

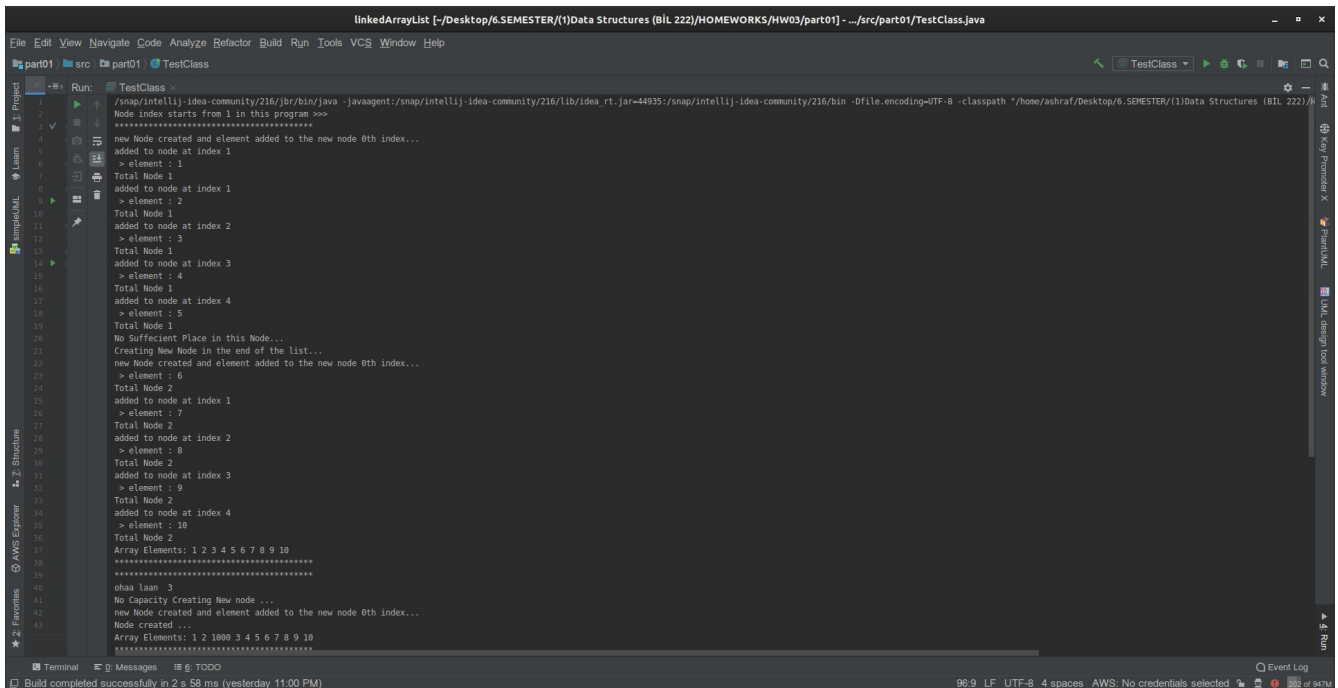
DATA STRUCTURE HOMEWORK REPORTS

HW03 PART01 AND PART02

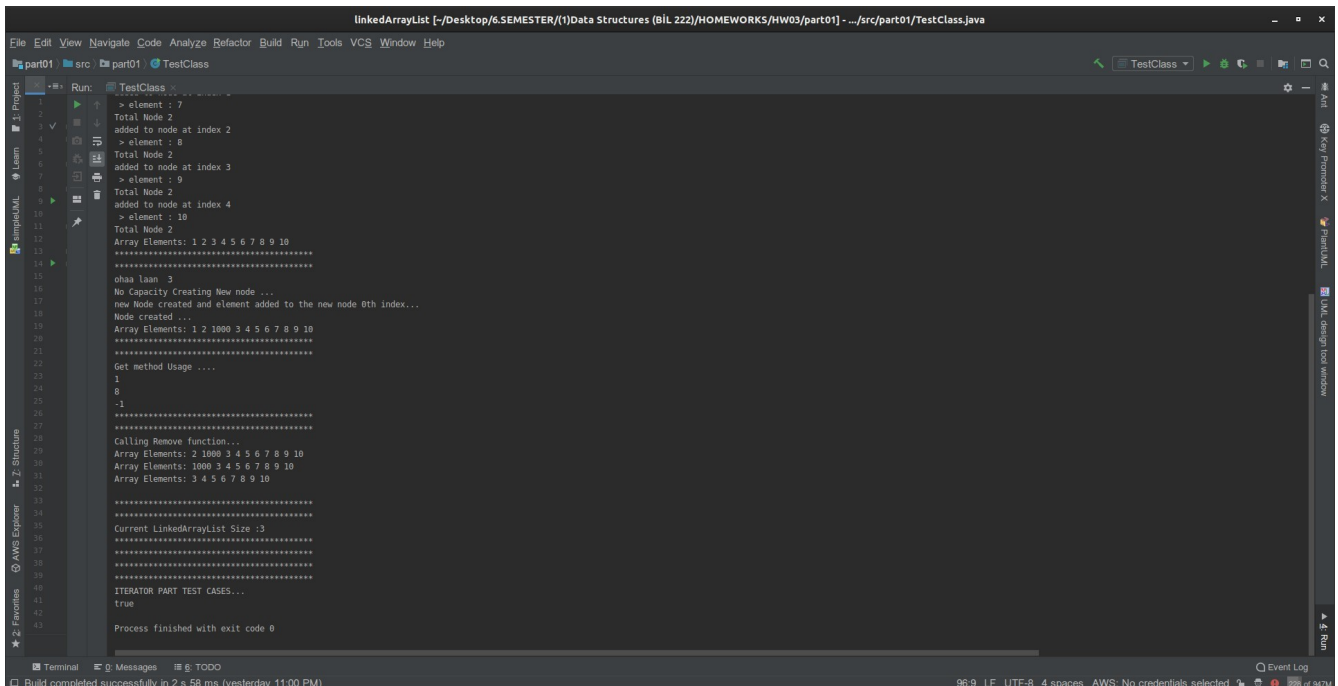
MOHAMMAD ASHRAF YAWAR
161044123

PART01

screen shots:



```
Run: TestClass
  /snap/intellij-idea-community/216/jbr/bin/java -javaagent:/snap/intellij-idea-community/216/lib/idea_rt.jar-44935:/snap/intellij-idea-community/216/bin -Dfile.encoding=UTF-8 -classpath "/home/ashraf/Desktop/6_SEMESTER/(1)Data Structures (BIL 222)/HOMEWORKS/HW03/part01" .../src/part01/TestClass.java
Node index starts from 1 in this program >>>
new Node created and element added to the new node 0th index...
added to node at index 1
> element : 1
Total Node 1
added to node at index 1
> element : 2
Total Node 1
added to node at index 2
> element : 3
Total Node 1
added to node at index 3
> element : 4
Total Node 1
added to node at index 4
> element : 5
Total Node 1
No Sufficient Place in this Node...
Creating New Node in the end of the list...
new Node created and element added to the new node 0th index...
> element : 6
Total Node 2
added to node at index 1
> element : 7
Total Node 2
added to node at index 2
> element : 8
Total Node 2
added to node at index 3
> element : 9
Total Node 2
added to node at index 4
> element : 10
