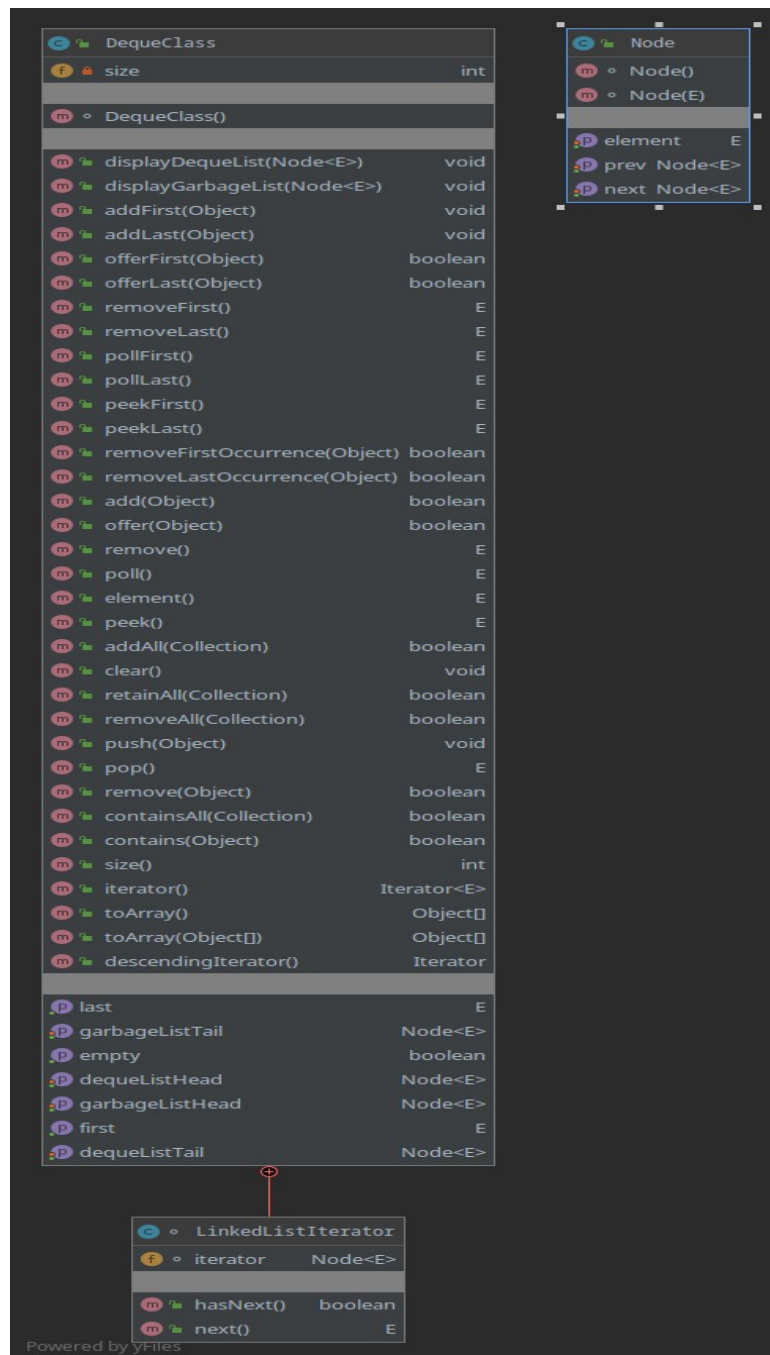


DATA STRUCTURE AND
ALGORITHM
HW04

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PART02

UML:



PROBLEM SOLUTION APPROACH:

since we were asked to implement deque interface and overload desired methods from that interface I have implemented them according to the linkedlist that we created inside over DequeClass.

I make use of double linked list with each node having next and previous references in order to access the head tail and add and remove in constant time.

I have two linkedlist one for keeping actual data one for avoiding garbage collection and creating new node when it's needed as soon as we have at least one node in out garbageLinkedList.

I make use of try catch mechanism in order to avoid any possible Exception and not to crash programs until it's last input possible.

