Assignment 3

21AIE111

Data Structure and Algorithms – SEM-II

Professor – Dr. Sachin Sir

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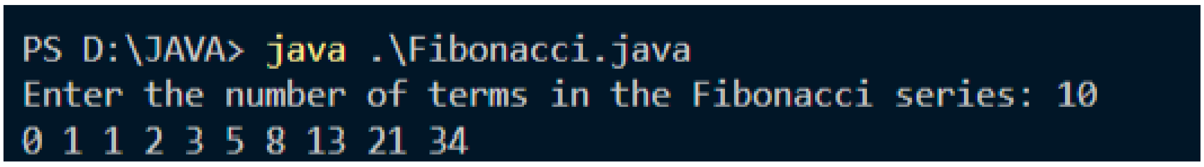
1. Write java code to print Fibonacci series, upto 10 positions, without recursion (Fibonacci series: 0 1 1 2 3 5 8 13…).

CODE:

Method 1

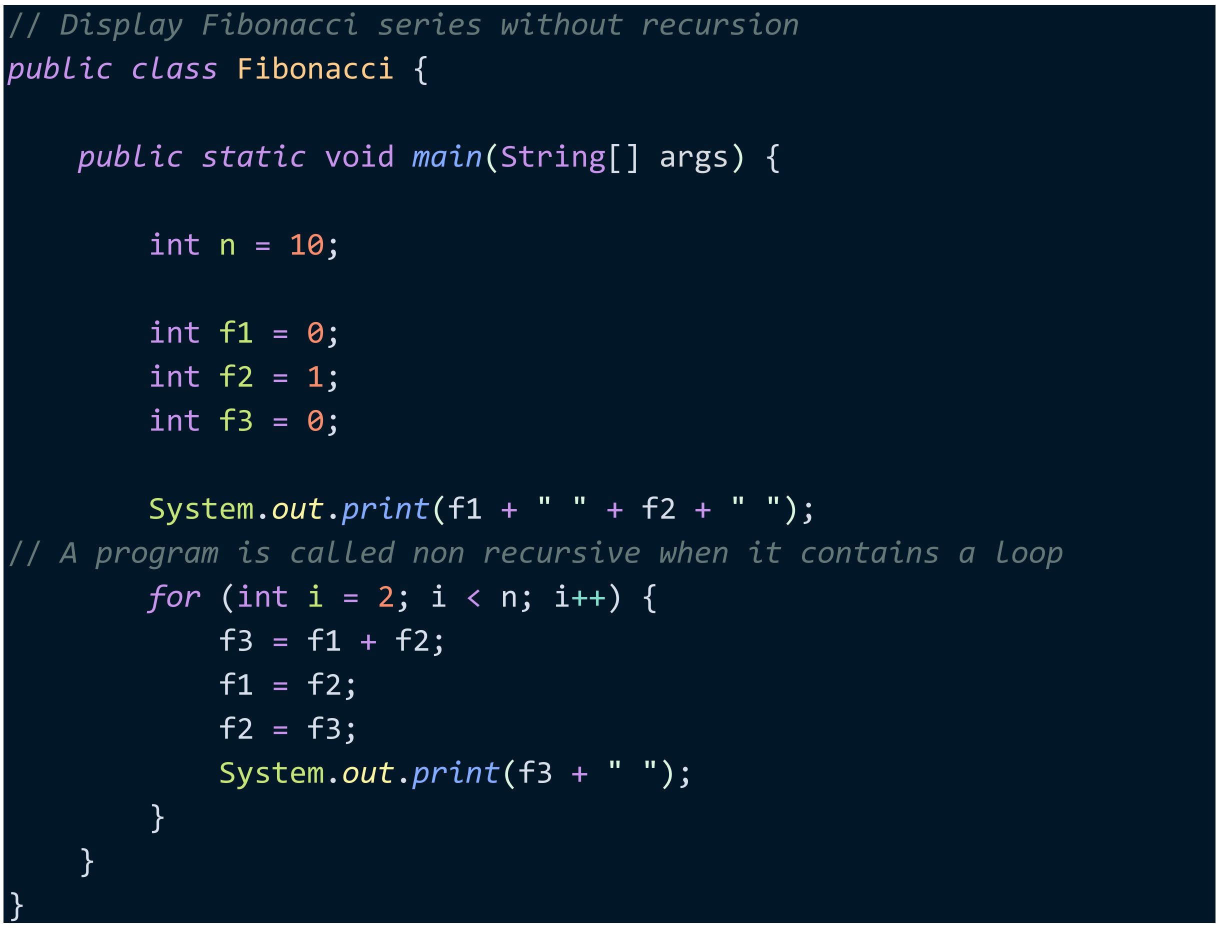
```java
// Display Fibonacci series without recursion

import java.util.Scanner;

public class Fibonacci
{
    public static void main(String[] args)
    {
        Scanner input = new Scanner(System.in);
        System.out.print("Enter the number of terms in the Fibonacci series: ");
        int n = input.nextInt();
        int f1 = 0;
        int f2 = 1;
        int f3 = 0;

        System.out.print(f1 + " " + f2 + " ");
// A program is called non recursive when it contains a loop

        for (int i = 2; i < n; i++) {
            f3 = f1 + f2;
            f1 = f2;
            f2 = f3;
            System.out.print(f3 + " ");
        }


    }
}
```

OUPUT:



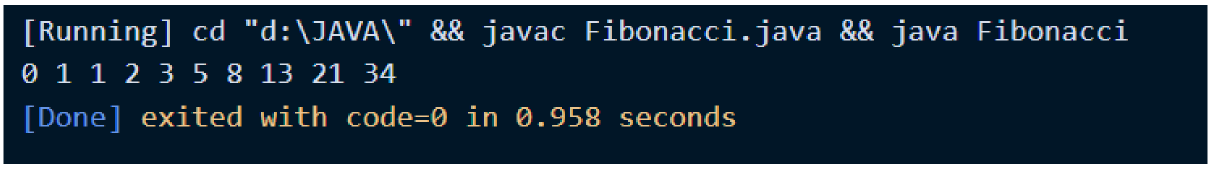
```
PS D:\JAVA> java .\Fibonacci.java
Enter the number of terms in the Fibonacci series: 10
0 1 1 2 3 5 8 13 21 34
```

Method 2



```java
// Display Fibonacci series without recursion
public class Fibonacci {

    public static void main(String[] args) {

        int n = 10;

        int f1 = 0;
        int f2 = 1;
        int f3 = 0;

        System.out.print(f1 + " " + f2 + " ");
// A program is called non recursive when it contains a loop
        for (int i = 2; i < n; i++) {
            f3 = f1 + f2;
            f1 = f2;
            f2 = f3;
            System.out.print(f3 + " ");
        }
    }
}
```

OUTPUT:



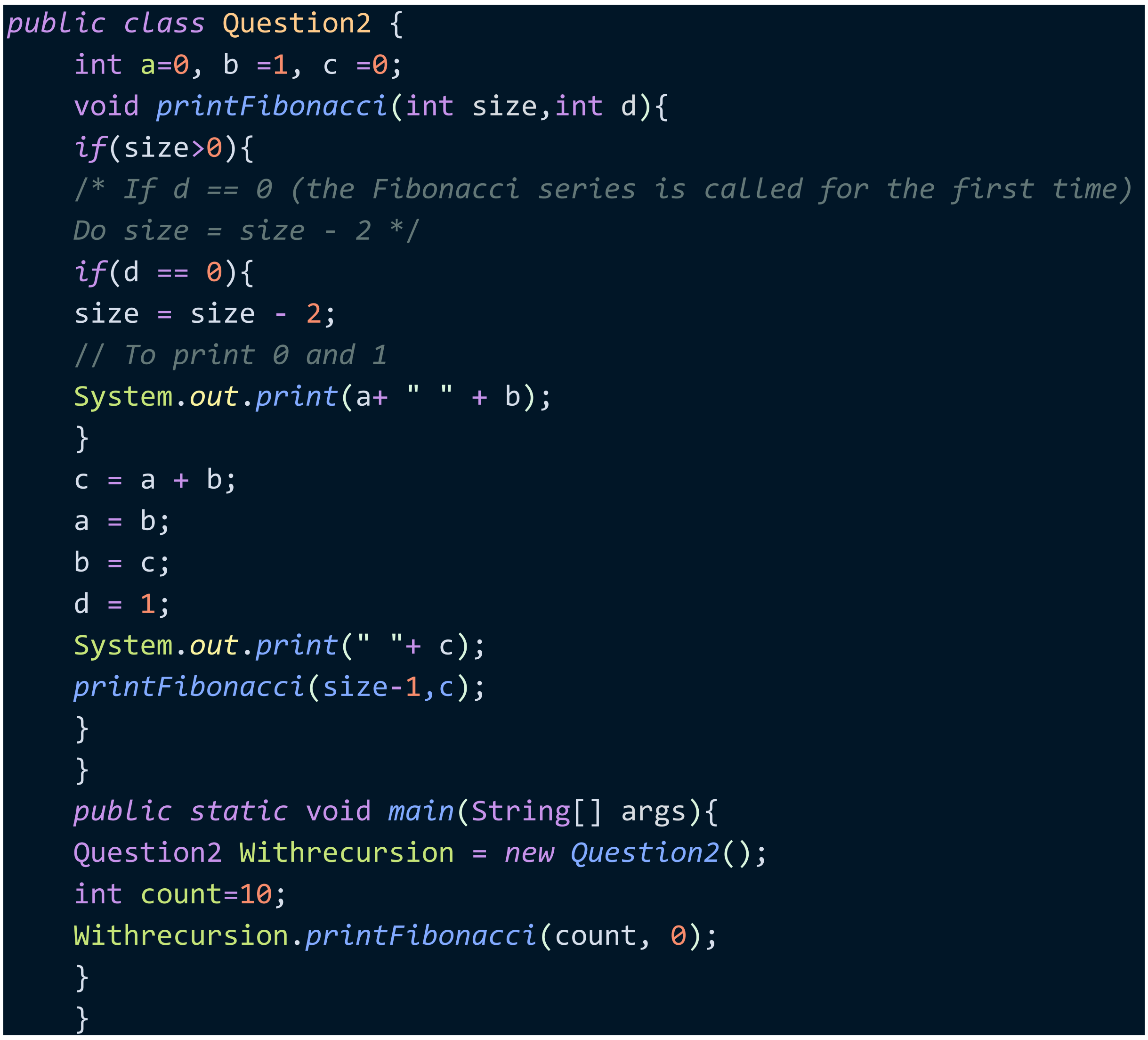
```
[Running] cd "d:\JAVA\" && javac Fibonacci.java && java Fibonacci
0 1 1 2 3 5 8 13 21 34
[Done] exited with code=0 in 0.958 seconds
```

- Fibonacci series is a series of numbers where the next number is the sum of previous two numbers starting with 0 and 1.
- We have taken two initial values f1 and f2 which will start the Fibonacci series and values in f1 and f2 initially will be printed to initialize the series and then f3 will store the output (i.e., sum of f1 and f2) in form of loop where (i<n).
- We have created a code in such a way that takes input in form of number of elements(n) in method 1.
- We have taken n = 10 as an input to number of elements in method 2.

2. Write java code to print Fibonacci series, upto 10 positions, with recursion.

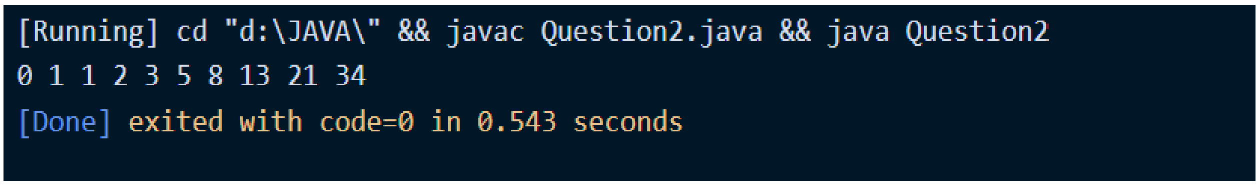
CODE:

Method 1:



```
public class Question2 {
    int a=0, b =1, c =0;
    void printFibonacci(int size,int d){
    if(size>0){
    /* If d == 0 (the Fibonacci series is called for the first time)
    Do size = size - 2 */
    if(d == 0){
    size = size - 2;
    // To print 0 and 1
    System.out.print(a+ " " + b);
    }
    c = a + b;
    a = b;
    b = c;
    d = 1;
    System.out.print(" "+ c);
    printFibonacci(size-1,c);
    }
    }
    public static void main(String[] args){
    Question2 Withrecursion = new Question2();
    int count=10;
    Withrecursion.printFibonacci(count, 0);
    }
    }
```

OUTPUT:



```
[Running] cd "d:\JAVA\" && javac Question2.java && java Question2
0 1 1 2 3 5 8 13 21 34
[Done] exited with code=0 in 0.543 seconds
```

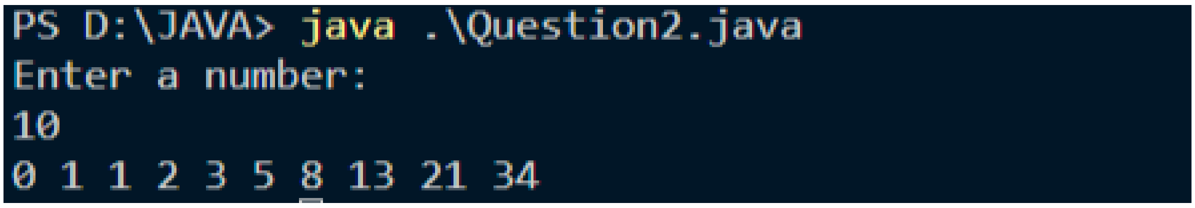
Explanation:

- The concept is same as the iterative approach but instead the function calls itself until size becomes 0.
- d is called to add the first two elements of Fibonacci series i.e., 0 & 1 and reduce the number of elements by 2 as 0 & 1 are already added.