Total Node 2
Array Elements: 1 2 3 4 5 6 7 8 9 10
*****
ohaa Laan 3
No Capacity Creating New node ...
new Node created and element added to the new node 0th index...
Node created ...
Array Elements: 1 2 1000 3 4 5 6 7 8 9 10
*****
```



```
Run: TestClass
  /snap/intellij-idea-community/216/jbr/bin/java -javaagent:/snap/intellij-idea-community/216/lib/idea_rt.jar-44935:/snap/intellij-idea-community/216/bin -Dfile.encoding=UTF-8 -classpath "/home/ashraf/Desktop/6_SEMESTER/(1)Data Structures (BIL 222)/HOMEWORKS/HW03/part01" .../src/part01/TestClass.java
> element : 7
Total Node 2
added to node at index 2
> element : 8
Total Node 2
added to node at index 3
> element : 9
Total Node 2
added to node at index 4
> element : 10
Total Node 2
Array Elements: 1 2 3 4 5 6 7 8 9 10
*****
ohaa Laan 3
No Capacity Creating New node ...
new Node created and element added to the new node 0th index...
Node created ...
Array Elements: 1 2 1000 3 4 5 6 7 8 9 10
*****
Get method Usage ....
1
8
-1
*****
Calling Remove function...
Array Elements: 2 1000 3 4 5 6 7 8 9 10
Array Elements: 1000 3 4 5 6 7 8 9 10
Array Elements: 3 4 5 6 7 8 9 10
*****
Current LinkedList Size :3
*****
ITERATOR PART TEST CASES...
true
Process finished with exit code 0
```

