"Experiment 1.4"

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Part 1.1

1. Aim/Overview of the practical:

Code to Insert and Delete an element at the beginning and at end in Doubly Linked List.

2. Algorithm/Flowchart (For programming based labs):

i. Insertion at beginning:

START
Step 1: If head = NULL,
initialize head->val = val, head->prev and head->next = NULL,
go to step 3.

Step 2: If head not = NULL,
intialize temp->val = val
temp->prev = NULL
temp->next = head
head->prev = temp
head = temp

Step 3: New node is inserted at beginning.
END

ii. Insertion at end:

START
Step 1: If head = NULL,
initialize head->val = val, head->prev and head->next = NULL,
go to step 4.

Step 2: If head not = NULL,
temp = head
while temp->next not = NULL, do temp = temp->next

Step 3: Intialize temp->next->val = val
temp->next->prev = temp
temp->next->next = NULL

Step 4: New node is inserted at end.
END

iii. Insertion after specific node:

START
Step 1: If head = NULL,
initialize head->val = val, head->prev and head->next = NULL,
go to step 4.

Step 2: If head not = NULL,
temp = head
while temp->val not = entry_node, do temp = temp->next

Step 3: Intialize new_node->val = val
temp->next->prev = new_node
new_node->next = temp->next
temp->next = new_node, new_node->prev = temp

Step 4: New node is inserted at end.
END

iv. Deletion at beginning:

START
Step 1: If head = NULL,
print Underflow
go to step 3.

Step 2: If head not = NULL,
head = head->next
head->prev = NULL

Step 3: New node is deleted at beginning, unless there is Underflow condition.
END

v. Deletion at end:

START
Step 1: If head = NULL,
print Underflow
go to step 3.

Step 2: If head not = NULL,
temp = head
while temp->next not = NULL, do node = temp->next
temp->prev->next = NULL

Step 3: New node is deleted at end, unless there is Underflow condition.
END

vi. Deletion of certain node:

START
Step 1: If head = NULL,
    print Underflow
    go to step 3.

Step 2: If head not = NULL,
    temp = head
    while temp->next not = req_node, do node = temp->next
    temp->next->prev = temp.prev
    temp->prev->next = temp.next

Step 3: Required node is deleted, unless there is Underflow condition.
END

4. Steps for experiment/practical/Code:

```
import java.util.*;
class Node {
        Node left, right;
        int val;
        Node(int val) {
                this.val = val;
        }
}

public class Test {
        Node head;

        void deleteend() {
                Node node = head;
                while(node.right!=null) {
                        node = node.right;
                }
                node.left.right = null;
```

```
}

void deletebeg() {
        head = head.right;
        head.left = null;
}

void delete(int val) {
        Node node = head;
        while(node.val!=val) {
                node = node.right;
        }
        node.right.left = node.left;
        node.left.right = node.right;
}

void insertbeg(int val) {
        if(head==null) {
                head = new Node(val);
                head.left = null;
                head.right = null;
                return;
        }
        Node node = new Node(val);
        node.left = null;
        node.right = head;
        head.left = node;
        head = node;
}

void insertafter(int val, int x) {
        Node node = head;
        while(node.val!=val) {
                node = node.right;
        }
        Node ins = new Node(x);
        node.right.left = ins;
        ins.right = node.right;
```

```
		node.right = ins;
		ins.left = node;
	}

	void insert(int val) {
		if(head==null) {
			head = new Node(val);
			head.left = null;
			head.right = null;
			return;
		}
		Node node = head;
		while(node.right!=null) {
			node = node.right;
		}
		node.right = new Node(val);
		node.right.left = node;
		node.right.right = null;
	}

	void print() {
		Node node = head;
		while(node!=null) {
			System.out.print(node.val+" ");
			node = node.right;
		}
	}
	public static void main(String args[]) {
		Test ob = new Test();
		Scanner in = new Scanner(System.in);
		ob.insert(1);
		ob.insert(2);
		ob.insert(3);
		ob.print();
		ob.insertbeg(4);
		System.out.println();
		ob.print();
		ob.insertafter(2, 5);
```

```
                System.out.println();
                ob.print();
                ob.delete(1);
                System.out.println();
                ob.print();
                ob.deletebeg();
                System.out.println();
                ob.print();
                ob.deleteend();
                System.out.println();
                ob.print();
        }
}
```

5. Observations/Discussions/ Complexity Analysis:

Insertion/Deletion at beginning happens in O(1) time. Insertion/Deletion at end or after will take O(n) time, but this can be done in O(1) time if we maintain a tail node, which will store the current last node in the list.