Method 2:

```
// Show elements of Fibonacci series with recursion
// Take input as some element in form of n and put if condition in
such a way that when n is 0,1 or 2 then it will print null,0 and 1
respectively and when n is greater than 1 then it will print
Fibonacci series till nth element.

import java.util.Scanner;

public class Question2 {
    public static void main(String[] args) {
        Scanner sc = new Scanner(System.in);
        System.out.println("Enter a number: ");
        int n = sc.nextInt();
        if(n == 0) {
            System.out.println("null");
        }
        else if(n == 1) {
            System.out.println(0);
        }
        else if(n == 2) {
            System.out.println(1);
        }
        else {
            int a = 0;
            int b = 1;
            int c;
            System.out.print(a + " " + b + " ");

            for (int i = 2; i < n; i++) {
                c = a + b;
                a = b;
                b = c;
                System.out.print(c + " ");
            }

        }
}
}
```

OUTPUT:



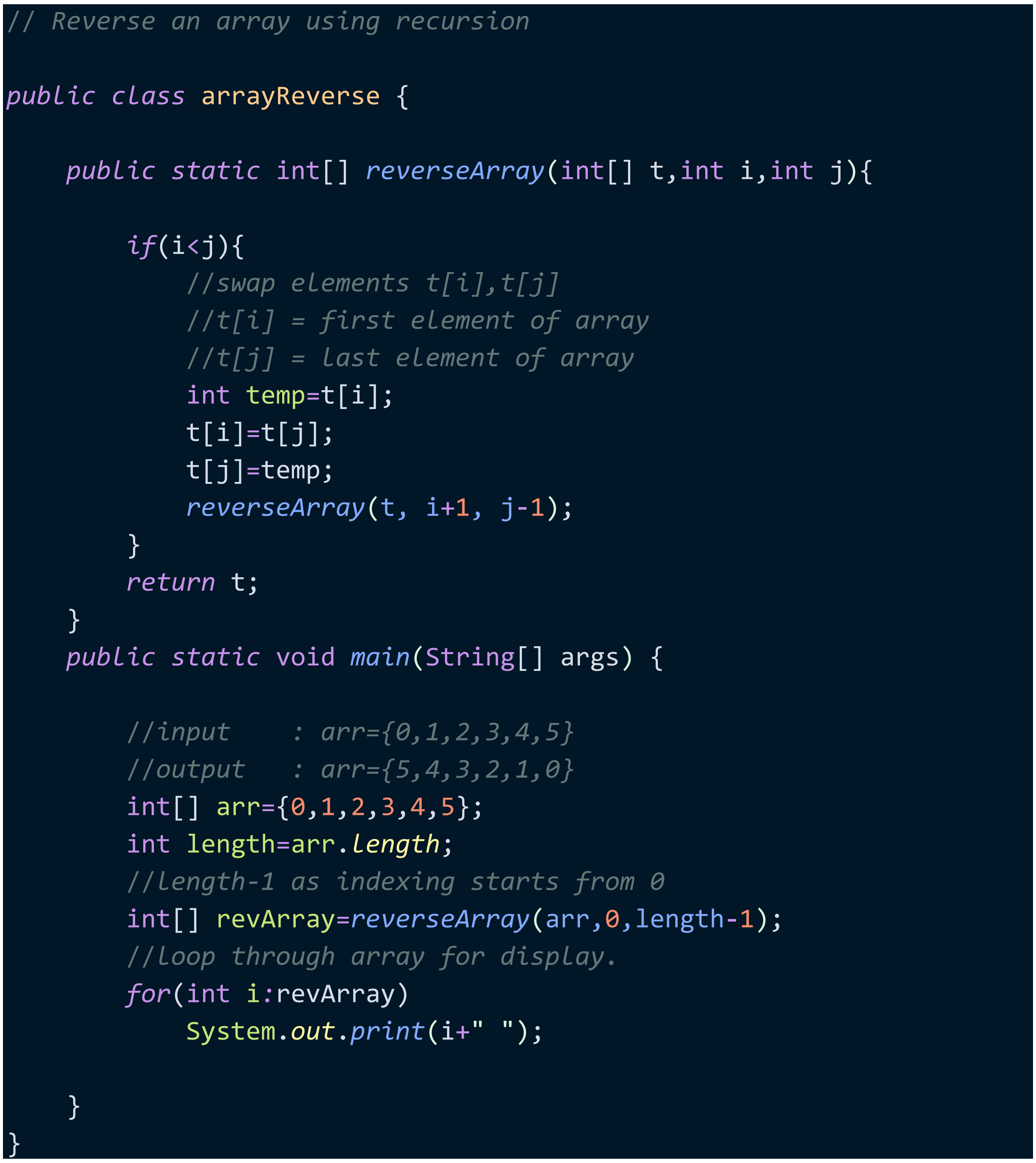
```
PS D:\JAVA> java .\Question2.java
Enter a number:
10
0 1 1 2 3 5 8 13 21 34
```

Explanation:

- We have created a code in such a way that takes input in form of number of elements(n) in method 1.
- We created multiple conditional statements which will give us output in form of recursion that is calling the function itself again and again.

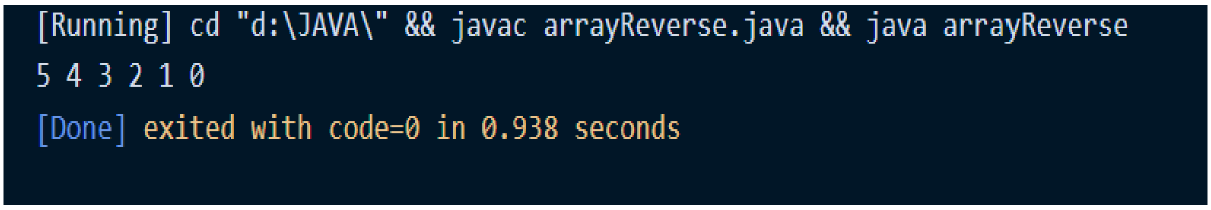
3. Write a java code to reverse an array using recursion.

CODE:



```java
// Reverse an array using recursion

public class arrayReverse {

    public static int[] reverseArray(int[] t,int i,int j){

        if(i<j){
            //swap elements t[i],t[j]
            //t[i] = first element of array
            //t[j] = last element of array
            int temp=t[i];
            t[i]=t[j];
            t[j]=temp;
            reverseArray(t, i+1, j-1);
        }
        return t;
    }
    public static void main(String[] args) {

        //input    : arr={0,1,2,3,4,5}
        //output   : arr={5,4,3,2,1,0}
        int[] arr={0,1,2,3,4,5};
        int length=arr.length;
        //length-1 as indexing starts from 0
        int[] revArray=reverseArray(arr,0,length-1);
        //loop through array for display.
        for(int i:revArray)
            System.out.print(i+" ");

    }
}
```

OUTPUT:



```
[Running] cd "d:\JAVA\" && javac arrayReverse.java && java arrayReverse
5 4 3 2 1 0
[Done] exited with code=0 in 0.938 seconds
```

Explanation:

- We have created a method named reverseArray with three input variables.
- If conditional statement is created which will swap elements if t[i] != t[j],
  elements will not be swapped if t[i] = t[j].
- Finally, we will increase i^{th} index and decrease j^{th} index by one as we move ahead and will return our array t.
- We create a main class in which we will give an input of which we get output.