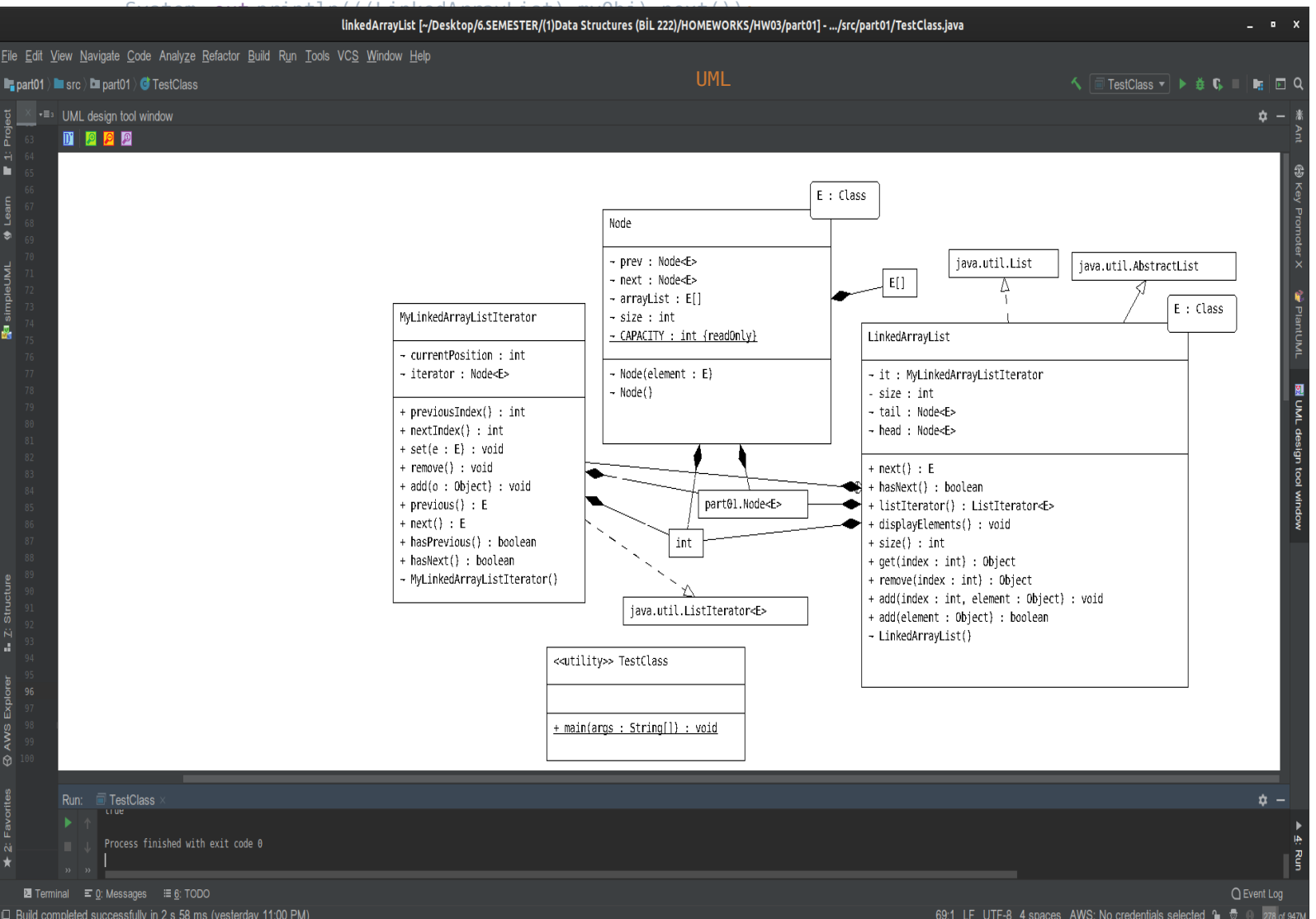
test cases:

```
/add(Object element);
myObj.add(1);
myObj.add(2);
myObj.add(3);
myObj.add(4);
myObj.add(5);
myObj.add(6);
myObj.add(7);
myObj.add(8);
myObj.add(9);
myObj.add(10);

System.out.println(myObj.get(0));
System.out.println(myObj.get(8));
System.out.println(myObj.get(11));

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

System.out.println(((LinkedList) myObj).next());
```