6. Result/Output/Writing Summary:

```
PROBLEMS 4    OUTPUT    DEBUG CONSOLE    TERMINAL

PS E:\work\java> cd "e:\work\java\" ; if ($?) { javac Test.java } ; if ($?) { java Test }
After insertion at end: 1 2 3
After insertion at beginning: 4 1 2 3
After insertion of 5 after node->val 2: 4 1 2 5 3
After deletion of node->val 1: 4 2 5 3
After deletion at beginning: 2 5 3
After deletion at end: 2 5
PS E:\work\java>
```

Part 1.2

1. Aim/Overview of the practical:

Code to Insert and Delete an element at the beginning and at end in Circular Linked List.

2. Algorithm/Flowchart (For programming based labs)**:**

i. Insertion at beginning:

START
Step 1: If head = NULL,
    initialize head->val = val, head->next = head,
    go to step 3.

Step 2: If head not = NULL,
    temp = head->next
    Initialize head->next->val = val
    head->next->next = temp

Step 3: New node is inserted at beginning.
END

ii. Insertion at end:

START
Step 1: If head = NULL,
    initialize head->val = val, head->next = head,
    go to step 4.

Step 2: If head not = NULL,
    temp = head
    while temp->next not = head, do temp = temp->next

Step 3: Intialize temp->next->val = val
temp->next->prev = temp
temp->next->next = NULL

Step 4: New node is inserted at end.
END

iii. Deletion at beginning:

START
Step 1: If head = NULL,
print Underflow
go to step 2.

Step 2: If head->next = head
head = head->next = NULL

Step 3: If head not = NULL,
head->next = head->next->next

Step 4: New node is deleted at beginning, unless there is Underflow condition.
END

iv. Deletion at end:

START
Step 1: If head = NULL,
print Underflow
go to step 3.

Step 2: If head not = NULL,
temp = head

while temp->next->next not = head, do node = temp->next
temp->next = head

Step 3: New node is deleted at end, unless there is Underflow condition.
END

4. Steps for experiment/practical/Code:

```
import java.util.*;

class Node {
	Node next;
	int val;
	Node(int val) {
		this.val = val;
	}
}
public class Test {
	Node head;

	void deletebeg() {
		if(head==null) {
			System.out.println("Underflow");
			return;
		}
		else if(head.next==head) {
			head = null;
			head.next = null;
			return;
		}
		head.next = head.next.next;
	}

	void deleteend() {
		if(head==null) {
			System.out.println("Underflow");
			return;
```

```
        }
        else if(head.next==head) {
                head = null;
                head.next = null;
                return;
        }
        Node node = head;
        while(node.next.next!=head)
                node = node.next;
        node.next = head;
}

void insertend(int val) {
        if(head==null) {
                head = new Node(val);
                head.next = head;
                return;
        }
        Node node = head;
        while(node.next!=head) {
                node = node.next;
        }
        node.next = new Node(val);
        node.next.next = head;
}

void insertbeg(int val) {
        if(head==null) {
                head = new Node(val);
                head.next = head;
                return;
        }
        Node temp = head.next;
        head.next = new Node(val);
        head.next.next = temp;
}

public void display() {
```

```
        Node node = head;
        while(node.next!=head) {
            System.out.print(node.val+" ");
            node = node.next;
        }
        System.out.println(node.val+"-> "+head.val+"...\n");
    }
    public static void main(String args[]) {
        Test ob = new Test();
        ob.insertend(1);
        ob.insertend(2);
        ob.insertend(3);
        ob.insertend(4);
        ob.insertend(5);
        System.out.print("List after inserting elements at end: ");
        ob.display();
        System.out.print("After inserting 6 at the beginning: ");
        ob.insertbeg(6);
        ob.display();
        System.out.print("After deleting at beginning: ");
        ob.deletebeg();
        ob.display();
        System.out.print("After deleting at end: ");
        ob.deleteend();
        ob.display();
    }
}
```

5. Observations/Discussions/ Complexity Analysis:

Insertion/Deletion at beginning happens in O(1) time. Insertion/Deletion at end will take O(n) time, but similar to doubly linked list, this can be done in O(1) time if we maintain a tail node, which will store the current last node in the list.