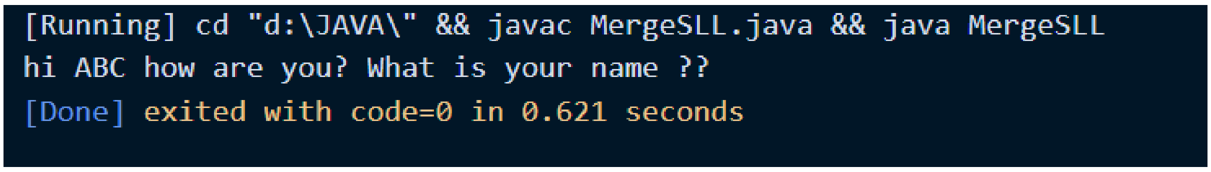
4. Write a java code to merge two single linked list. Consider the linked list with atleast 5 nodes.

CODE: Using String

```
public class MergeSLL {
    Node head;
    Node tail;
    static class Node{
    String data;
    Node next;
    // Constructor is used to create new nodes
    Node(String d){
    data = d;
    next = null;
    }
    }
    // To display the output to terminal
    public void DisplayList(){
    // Start from head
    Node node = head;
    /* While loop to traverse through the linked list.
    It will stop execution once the node is null.
    */
    while(node!=null){
    // node.data is used to access the data inside node
    System.out.print(node.data + " ");
    // proceed to next node
    node = node.next;
    }
    }
    // Method to add nodes to linked list
    void add(String data)
    {
    // Create a temp node to hold data
    Node temp = new Node(data);
    /* If head is null, then the temp node is supposed to be the
head.
    The head is only null if the linked list is empty
    */
    if(head == null){
    head = temp;
    }
```

```java
    /*
    Append nodes to the tail, than traversing through the whole
linked list the adding to final node.
    Appending by traversal will result in o(n) time complexity.
    */
    else if(tail != null){
    tail.next = temp;
    tail = tail.next;
    }
    else {
    tail = head.next = temp;
    }
    }
    public static void mergeLL(MergeSLL LList, MergeSLL LList2){
    // Create node and assign the second Linked List’s head to it.
    Node node = LList2.head;
    /* This will add nodes of LList2 to LList1 and exit once
    All the elements are added*/
    while(node != null){
    // Add the value from node of 2nd LList to tail of 1st LList
    LList.tail.next = node;
    LList.tail = LList.tail.next;
    node = node.next;
    }// Each Linked list contains atleast 5 nodes
    }
    public static void main(String[] args) {
    MergeSLL LList = new MergeSLL();
    MergeSLL LList2 = new MergeSLL();
    LList.add("hi");
    LList.add("ABC");
    LList.add("how");
    LList.add("are");
    LList.add("you?");
    LList2.add("What");
    LList2.add("is");
    LList2.add("your");
    LList2.add("name");
    LList2.add("??");
    mergeLL(LList, LList2);
    LList2 = null;
    LList.DisplayList();
    }
    }
```

OUTPUT:



```
[Running] cd "d:\JAVA\" && javac MergeSLL.java && java MergeSLL
hi ABC how are you? What is your name ??
[Done] exited with code=0 in 0.621 seconds
```

Explanation:

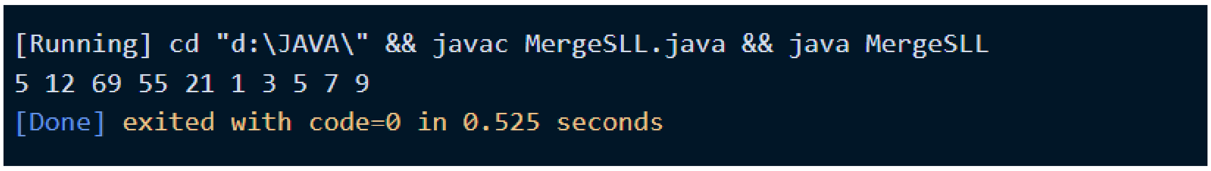
- A constructor is created which will be used to create linked list.
- A method (add) is created which will be used to add data in linked list.
- mergeLL method is used to point tail of linked list 1 to head of linked list 2.
- Using while loop we will append nodes in linked list 1 from linked list 2.
- Finally, we make LList2 data null so the memory is freed and LLists got merged.

CODE: Using integer

```
public class MergeSLL {
    Node head;
    Node tail;
    static class Node{
    int data;
    Node next;
    // Constructor is used to create new nodes
    Node(int data2){
    data = data2;
    next = null;
    }
    }
    // To display the output to terminal
    public void DisplayList(){
    // Start from head
    Node node = head;
    /* While loop to traverse through the linked list.
    It will stop execution once the node is null.
    */
    while(node!=null){
    // node.data is used to access the data inside node
    System.out.print(node.data + " ");
    // proceed to next node
    node = node.next;
    }
    }
    // Method to add nodes to linked list
    void add(int data)
    {
    // Create a temp node to hold data
    Node temp = new Node(data);
    /* If head is null, then the temp node is supposed to be the
head.
    The head is only null if the linked list is empty
    */
    if(head == null){
    head = temp;
    }
    /*
    Append nodes to the tail, than traversing through the whole
linked list then
    adding to final node.
    This approach will help to append new nodes with o(1) time
complexity.
    Appending by traversal will result in o(n) time complexity.
    */
    else if(tail != null){
    tail.next = temp;
    tail = tail.next;
    }
    else {
    tail = head.next = temp;
    }
    }
    public static void mergeLL(MergeSLL LList, MergeSLL LList2){
    // Create node and assign the second Linked List's head to it.
    Node node = LList2.head;
    /* This will add nodes of LList2 to LList1 and exit once
    All the elements are added*/
    while(node != null){
    // Add the value from node to tail of 1st LList
    LList.tail.next = node;
    LList.tail = LList.tail.next;
```

```java
node = node.next;
}
}
public static void main(String[] args) {
MergeSLL LList = new MergeSLL();
MergeSLL LList2 = new MergeSLL();
LList.add(5);
LList.add(12);
LList.add(69);
LList.add(55);
LList.add(21);
LList2.add(1);
LList2.add(3);
LList2.add(5);
LList2.add(7);
LList2.add(9);
mergeLL(LList, LList2);
LList2 = null;
LList.DisplayList();
}
}
```

OUTPUT:



```
[Running] cd "d:\JAVA\" && javac MergeSLL.java && java MergeSLL
5 12 69 55 21 1 3 5 7 9
[Done] exited with code=0 in 0.525 seconds
```

Explanation:

- Same as done with data type string, in this case data type is changed to int.