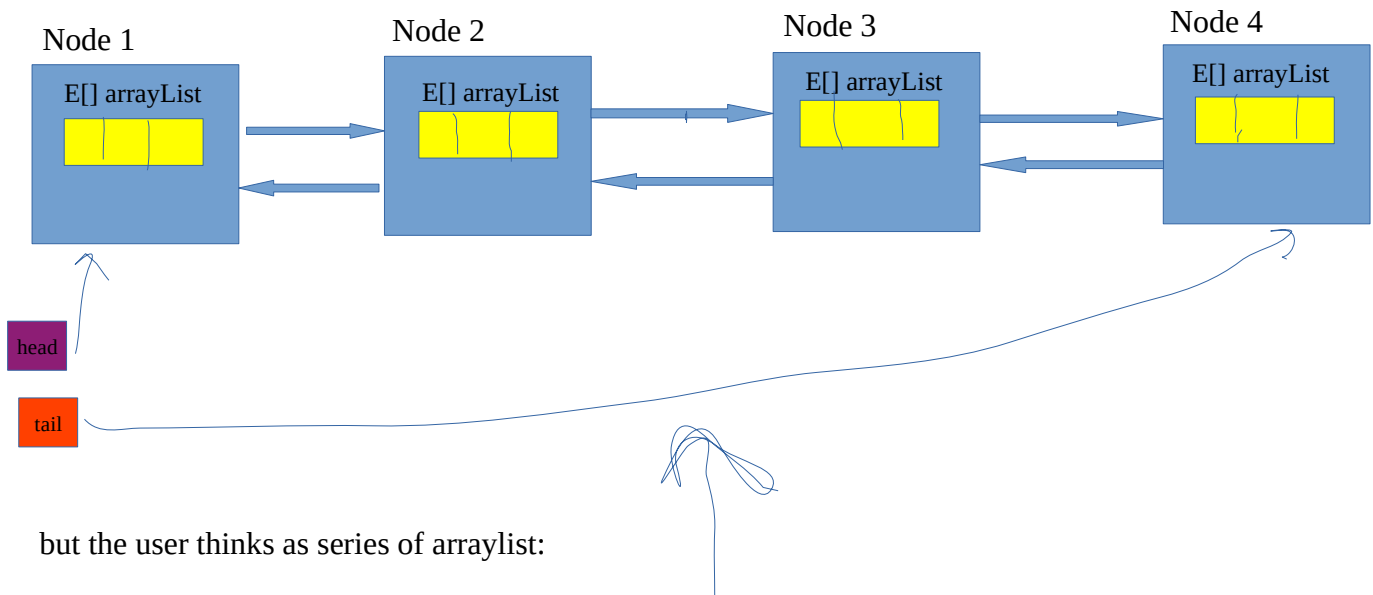
Problem Approach:

in this project we have a `LinkedList` class which acts like `ArrayList` in collection framework and more precisely `List` interface.