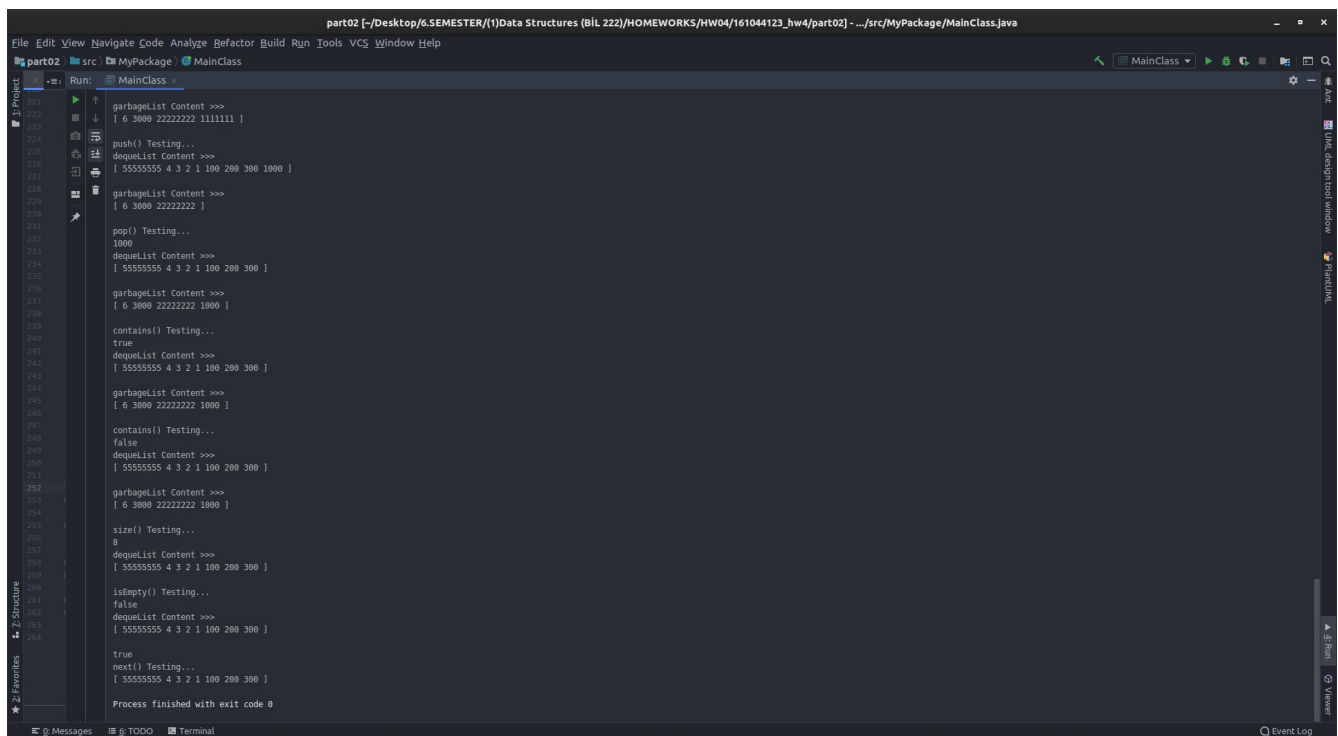
While compiling code I make use of idea called intelli j .
in iterator part I have an inner class for iterator which iterates through DequeLinkedList.