5. Write a java code to merge two double linked list. Consider the linked list with atleast 5 nodes.

CODE: Using String

```
// Merge two doubly linked lists and return the merged list.

public class DoublyLinkedList {
    Node head;
    Node tail;

    static class Node{
        String data;
        Node prev;
        Node next;

        Node(String d){
            data=d;
        }
    }
    public void add(String d){
        Node newNode = new Node(d);
        newNode.prev = null;
        newNode.next = head;

        if(head == null) {
            //Both head and tail will point to newNode
            head = tail = newNode;
            //head's previous will point to null
            head.prev = null;
            //tail's next will point to null, as it is the last node
of the list
            tail.next = null;
        }
        //Add newNode as new tail of the list
        else {
            //newNode will be added after tail such that tail's next
will point to newNode
            tail.next = newNode;
            //newNode's previous will point to tail
            newNode.prev = tail;
            //newNode will become new tail
```

```java
            tail = newNode;
            //As it is last node, tail's next will point to null
            tail.next = null;
        }
    }
    public void DisplayList(){
        // Start from head
        Node node = head;
        /* While loop to traverse through the linked list.
        It will stop execution once the node is null.
        */
        while(node!=null){
        // node.data is used to access the data inside node
        System.out.print(node.data + " ");
        // proceed to next node
        node = node.next;
        }
        }

    public static void mergeLL(DoublyLinkedList LList,
DoublyLinkedList LList2){
        Node node  = LList2.head;
        while(node != null){
            LList.tail.next = node;
            LList.tail.next.prev = LList.tail;
            LList.tail = LList.tail.next;
            node = node.next;
        }
    }
public static void main(String[] args) {
        DoublyLinkedList LList = new DoublyLinkedList();
        DoublyLinkedList LList2 = new DoublyLinkedList();

        LList.add("Hi");
        LList.add("XYZ");
        LList.add("have");
        LList.add("you");
        LList.add("completed");

        LList2.add("D");
        LList2.add("S");
        LList2.add("A");
        LList2.add("assignment");
        LList2.add("?");

        mergeLL(LList, LList2);

       LList.DisplayList();
    }
}
```

OUTPUT:

```
[Running] cd "d:\JAVA\" && javac DoublyLinkedList.java && java DoublyLinkedList
Hi XYZ have you completed D S A assignment ?
[Done] exited with code=0 in 1.373 seconds
```

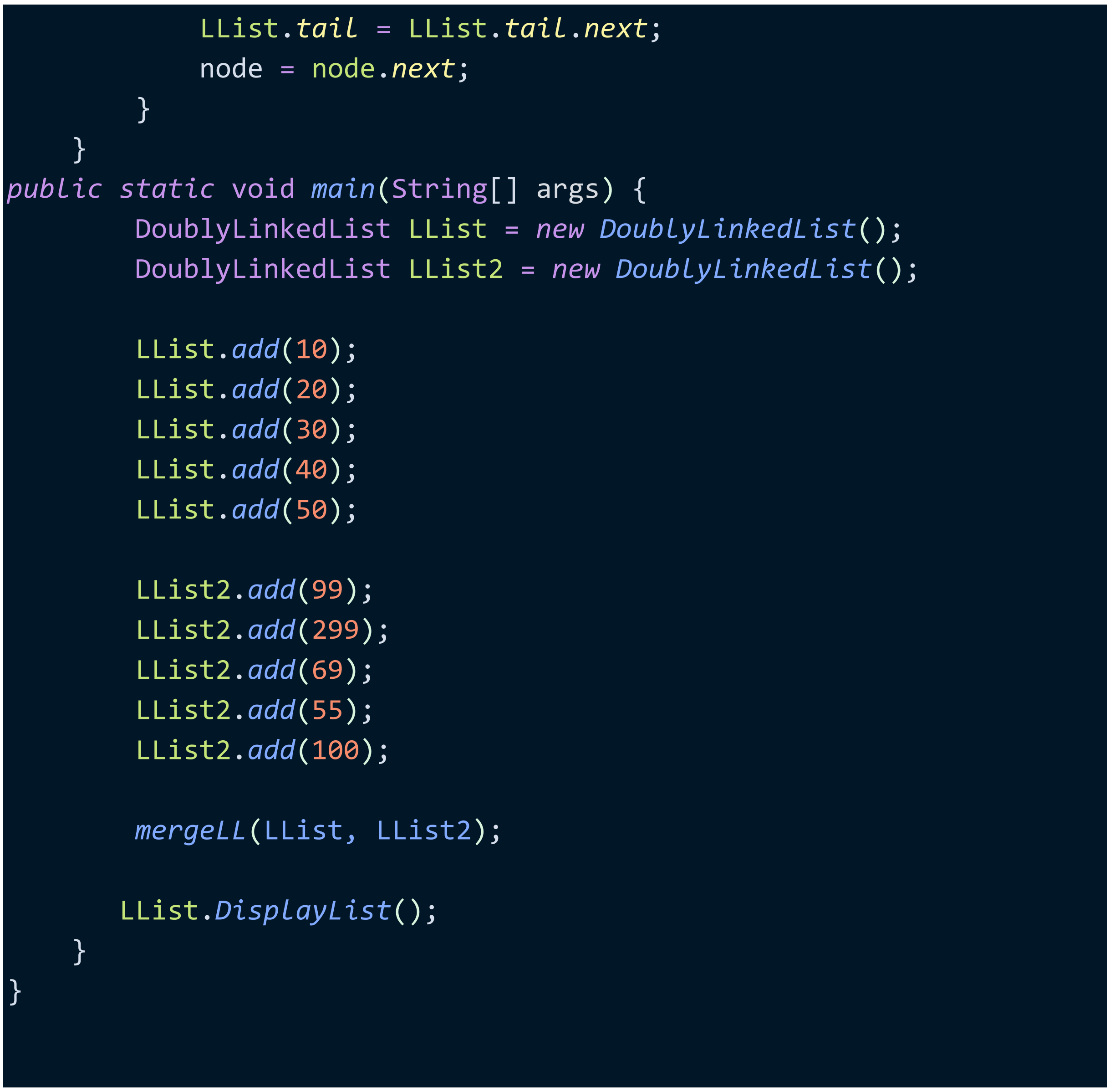
Explanation:

- A constructor is created which will be used to create linked list.
- A method (add) is created which will be used to add data in linked list.
- mergeLL method is used to point next of tail of linked list 1 to head of linked list 2 and previous of head of linked list 2 to tail of linked list 1.
- Using while loop we will append nodes in linked list 1 from linked list 2.

CODE:

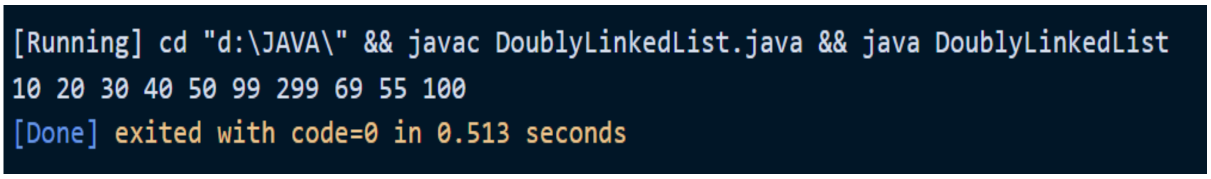
Using Integer

```
// Merge two doubly linked lists and return the merged list.

public class DoublyLinkedList {
    Node head;
    Node tail;

    static class Node{
        int data;
        Node prev;
        Node next;

        Node(int d){
            data=d;
        }
    }
    public void add(int d){
        Node newNode = new Node(d);
        newNode.prev = null;
        newNode.next = head;

        if(head == null) {
            //Both head and tail will point to newNode
            head = tail = newNode;
            //head's previous will point to null
            head.prev = null;
            //tail's next will point to null, as it is the last node
of the list
            tail.next = null;
        }
        //Add newNode as new tail of the list
        else {
            //newNode will be added after tail such that tail's next
will point to newNode
            tail.next = newNode;
            //newNode's previous will point to tail
            newNode.prev = tail;
            //newNode will become new tail
            tail = newNode;
            //As it is last node, tail's next will point to null
            tail.next = null;
        }
    }
    public void DisplayList(){
        // Start from head
        Node node = head;
        while(node!=null){
        // node.data is used to access the data inside node
        System.out.print(node.data + " ");

        node = node.next;
        }
        }

    public static void mergeLL(DoublyLinkedList LList,
DoublyLinkedList LList2){
        Node node  = LList2.head;
        while(node != null){
            LList.tail.next = node;
            LList.tail.next.prev = LList.tail;
```



```
            LList.tail = LList.tail.next;
            node = node.next;
        }
    }
public static void main(String[] args) {
        DoublyLinkedList LList = new DoublyLinkedList();
        DoublyLinkedList LList2 = new DoublyLinkedList();

        LList.add(10);
        LList.add(20);
        LList.add(30);
        LList.add(40);
        LList.add(50);

        LList2.add(99);
        LList2.add(299);
        LList2.add(69);
        LList2.add(55);
        LList2.add(100);

        mergeLL(LList, LList2);

       LList.DisplayList();
    }
}
```

OUTPUT:



```
[Running] cd "d:\JAVA\" && javac DoublyLinkedList.java && java DoublyLinkedList
10 20 30 40 50 99 299 69 55 100
[Done] exited with code=0 in 0.513 seconds
```

6. Write a java code to arrange the elements of stack in increasing order.

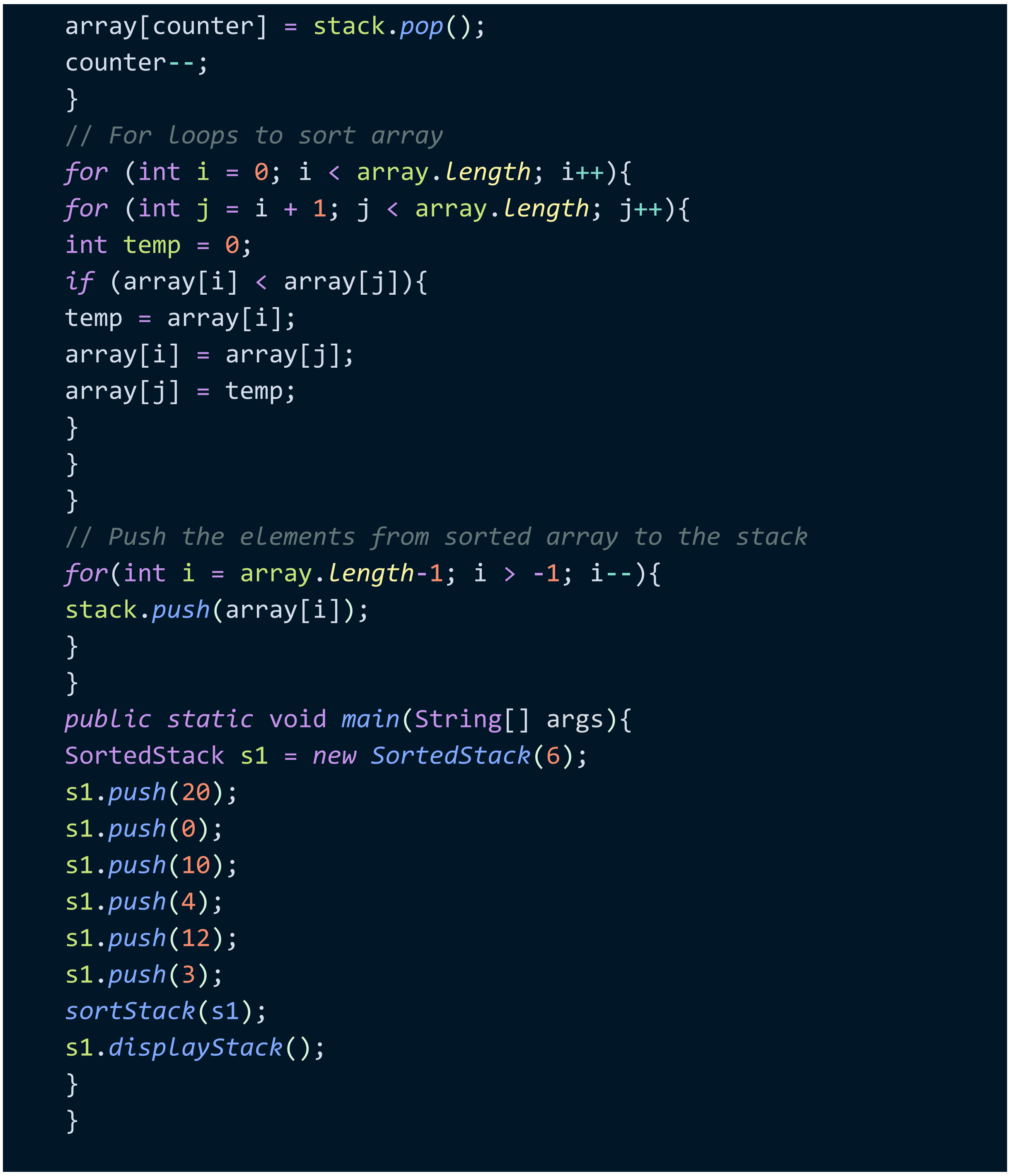
5	3
4	12
3	4
2	10
1	0
0	20

First column indicates the index location and second column indicates the value in the stack.