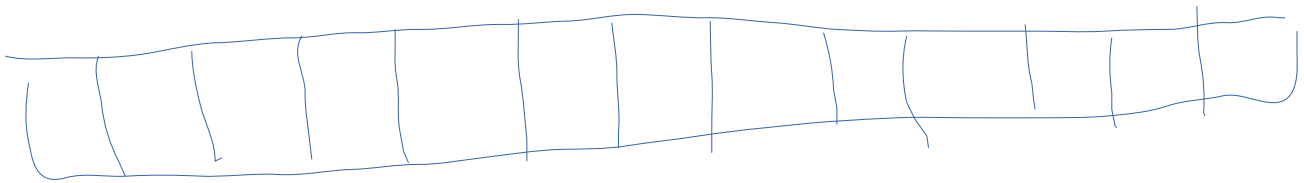
`LinkedList` Class contains a doubly linkedlist structure and each node of the linkedlist contains a generic partially filled array.

Users of this class(`LinkedList`) use it as tough `ArrayList` and calls it's methods just like `ArrayList` regardless of knowing the internal structure of the class.

I implemented this `ArrayList` kind abstraction using `LinkedList` class and node class here is a work flow of it:



but the user thinks as series of arraylist:

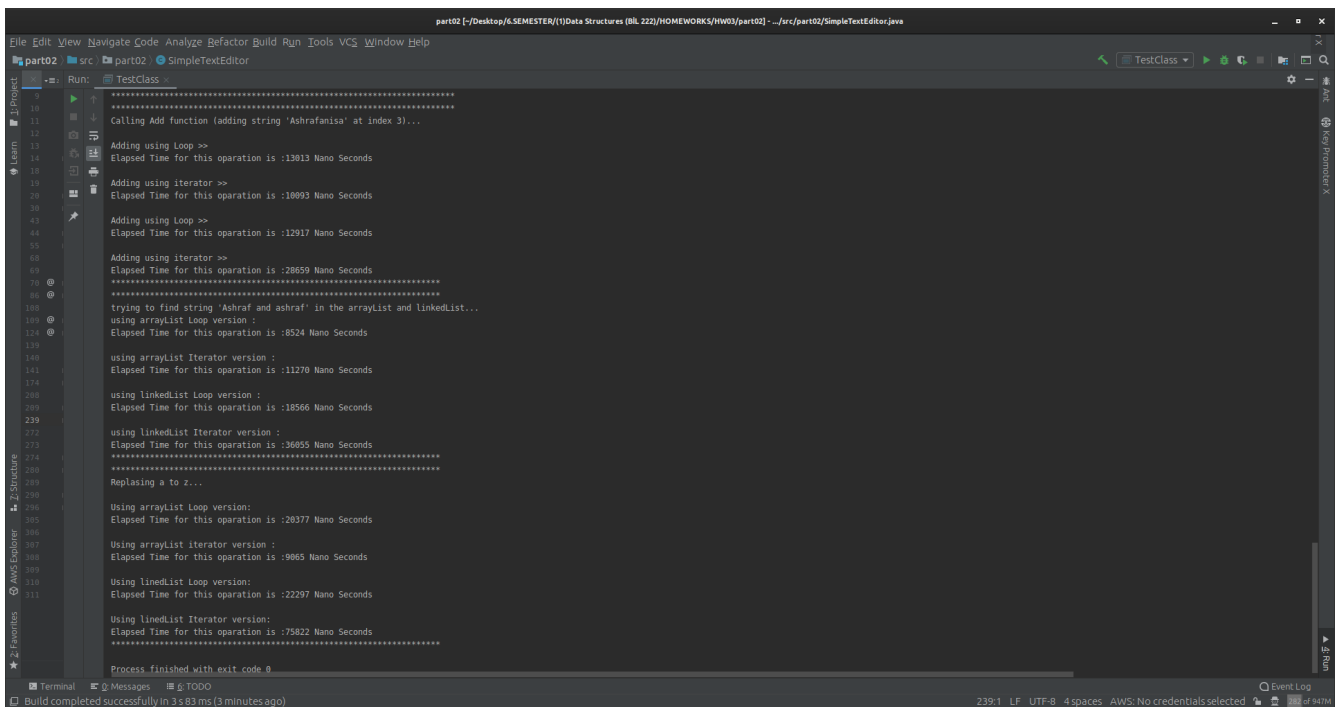


PART02

SCREEN SHOTS OF WORKING OF ALL FUNCTIONS:

```
part02 [-/Desktop/6 SEMESTER/11Data Structures (BIL 222)/HOMEWORKS/HW03/part02] - ./src/part02/SimpleTextEditor.java
File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
part02 src part02 SimpleTextEditor
Run: TestClass
9 /snap/intellij-idea-community/216/jbr/bin/java -javaagent:/snap/intellij-idea-community/216/lib/idea_rt.jar=34961:/snap/intellij-idea-community/216/bin -Dfile.encoding=UTF-8 -classpath "/home/ashraf/Desktop/6 SEMESTER/11Data Structures (BIL 222)/HOMEWORKS/HW03/part02" ./src/part02/SimpleTextEditor.java
10 Testing all the methods used in this part of homework >>>
11 *****
12 Reading from file01.txt ...
13 Text read from file to arrayList and LinkedList Successfully :)
14 MEASURING THE RUNNING TIME OF IMPLEMENTATION OF READ FUNCTIONS IN TWO DIFFERENT SIZED TXT FILES... >>>
15 arrayList Using Loop:
16 Elapsed Time for this operation is :1016674 Nano Seconds
17
18
19 arrayList Using iterator:
20 Elapsed Time for this operation is :609150 Nano Seconds
21
22
23 LinkedList Using Loop:
24 Elapsed Time for this operation is :451234 Nano Seconds
25
26
27 LinkedList Using iterator:
28 Elapsed Time for this operation is :484600 Nano Seconds
29 *****
30
31 Reading from file02.txt ...
32 Text read from file to arrayList and LinkedList Successfully :)
33 arrayList Using Loop:
34 Elapsed Time for this operation is :21522402 Nano Seconds
35
36
37 arrayList Using iterator:
38 Elapsed Time for this operation is :165038402 Nano Seconds
39
40
41 LinkedList Using Loop:
42 Elapsed Time for this operation is :6684206 Nano Seconds
43
44
45 LinkedList Using iterator:
46 Elapsed Time for this operation is :5223834 Nano Seconds
47 *****
48
49 Calling Add function (adding string 'Ashrafanisa' at index 3)...
50 Adding using Loop >>
51
52 New text in arrayList:
53 thiAshrafAAAAAAAAAAAAAAAAisasis;laksjdf;alsfda;sljfd
54 asdfasdfsdfasdfsdf
55 asdfasdfsdfasdfsdf
56 asdfasdfsdf
57 thisis;laksjdf;alsfda;sljfd
58 asdfasdfsdfasdfsdf
59 asdfasdfsdfasdfsdf
60 asdfasdfsdf
61
62 Adding using Loop >>
63
64 New text in arrayList:
65 thiAshrafAAAAAAAAAAAAAAAAisasis;laksjdf;alsfda;sljfd
66 asdfasdfsdfasdfsdf
67 asdfasdfsdfasdfsdf
68 asdfasdfsdf
69 thisis;laksjdf;alsfda;sljfd
70 asdfasdfsdfasdfsdf
71 asdfasdfsdfasdfsdf
72 asdfasdfsdf
73
74 Adding using Loop >>
75
76 New text in LinkedList:
77 thiAshrafAAAAAAAAAAAAAAAAisasis;laksjdf;alsfda;sljfd
78 asdfasdfsdfasdfsdf
79 asdfasdfsdfasdfsdf
80 asdfasdfsdfasdfsdf
81 asdfasdfsdf
82 thisis;laksjdf;alsfda;sljfd
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84 asdfasdfsdfasdfsdf
85 asdfasdfsdf
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87 Adding using Loop >>
88
89 New text in LinkedList:
90 thiAshrafAAAAAAAAAAAAAAAAisasis;laksjdf;alsfda;sljfd
91 asdfasdfsdfasdfsdf
92 asdfasdfsdfasdfsdf
93 asdfasdfsdfasdfsdf
94 asdfasdfsdf
95 thisis;laksjdf;alsfda;sljfd
96 asdfasdfsdfasdfsdf
97 asdfasdfsdfasdfsdf
98 asdfasdfsdf
99 *****
100
101 Trying to Find string 'Ashraf and ashraf' in the arrayList and LinkedList...
102 using arrayList Loop version :
103 returned index is : 4
104 returned : -1 String Not Found!!!! :(
105
106 using arrayList Iterator version :
107 returned index is : 4
108 returned : -1 String Not Found!!!! :(
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```

