simple first check - if they are not the same length they cant be an anagram.
                if (s1.length() != s2.length()) {
                        return false;
                }

                // Convert string the char arrays
                // so we can sort and compare
                char[] charArray1 = s1.toCharArray();
                char[] charArray2 = s2.toCharArray();

                // doing a simple sort of our char array will allow us to then
                // check if they are equal.
                Arrays.sort(charArray1);
                Arrays.sort(charArray2);

                // if the sorted arrays of characters are equal then
                //  return true, else return false.
                return Arrays.equals(charArray1, charArray2);
        }
}
```

Program 6

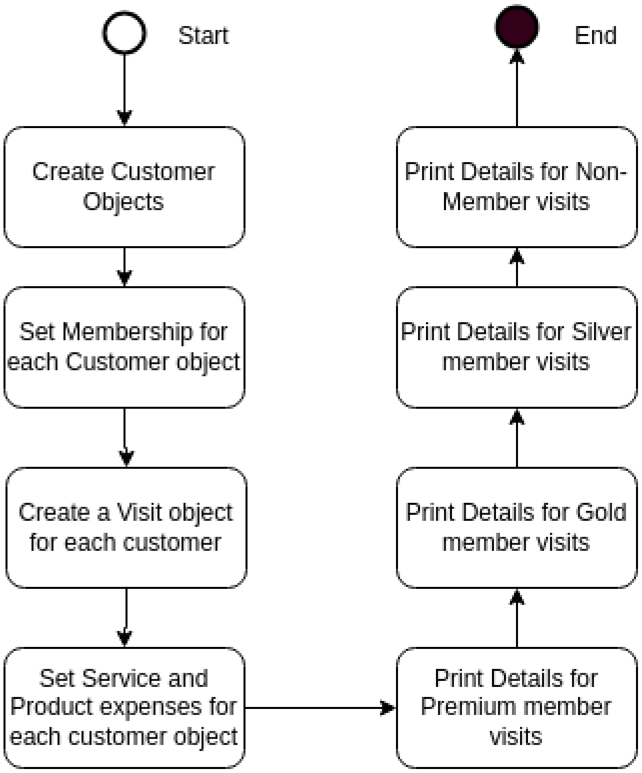
You are asked to write a discount system for a beauty saloon, which provides services and sells beauty products. It offers 3 types of memberships: Premium, Gold and Silver. Premium, gold and silver members receive a discount of 20%, 15%, and 10%, respectively, for all services provided. Customers without membership receive no discount. All members receives a flat 10% discount on products purchased (this might change in future). Your system shall consist of three classes: Customer, Discount and Visit, as shown in the class diagram. It shall compute the total bill if a customer purchases $xofproductsand$y of services, for a visit. Also write a test program to exercise all the classes.

Terminal Out



```
ziller@tuyo-nuc:~/Repos/CS2514_Java/Assignment3/Program6$ java BeautySalonTest
=== Premium Member ===
Customer: Darren
Member: Yes
 Member Type: Premium
Service Expense: $100.0
Product Expense: $50.0
Total Bill: $125.00

=== Gold Member ===
Customer: Ruairi
Member: Yes
 Member Type: Gold
Service Expense: $100.0
Product Expense: $50.0
Total Bill: $130.00

=== Silver Member ===
Customer: Emma
Member: Yes
 Member Type: Silver
Service Expense: $120.0
Product Expense: $150.0
Total Bill: $243.00

=== Non-Member ===
Customer: Tom
Member: No
 Member Type: None
Service Expense: $10.0
Product Expense: $5.0
Total Bill: $15.00
ziller@tuyo-nuc:~/Repos/CS2514_Java/Assignment3/Program6$
```

Flowchart


Start
End
Create Customer Objects
Set Membership for each Customer object
Create a Visit object for each customer
Set Service and Product expenses for each customer object
Print Details for Premium member visits
Print Details for Gold member visits
Print Details for Silver member visits
Print Details for Non-Member visits

Source Code

Customer Class

```
// Class to represent Customer.
// Standard name parameter, but with additional attributes for
// Membership information.
public class Customer {
        private String name;
        private String memberType;
        private boolean member;

        // Constructor for Customer
        public Customer(String name) {
                this.name = name;
                this.member = false;
                this.memberType = "None";
        }

        // Simple getter/setter methods.
        public String getName() {
                return name;
        }

        public boolean isMember() {
                return member;
        }

        public void setMember(boolean member){
                this.member = member;
        }

        public String getMemberType() {
                return this.memberType;
        }

        public void setMemberType(String memberType) {
                this.memberType = memberType;
                this.member = !memberType.equals("None");
        }

        // Using override java annotation to make code usage more intutitive.
        @Override
        public String toString() {
                return "Customer: " + name +
                        "\nMember: " + (member ? "Yes" : "No") +
                        "\n Member Type: " + memberType;
        }
}
```

Discount Class

```
public class Discount {

        // Using private static variables to hold the discount rates.
        // This means there is one shared copy, ergo no instance will hold
        // duplicate info.
        private static double serviceDiscountPremium = 0.2;
        private static double serviceDiscountGold = 0.15;
        private static double serviceDiscountSilver = 0.1;
        private static double productDiscountPremium = 0.1;
        private static double productDiscountGold = 0.1;
        private static double productDiscountSilver = 0.1;