COMMAND LINE RESULTS:

```
part02 [-/Desktop/6.SEMESTER/(1)Data Structures (BIL 222)/HOMEWORKS/HW04/part02] - .../src/MyPackage/MainClass.java
File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
part02 src MyPackage MainClass
Run: MainClass
/opt/jdk-13.0.2/bin/java -javaagent:/snap/intellij-idea-educational/18/lib/idea_rt.jar=33257:/snap/intellij-idea-educational/18/bin -Dfile.encoding=UTF-8 -classpath "/home/ashraf/Desktop/6.SEMESTER/(1)Data Structures (BIL 222)/HOMEWORKS/HW04/part02/out/production/hw04_part02" MyPackage.MainClass
removeFirst() Testing...
dequeList Content >>>
[ ]
garbageList Content >>>
[ ]
removeLast() Testing...
dequeList Content >>>
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garbageList Content >>>
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pollFirst() Testing...
dequeList Content >>>
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garbageList Content >>>
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pollLast() Testing...
dequeList Content >>>
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garbageList Content >>>
[ ]
addFirst() Testing...
dequeList Content >>>
[ 3 2 1 ]
garbageList Content >>>
[ ]
addLast() Testing...
dequeList Content >>>
[ 3 2 1 100 200 300 ]
garbageList Content >>>
[ ]
offerFirst() Testing...
dequeList Content >>>
[ 6 5 4 3 2 1 100 200 300 ]
garbageList Content >>>
[ ]
offerLast() Testing...
```

```
part02 [-/Desktop/6.SEMESTER/(1)Data Structures (BIL 222)/HOMEWORKS/HW04/part02] - .../src/MyPackage/MainClass.java
File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
part02 src MyPackage MainClass
Run: MainClass
offerLast() Testing...
dequeList Content >>>
[ 6 5 4 3 2 1 100 200 300 1000 2000 3000 ]
garbageList Content >>>
[ ]
removeFirst() Testing...
Removed Item : 6
dequeList Content >>>
[ 5 4 3 2 1 100 200 300 1000 2000 3000 ]
garbageList Content >>>
[ 6 ]
removeLast() Testing...
Removed Item : 3000
dequeList Content >>>
[ 5 4 3 2 1 100 200 300 1000 2000 ]
garbageList Content >>>
[ 6 3000 ]
pollFirst() Testing...
Polled Item : 5
dequeList Content >>>
[ 4 3 2 1 100 200 300 1000 2000 ]
garbageList Content >>>
[ 6 3000 5 ]
pollLast() Testing...
Polled Item : 2000
dequeList Content >>>
[ 4 3 2 1 100 200 300 1000 ]
garbageList Content >>>
[ 6 3000 5 2000 ]
getFirst() Testing...
get Item : 4
dequeList Content >>>
[ 4 3 2 1 100 200 300 1000 ]
garbageList Content >>>
[ 6 3000 5 2000 ]
getLast() Testing...
get Item : 1000
dequeList Content >>>
[ 3 2 1 100 200 300 1000 ]
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```
part02 [-/Desktop/6.SEMESTER/(1)Data Structures (Bil. 222)/HOMEWORK5/HW04/part02] - .../src/MyPackage/MainClass.java
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part02 src MyPackage MainClass
Run: MainClass
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```



```
part02 [-/Desktop/6.SEMESTER(1)Data Structures (BIL 222)/HOMEWORKS/HW04/161044123_hw4/part02] - .../src/MyPackage/MainClass.java
File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
part02 src MyPackage MainClass
Run: MainClass
221 garbageList Content >>>
222 [ 6 3000 2222222 1111111 ]
223
224 push() Testing...
225 dequeList Content >>>
226 [ 55555555 4 3 2 1 100 200 300 1000 ]
227
228 garbageList Content >>>
229 [ 6 3000 2222222 ]
230
231 pop() Testing...
232 1000
233 dequeList Content >>>
234 [ 55555555 4 3 2 1 100 200 300 ]
235
236 garbageList Content >>>
237 [ 6 3000 2222222 1000 ]
238
239 contains() Testing...
240 true
241 dequeList Content >>>
242 [ 55555555 4 3 2 1 100 200 300 ]
243
244 garbageList Content >>>
245 [ 6 3000 2222222 1000 ]
246
247 contains() Testing...
248 false
249 dequeList Content >>>
250 [ 55555555 4 3 2 1 100 200 300 ]
251
252 garbageList Content >>>
253 [ 6 3000 2222222 1000 ]
254
255 size() Testing...
256 8
257 dequeList Content >>>
258 [ 55555555 4 3 2 1 100 200 300 ]
259
260 isEmpty() Testing...
261 false
262 dequeList Content >>>
263 [ 55555555 4 3 2 1 100 200 300 ]
264
265 true
266 next() Testing...
267 [ 55555555 4 3 2 1 100 200 300 ]
268
269 Process finished with exit code 0
```

TEST CASES:

```
System.out.println("removeFirst() Testing...");
System.out.println("dequeList Content >>> ");
myObject.displayDequeList(myObject.getDequeListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//removeLast()
System.out.println("removeLast() Testing...");
System.out.println("dequeList Content >>> ");
myObject.displayDequeList(myObject.getDequeListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//pollFirst()
System.out.println("pollFirst() Testing...");
System.out.println("dequeList Content >>> ");
myObject.displayDequeList(myObject.getDequeListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//pollLast()
System.out.println("pollLast() Testing...");
System.out.println("dequeList Content >>> ");
myObject.displayDequeList(myObject.getDequeListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//addFirst()
System.out.println("addFirst() Testing...");
myObject.addFirst(1);
myObject.addFirst(2);
myObject.addFirst(3);
System.out.println("dequeList Content >>> ");
myObject.displayDequeList(myObject.getDequeListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//addLast()
System.out.println("addLast() Testing...");
myObject.addLast(100);
myObject.addLast(200);
myObject.addLast(300);
System.out.println("dequeList Content >>> ");
myObject.displayDequeList(myObject.getDequeListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//offerFirst()
System.out.println("offerFirst() Testing...");
myObject.offerFirst(4);
myObject.offerFirst(5);
myObject.offerFirst(6);
System.out.println("dequeList Content >>> ");
myObject.displayDequeList(myObject.getDequeListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//offerLast()
System.out.println("offerLast() Testing...");
myObject.addLast(1000);
myObject.addLast(2000);
myObject.addLast(3000);
System.out.println("dequeList Content >>> ");
myObject.displayDequeList(myObject.getDequeListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//removeFirst()
System.out.println("removeFirst() Testing...");
System.out.println("Removed Item : " + myObject.removeFirst());
System.out.println("dequeList Content >>> ");
myObject.displayDequeList(myObject.getDequeListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//removeLast()
System.out.println("removeLast() Testing...");
System.out.println("Removed Item : " + myObject.removeLast());
System.out.println("dequeList Content >>> ");
myObject.displayDequeList(myObject.getDequeListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//pollFirst()
System.out.println("pollFirst() Testing...");
System.out.println("Polled Item : " + myObject.pollFirst());
System.out.println("dequeList Content >>> ");
myObject.displayDequeList(myObject.getDequeListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//pollLast()
System.out.println("pollLast() Testing...");
System.out.println("Polled Item : " + myObject.pollLast());
System.out.println("dequeList Content >>> ");
myObject.displayDequeList(myObject.getDequeListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//getFirst()
System.out.println("getFirst() Testing...");
System.out.println("get Item : " + myObject.getFirst());
System.out.println("dequeList Content >>> ");
myObject.displayDequeList(myObject.getDequeListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//getLast()
System.out.println("getLast() Testing...");
System.out.println("get Item : " + myObject.getLast());
System.out.println("dequeList Content >>> ");
myObject.displayDequeList(myObject.getDequeListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//peekFirst()
System.out.println("peekFirst() Testing...");
System.out.println("Peeked Item : " + myObject.peekFirst());
System.out.println("dequeList Content >>> ");
myObject.displayDequeList(myObject.getDequeListHead());
System.out.println("garbageList Content >>> ");
```



```
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//peekLast()
```

```
System.out.println("pollLast() Testing...");  
System.out.println("Peeked Item : " + myObject.peekLast());  
System.out.println("dequeueList Content >>> ");  
myObject.displayDequeueList(myObject.getDequeueListHead());  
System.out.println("garbageList Content >>> ");  
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//removeFirstOccurrence()
```

```
System.out.println("removeFirstOccurrence() Testing...");  
myObject.removeFirstOccurrence(4);  
System.out.println("dequeueList Content >>> ");  
myObject.displayDequeueList(myObject.getDequeueListHead());  
System.out.println("garbageList Content >>> ");  
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//add()
```

```
System.out.println("add() Testing...");  
myObject.add(1111111);  
System.out.println("dequeueList Content >>> ");  
myObject.displayDequeueList(myObject.getDequeueListHead());  
System.out.println("garbageList Content >>> ");  
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//offer()
```

```
System.out.println("offer() Testing...");  
myObject.offer(2222222);  
System.out.println("dequeueList Content >>> ");  
myObject.displayDequeueList(myObject.getDequeueListHead());  
System.out.println("garbageList Content >>> ");  
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//remove()
```

```
System.out.println("remove() Testing...");  
myObject.remove();  
System.out.println("dequeueList Content >>> ");  
myObject.displayDequeueList(myObject.getDequeueListHead());  
System.out.println("garbageList Content >>> ");  
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//poll()
```

```
System.out.println("poll() Testing...");  
myObject.poll();  
System.out.println("dequeueList Content >>> ");  
myObject.displayDequeueList(myObject.getDequeueListHead());  
System.out.println("garbageList Content >>> ");  
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//element()
```