6. Result/Output/Writing Summary:

```
PROBLEMS 3    OUTPUT    DEBUG CONSOLE    TERMINAL

PS E:\work\java> cd "e:\work\java\" ; if ($?) { javac Test.java } ; if ($?) { java Test }
List after inserting elements at end: 1 2 3 4 5-> 1...

After inserting 6 at the beginning: 1 6 2 3 4 5-> 1...

After deleting at beginning: 1 2 3 4 5-> 1...

After deleting at end: 1 2 3 4-> 1...
```

Part 2

1. Aim:

Code to push & pop and check Isempty, Isfull, and return top element in stacks.

2. Algorithm:

i. Push:

START
Step 1: If isFull() = true,
    print Overflow
    go to step 3.

Step 2: Else,
    Initialize temp->val = val
    temp->next = head
    head = temp;
    size = size + 1

Step 3: New element is pushed on top stack, unless there is overflow condition.
END

ii. Pop

START
Step 1: If isEmpty() = true,
    print Underflow
    go to step 3.

Step 2: Else,
    head = head->next

Step 3: Top element is popped from stack, unless there is underflow condition.
END

iii. isFull

START
Step 1: If size = max
return true

Step 2: Else
return false
END

iv. isEmpty

START
Step 1: If size = 0
return true

Step 2: Else
return false
END

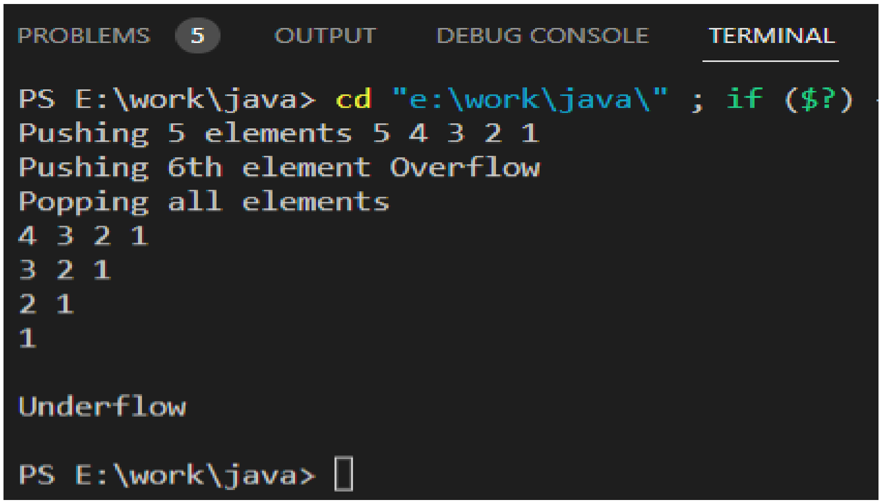
3. Code:

```
class Node {
	Node next;
	int val;
	Node(int val) {
		this.val = val;
	}
```

```
}
public class Test {
	int h=0, max=5;
	Node head=null;

	void push(int val) {
		if(h==max) {
			System.out.println("Overflow");
			return;
		}
		Node node = new Node(val);
		node.next = head;
		head = node;
		h++;
	}

	void pop() {
		if(h==0) {
			System.out.println("Underflow");
			return;
		}
		head = head.next;
		h--;
	}

	int peek() {
		return head.val;
	}

	void display() {
		Node node = head;
		while(node!=null) {
			System.out.print(node.val+" ");
			node = node.next;
		}
		System.out.println();
	}
```

```
    public static void main(String args[]) {
        Test ob = new Test();
        ob.push(1);
        ob.push(2);
        ob.push(3);
        ob.push(4);
        ob.push(5);
        ob.display();
        ob.push(6);
        ob.pop();
        ob.display();
        ob.pop();
        ob.display();
        ob.pop();
        ob.display();
        ob.pop();
        ob.display();
        ob.pop();
        ob.display();
        ob.pop();
        ob.display();
    }
}
```

4. Output:



5. Complexity Analysis:

All operations happen in O(1) as only 1 element is accessed whose location is always known, i.e. the first element.

Learning outcomes (What I have learnt):

1. Learnt about doubly and circular linked list data structures and their applications.
2. Learnt how implement linked lists in java using classes and objects in java.
3. Learnt about Stack data structure and how to implement it in a program using linked list in java.

Evaluation Grid (To be created as per the SOP and Assessment guidelines by the faculty):

Sr. No.	Parameters	Marks Obtained	Maximum Marks
1.			
2.			
3.			