CODE: Using Array

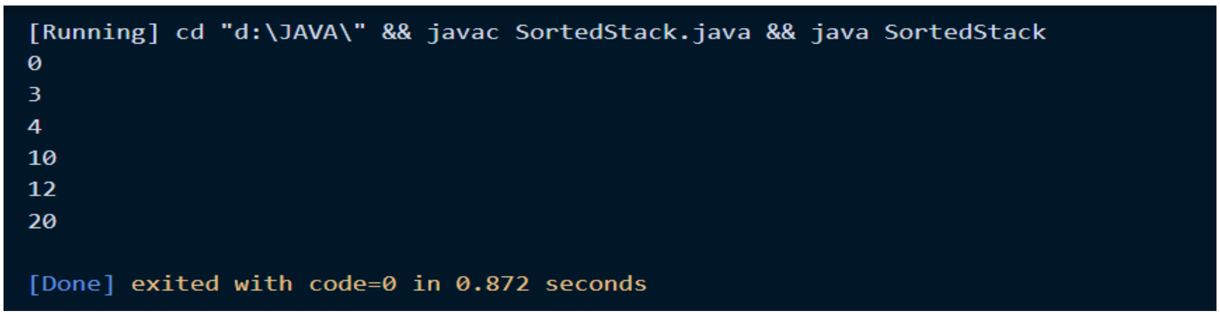
```java
// Sort the stack elements in increasing order.

public class SortedStack {
    // The stack is created using arrays
    public int [] array;
    public int top;
    public int length;
    // Constructor to create stack of dimension provided as
argument.
    SortedStack(int dim){
    array = new int [dim];
    length = dim;
    // Top is maintained, the default value is -1 (no elements)
    top = -1;
    }
    // Method for pushing element to Stack
    public void push(int data){
    // Check if Stack is full. If yes, exit
    if(isFull()){
    System.out.println("Stack Full");
    System.exit(1);
    }
```

```
// Increment the Stack pointer
top = top+1;
array[top] = data;
}
// Method to pop element from Stack
public int pop(){
// Check if stack is empty. If yes, exit.
if(isEmpty()){
System.out.println("Stack Empty");
System.exit(1);
}
// Decrement the stack pointer
top = top - 1;
// Return the popped value
return array[top+1];
}
// Method to check if the Stack is full
public boolean isFull(){
/* If Stack Pointer is = length -1 then the Stack is full
and this method will return true. */
return top==(length-1);
}
// Method to check if the Stack is full
public boolean isEmpty(){
// If Stack Pointer is -1, the Stack is empty.
return top==-1;
}
// Method to print the values in Stack
public void displayStack(){
// Same as traversing an array
for(int i = 0; i < top+1; i++){
System.out.println(array[i]);
}
}
public static void sortStack(SortedStack stack){
// Create an array of stack's length
int [] array = new int[stack.length];
// An array index counter
int counter = stack.length-1;
// While stack is not empty, execute this loop
while(!stack.isEmpty()){
// Pop element from stack and put it into array
```



```
array[counter] = stack.pop();
counter--;
}
// For loops to sort array
for (int i = 0; i < array.length; i++){
for (int j = i + 1; j < array.length; j++){
int temp = 0;
if (array[i] < array[j]){
temp = array[i];
array[i] = array[j];
array[j] = temp;
}
}
}
// Push the elements from sorted array to the stack
for(int i = array.length-1; i > -1; i--){
stack.push(array[i]);
}
}
public static void main(String[] args){
SortedStack s1 = new SortedStack(6);
s1.push(20);
s1.push(0);
s1.push(10);
s1.push(4);
s1.push(12);
s1.push(3);
sortStack(s1);
s1.displayStack();
}
}
```

OUTPUT:

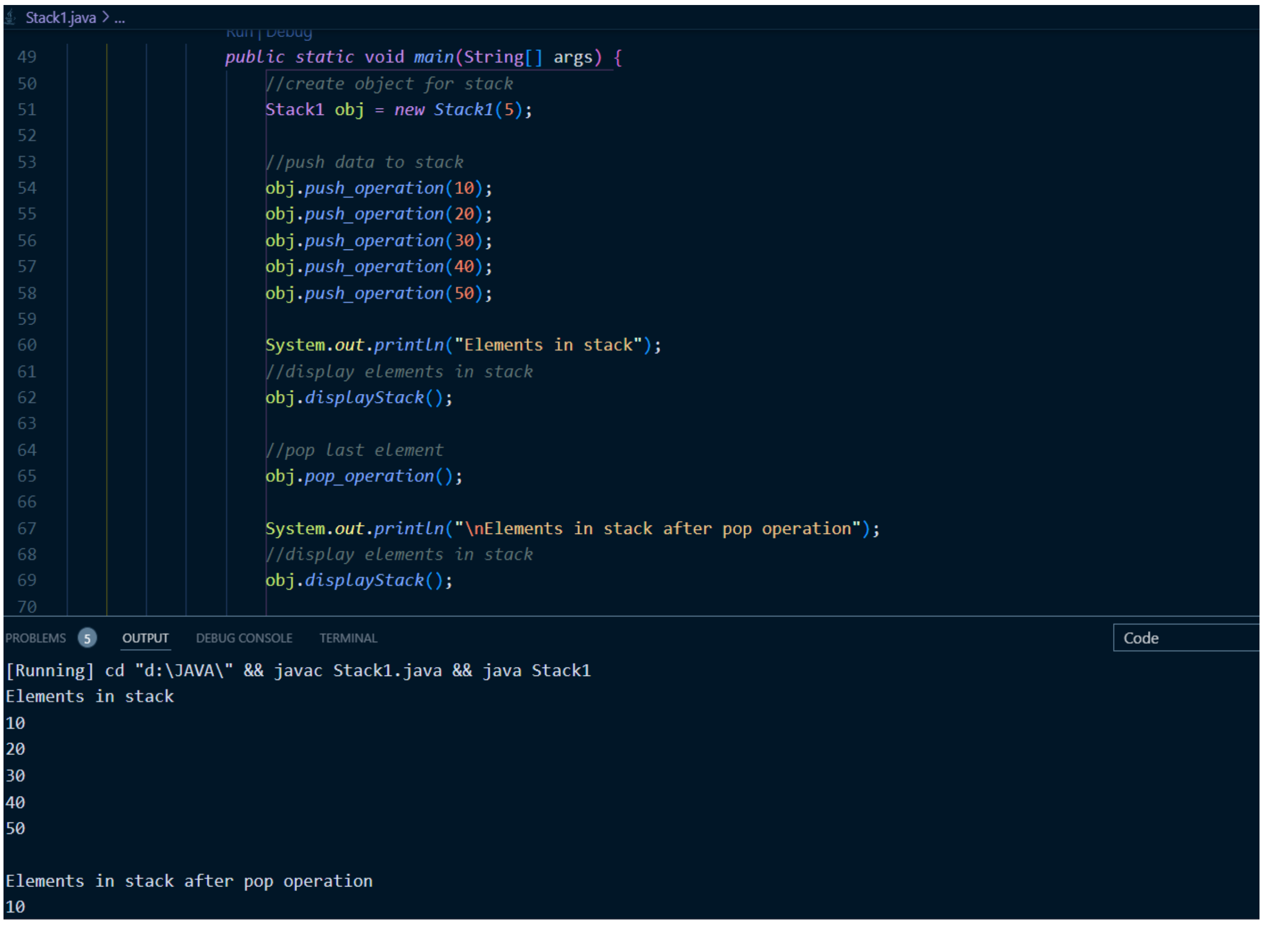


```
[Running] cd "d:\JAVA\" && javac SortedStack.java && java SortedStack
0
3
4
10
12
20

[Done] exited with code=0 in 0.872 seconds
```

Explanation:

- We create a stack using array method, where we initialize push, pop, if full, if empty, display method.
- We create our required method that is sorting the elements of stack in ascending order (increasing order).
- In sorting method, we create an array to store the elements of input stack in sorted form and then that method after sorting will put the elements back into the stack.