        // Public static method to get service discount rate based on the type
        public static double getServiceDiscountRate(String memberType) {
                // In case users of our API miss-type member string, force string to UPPER
        String upperType = memberType.toUpperCase();

                // switch statement will control the correct rate returned for the
                // membership level.
                switch (upperType) {
                        case "PREMIUM":
                                // Note here and below - I don't have to do a 'this.'
                                // as my rates are private static :-)
                                return serviceDiscountPremium;
                        case "GOLD":
                                return serviceDiscountGold;
                        case "SILVER":
                                return serviceDiscountSilver;
                        default:
                                return 0.0; // Default return value of 0% discount
                }
        }
        // Public static method to get product discount rate based on membership type
        public static double getProductDiscountRate(String memberType)  {
                // In case users of our API miss-type member string, force string to UPPER
        String upperType = memberType.toUpperCase();

                // switch statement will control the correct rate returned for the
                // membership level.
                switch (upperType) {
                        case "PREMIUM":
                                return productDiscountPremium;
                        case "GOLD":
                                return productDiscountGold;
                        case "SILVER":
                                return productDiscountSilver;
                        default:
                                return 0.0; // Default return value of 0% discount
                }
        }
}
```

Visit Class

```
// The visit Class represents a Customers visit to the beauty saloon.
// It 'has-a' Customer instance, and that customer will use an instance
// of this class to determine what type of discount they can avail of
// for a service or product - dependent upon their membership level.
public class Visit {
        // 'has-a' customer reference
        private Customer customer;

        // Variables to record the visit expenses.
        private double serviceExpense;
        private double productExpense;

        // Constructor setting up a visit instance for a customer visit.
        public Visit(Customer customer){
                this.customer = customer;
                this.serviceExpense = 0.0;
                this.productExpense = 0.0;
        }

        // Record Service transactions
        public void setServiceExpense(double serviceExpense) {

                this.serviceExpense = serviceExpense;
        }

        // Record Product expenses
        public void setProductExpense(double productExpense) {

                this.productExpense = productExpense;
        }

        // Get the visit's service expense tally
        public double getServiceExpense() {
                return serviceExpense;
        }

        // Get the visit's product expense tally
        public double getProductExpense() {

                return productExpense;
        }


        public double getTotalExpense() {
                double serviceDiscount;
                double productDiscount;

                // Calculate service discount based on whether the customer is a member
                if (customer.isMember()) {
                        serviceDiscount = serviceExpense * Discount.getServiceDiscountRate(customer.ge
                } else {
                        serviceDiscount = 0.0;  // No discount if not a member
                }

                // Calculate product discount based on whether the customer is a member
                if (customer.isMember()) {
                        productDiscount = productExpense * Discount.getProductDiscountRate(customer.ge
                } else {
                        productDiscount = 0.0;  // No discount if not a member
                }

                // Calculate the total expense after applying the discounts
                return (serviceExpense - serviceDiscount) + (productExpense - productDiscount);

        }

        // Using override java annotation to make code usage more intutitive.
        @Override
        public String toString() {
                return customer.toString() +
                        "\nService Expense: $" + serviceExpense +
                        "\nProduct Expense: $" + productExpense +
                        "\nTotal Bill: $" + String.format("%.2f", getTotalExpense());
        }
}
```

BeautySalonTest Class

```
public class BeautySalonTest {
    public static void main(String[] args) {
        // Create customers
        Customer customer1 = new Customer("Darren");
        Customer customer2 = new Customer("Ruairi");
        Customer customer3 = new Customer("Emma");
        Customer customer4 = new Customer("Tom");

        // Set membership types for first 3 customers
        customer1.setMemberType("Premium");
        customer2.setMemberType("Gold");
        customer3.setMemberType("Silver");
        // Note, customer4 remains non-member

        // Customer 1 pays a visit
        Visit visit1 = new Visit(customer1);
        // And spends some money
        visit1.setServiceExpense(100.0);
        visit1.setProductExpense(50.0);

        // Customer 2 follows in.
        Visit visit2 = new Visit(customer2);
        // And buys the same stuff!
        visit2.setServiceExpense(100.0);
        visit2.setProductExpense(50.0);

        // Customer 3 makes an appearance.
        Visit visit3 = new Visit(customer3);
        // And has a bit more to spend
        visit3.setServiceExpense(120.0);
        visit3.setProductExpense(150.0);

        // Customer 4 comes in.
        Visit visit4 = new Visit(customer4);
        // And buys little because he decides he isn't a memeber
        visit4.setServiceExpense(10.0);
        visit4.setProductExpense(5.0);

        // Print results - using the nice override from the Visit class def.
        System.out.println("=== Premium Member ===");
        System.out.println(visit1);

        System.out.println("\n=== Gold Member ===");
        System.out.println(visit2);

        System.out.println("\n=== Silver Member ===");
        System.out.println(visit3);

        System.out.println("\n=== Non-Member ===");
        System.out.println(visit4);
    }
}
```