```
System.out.println("element() Testing...");
```

```
System.out.println(myObject.element());
System.out.println("dequeueList Content >>> ");
myObject.displayDequeueList(myObject.getDequeueListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//peek()
System.out.println("peek() Testing...");
System.out.println(myObject.peek());
System.out.println("dequeueList Content >>> ");
myObject.displayDequeueList(myObject.getDequeueListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//push()
System.out.println("push() Testing...");
myObject.push(55555555);
System.out.println("dequeueList Content >>> ");
myObject.displayDequeueList(myObject.getDequeueListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//pop()
System.out.println("pop() Testing...");
System.out.println(myObject.pop());
System.out.println("dequeueList Content >>> ");
myObject.displayDequeueList(myObject.getDequeueListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//contains()
System.out.println("contains() Testing...");
System.out.println(myObject.contains(3));
System.out.println("dequeueList Content >>> ");
myObject.displayDequeueList(myObject.getDequeueListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//contains()
System.out.println("contains() Testing...");
System.out.println(myObject.contains(7777777));
System.out.println("dequeueList Content >>> ");
myObject.displayDequeueList(myObject.getDequeueListHead());
System.out.println("garbageList Content >>> ");
myObject.displayGarbageList(myObject.getGarbageListTail());
```

```
//size()
System.out.println("size() Testing...");
System.out.println(myObject.size());
System.out.println("dequeueList Content >>> ");
myObject.displayDequeueList(myObject.getDequeueListHead());
```

```

//isEmpty()
System.out.println("isEmpty() Testing...");
System.out.println(myObject.isEmpty());
System.out.println("dequeList Content >>> ");
myObject.displayDequeList(myObject.getDequeListHead);

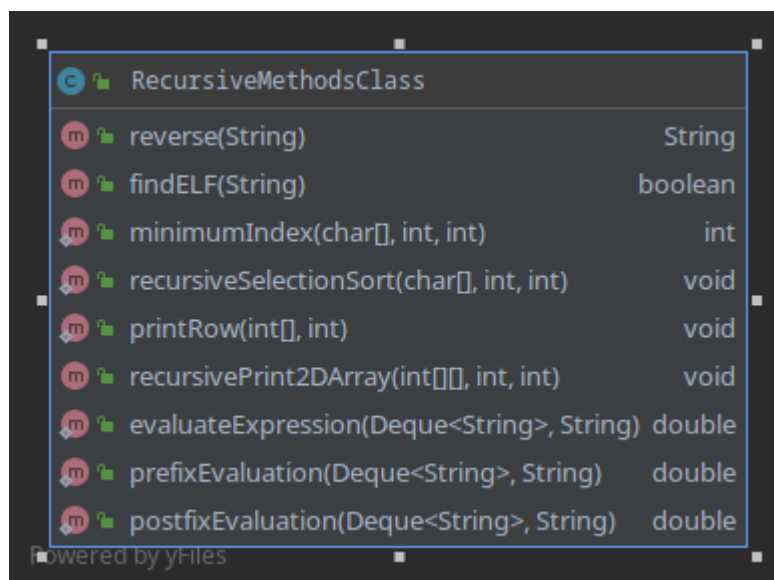
//hasNext();
System.out.println(iterator.hasNext());

//next();
System.out.println("next() Testing...");
System.out.print("[");
while (iterator.hasNext()){
    System.out.print(" "+iterator.next());
}
System.out.println(" ]");

```

PART03

UML:

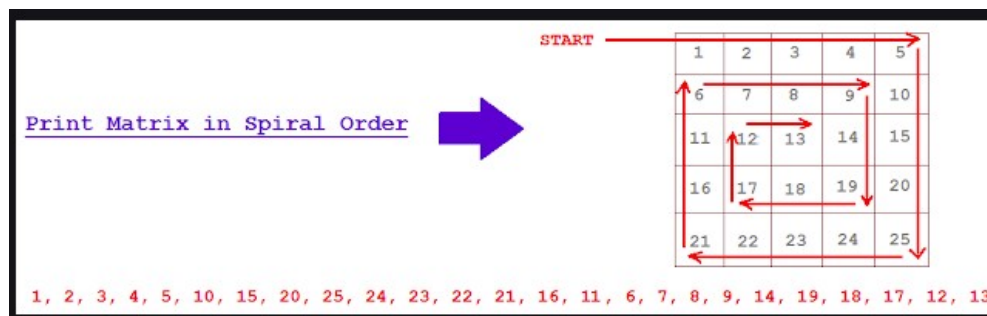


PROBLEM SOLUTION APPROACH:

>> I have used recursion in all the 6 function as it was desired

>> in prefix and postfix evaluation part I have used a common function to evaluate both type of expression. By the help of a string I indicate the type of the expression to be evaluated while calling the function evaluateExpression(). if st is "pref" then it means that we called the evaluateExpression() function to solve a prefix expression and the function will trade accordingly and same condition applies for postfix expression evaluation in which the function evaluateExpression() acts like possible evaluator since our st is "post".

>> in the last part 6. part where we are spouse to print the content of a 2D arrays in spiral order using recursion I used the classic method where everywhere in internet we can access it is called **first row to last column → last column to first row** method which is basically as follows:



TEST CASES:

```
//reverseString()
System.out.println(recObj.findELF("whiteleaf"));
System.out.println(recObj.findELF("tasteful"));
System.out.println(recObj.findELF("unfriendly"));
System.out.println(recObj.findELF("waffles"));
System.out.println(recObj.findELF("ttt"));

//recursiveSelectionSort()
char charArray[] = new char[]{"d", "r", "a", "c", "b"};
recObj.recursiveSelectionSort(charArray, charArray.length, 0);

//prefixEvaluation()
String input = "- + + 1 / - 2 * 4 6 2 1 / 1 4";
```

```

String[] ex = input.split ( " " );
Deque<String> lastEx = new LinkedList<String>();
for (String element : ex) { lastEx.addLast(element); }
System.out.println("value of Above Expression "+recObj.prefixEvaluation(lastEx,"pref"));

//postfixEvaluation()
String newinput = "1 2 4 6 * - 2 / + 1 + 1 4 / -";
String[] exe = newinput.split ( " " );
Deque<String> Ex = new LinkedList();
for (String element : exe) { Ex.addLast(element); }
System.out.println("value of Above Expression = +recObj.postfixEvaluation(Ex,"post")

//recursivePrintArray()
int array[][] = new int [5][4];
array[0][0] = 1;array[0][1] = 2;array[0][2] = 3;array[0][3] = 4;
array[1][0] = 5;array[1][1] = 6;array[1][2] = 7;array[1][3] = 8;
array[2][0] = 9;array[2][1] = 10;array[2][2] = 11;array[2][3] = 12;
array[3][0] = 13;array[3][1] = 14;array[3][2] = 15;array[3][3] = 16;
array[4][0] = 17;array[4][1] = 18;array[4][2] = 19;array[4][3] = 20;

System.out.print("Output : ");
recObj.print2DArray(array,0,array.length,0,array[0].length);
}

```

COMMAND LINE INPUTS:

```
part03 [-/Desktop/6.SEMESTER/(1)Data Structures (BIL 222)/HOMEWORKS/HW04/161044123_hw4/part03] - .../src/RecursiveMethodsPackage/RecursiveMethodsClass.java
File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
part03 src RecursiveMethodsPackage RecursiveMethodsClass MainClass
Run: /opt/jdk-13.0.2/bin/java -javaagent:/opt/idea-IU-193.6911.18/lib/idea_rt.jar=30887:/opt/idea-IU-193.6911.18/bin -Dfile.encoding=UTF-8 -classpath "/home/ashraf/Desktop/6.SEMESTER/(1)Data Structures (BIL 222)/HOMEWORKS/HW04/161044123_hw4/part03/out/production"
1 **** Test Class ****
2
3 reverseString() Testing...
4 Original String : "Hi This Is Third Part Of Homework 04"
5 Calling reverseString With Above String...
6 04 Homework Of Part Third Is This Hi
7
8
9
10
11
12
13
14 findELF() Testing...
15 true
16 true
17 true
18 true
19 false
20
21
22 recursiveSelectionSort() Testing...
23 Before Sorting >>> [ d r a c b ]
24 After Sorting >>> [ a b c d r ]
25
26
27
28
29
30
31
32
33 prefixEvaluation() Testing...
34 Expression is : [-, +, *, 1, /, -, 2, *, 4, 6, 2, 1, /, 1, 4]
35 value of Above Expression = -9.25
36
37
38 postfixEvaluation() Testing...
39 Expression is : [1, 2, 4, 6, *, -, 2, /, +, 1, +, 1, 4, /, -]
40 value of Above Expression = -9.25
41
42
43
44 recursivePrintArray() Testing...
45 Input is :
46 1 2 3 4
47 5 6 7 8
48 9 10 11 12
49 13 14 15 16
50 17 18 19 20
51 Output : 1 2 3 4 8 12 16 20 19 18 17 13 9 5 6 7 11 15 14 18
52
53 Process finished with exit code 0
```