NOTE: Stack output is given in form where 0th index element comes topmost and so on. Take the image posted below as reference:



```java
    public static void main(String[] args) {
        //create object for stack
        Stack1 obj = new Stack1(5);

        //push data to stack
        obj.push_operation(10);
        obj.push_operation(20);
        obj.push_operation(30);
        obj.push_operation(40);
        obj.push_operation(50);

        System.out.println("Elements in stack");
        //display elements in stack
        obj.displayStack();

        //pop last element
        obj.pop_operation();

        System.out.println("\nElements in stack after pop operation");
        //display elements in stack
        obj.displayStack();

```

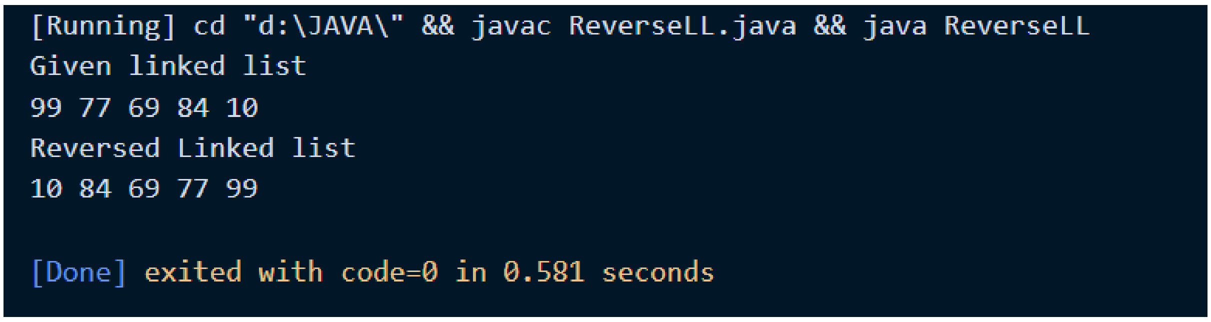
```
[Running] cd "d:\JAVA\" && javac Stack1.java && java Stack1
Elements in stack
10
20
30
40
50

Elements in stack after pop operation
10
```

7. Write a java code to reverse single linked list using recursion. Explain each step-in recursion graphically.

CODE:

```java
// Recursive Java program to reverse a linked list
class ReverseLL {
    static Node head; // head of list

    static class Node {
        int data;
        Node next;
        Node(int d)
        {
            data = d;
            next = null;
        }
    }

    static Node reverse(Node head)
    {
        if (head == null || head.next == null)
            return head;

        /* reverse the rest list and put
        the first element at the end */
        Node rest = reverse(head.next);
        head.next.next = head;

        head.next = null;

        /* fix the head pointer */
        return rest;
    }

    /* Function to print linked list, we created a temporary list */
    static void print()
    {
        Node temp = head;
        while (temp!= null) {
            System.out.print(temp.data + " ");
            temp = temp.next;
        }
        System.out.println();
    }

    static void push(int data)
    {
        Node temp = new Node(data);
        temp.next = head;
        head = temp;
    }


public static void main(String args[])
{
    /* Start with the empty list */

    push(10);
    push(84);
    push(69);
    push(77);
    push(99);

    System.out.println("Given linked list");
    print();

    head = reverse(head);

    System.out.println("Reversed Linked list");
    print();
}
}
```

OUTPUT:

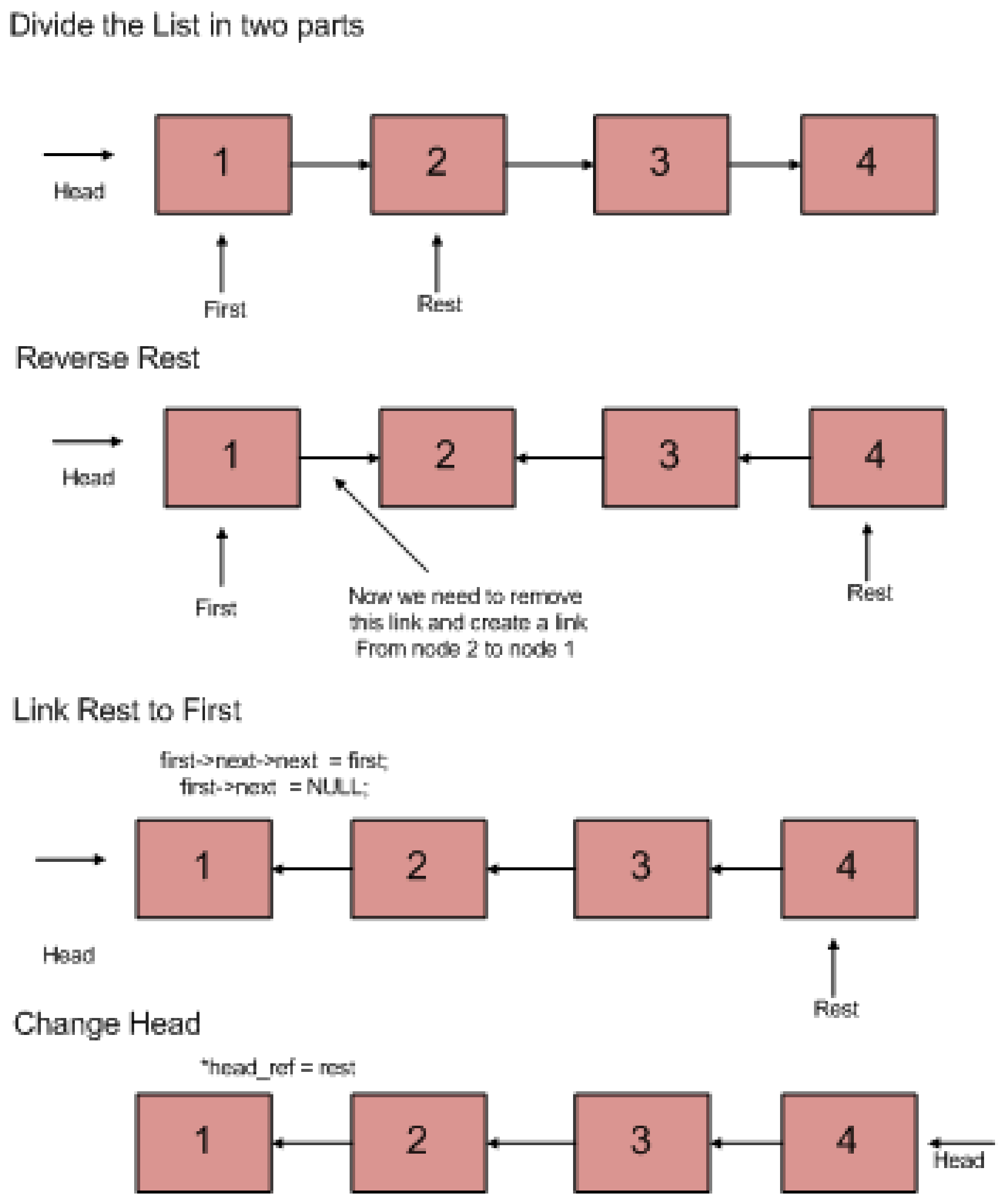


```
[Running] cd "d:\JAVA\" && javac ReverseLL.java && java ReverseLL
Given linked list
99 77 69 84 10
Reversed Linked list
10 84 69 77 99

[Done] exited with code=0 in 0.581 seconds
```

Explanation:

- We initialized a single linked list with integer as data type.
- We divided our single linked list into two parts, one is first node and other being rest of the list.
- We fixed the head and then We reverse the pointer of second part of division i.e., nodes other than first.
- We link rest of the nodes to first after reversing and then finally give the head to the last node.
- We created a temporary linked list and printed the data after reversing it recursively.

Graphical Image:



THANK YOU!