```
part02 [-/Desktop/6SEMESTER/11>Data Structures (BIL 222)/HOMEWORKS/HW03/part02] - .../src/part02/SimpleTextEditor.java
File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
part02 src part02 SimpleTextEditor
Run: TestClass
*****
10 *****
11 Calling Add function (adding string 'Ashrafanisa' at index 3)...
12 *****
13 Adding using Loop >>
14 Elapsed Time for this operation is :13813 Nano Seconds
15 *****
16 Adding using iterator >>
17 Elapsed Time for this operation is :10893 Nano Seconds
18 *****
19 Adding using Loop >>
20 Elapsed Time for this operation is :12917 Nano Seconds
21 *****
22 Adding using iterator >>
23 Elapsed Time for this operation is :28859 Nano Seconds
24 *****
25 *****
26 Trying to Find string 'Ashraf' and 'ashraf' in the arrayList and linkedList...
27 using arrayList Loop version :
28 Elapsed Time for this operation is :8524 Nano Seconds
29 *****
30 using arrayList Iterator version :
31 Elapsed Time for this operation is :11270 Nano Seconds
32 *****
33 using LinkedList Loop version :
34 Elapsed Time for this operation is :18566 Nano Seconds
35 *****
36 using LinkedList Iterator version :
37 Elapsed Time for this operation is :36855 Nano Seconds
38 *****
39 Replacing a to z...
40 *****
41 Using arrayList Loop version:
42 Elapsed Time for this operation is :28377 Nano Seconds
43 *****
44 Using arrayList Iterator version :
45 Elapsed Time for this operation is :9865 Nano Seconds
46 *****
47 Using linkedList Loop version:
48 Elapsed Time for this operation is :22297 Nano Seconds
49 *****
50 Using linkedList Iterator version:
51 Elapsed Time for this operation is :75822 Nano Seconds
52 *****
53 Process finished with exit code 0
Terminal Messages @:TODO
Build completed successfully in 3 s 83 ms (3 minutes ago) 239:1 LF UTF-8 4 spaces AWS: No credentials selected 947M
```

Test Cases:

```
System.out.println("arrayList Using loop:");
obj1.readToArrayListUsingLoop(file01);

obj1.readToArrayListUsingIterator(file01);
System.out.println("arrayList Using iterator:");

obj1.readToLinkedListUsingLoop(file01);
System.out.println("linkedList Using Loop:");

obj1.readToLinkedListUsingIterator(file01);
System.out.println("linkedList Using iterator:");

System.out.println("Reading from file02.txt ...");
System.out.println("Text read from file to arrayList and linkedlist Successfully :) ");

System.out.println("arrayList Using loop:");
obj2.readToArrayListUsingLoop(file02);

obj2.readToArrayListUsingIterator(file02);
System.out.println("arrayList Using iterator:");

obj2.readToLinkedListUsingLoop(file02);
System.out.println("linkedList Using Loop:");

obj2.readToLinkedListUsingIterator(file02);
System.out.println("linkedList Using iterator:");

//add(index,string);
System.out.println("Calling Add function (adding string 'Ashrafanisa' at index 3)...");
```

```
System.out.println("Adding using Loop >>");
obj1.addToArrayListUsingLoop(3,"Ashrafanisa");

System.out.println("Adding using iterator >>");
obj1.addToArrayListUsingIterator(10,"AAAAAAAAAAAAAAAAAAAA");

System.out.println("Adding using Loop >>");
obj1.addToLinkedListUsingLoop(3,"Ashrafanisa");

System.out.println("Adding using iterator >>");
obj1.addToLinkedListUsingIterator(10,"AAAAAAAAAAAAAAAAAAAA");

System.out.println("trying to find string 'Ashraf and ashraf' in the arrayList and
linkedList...");

System.out.println("using arrayList Loop version :");
int result = obj1.findFromArrayListUsingLoop("Ashraf");

System.out.println("using arrayList Iterator version :");
result = obj1.findFromArrayListUsingIterator("Ashraf");

System.out.println("using linkedList Loop version :");
result = obj1.findFromLinkedListUsingLoop("Ashraf");

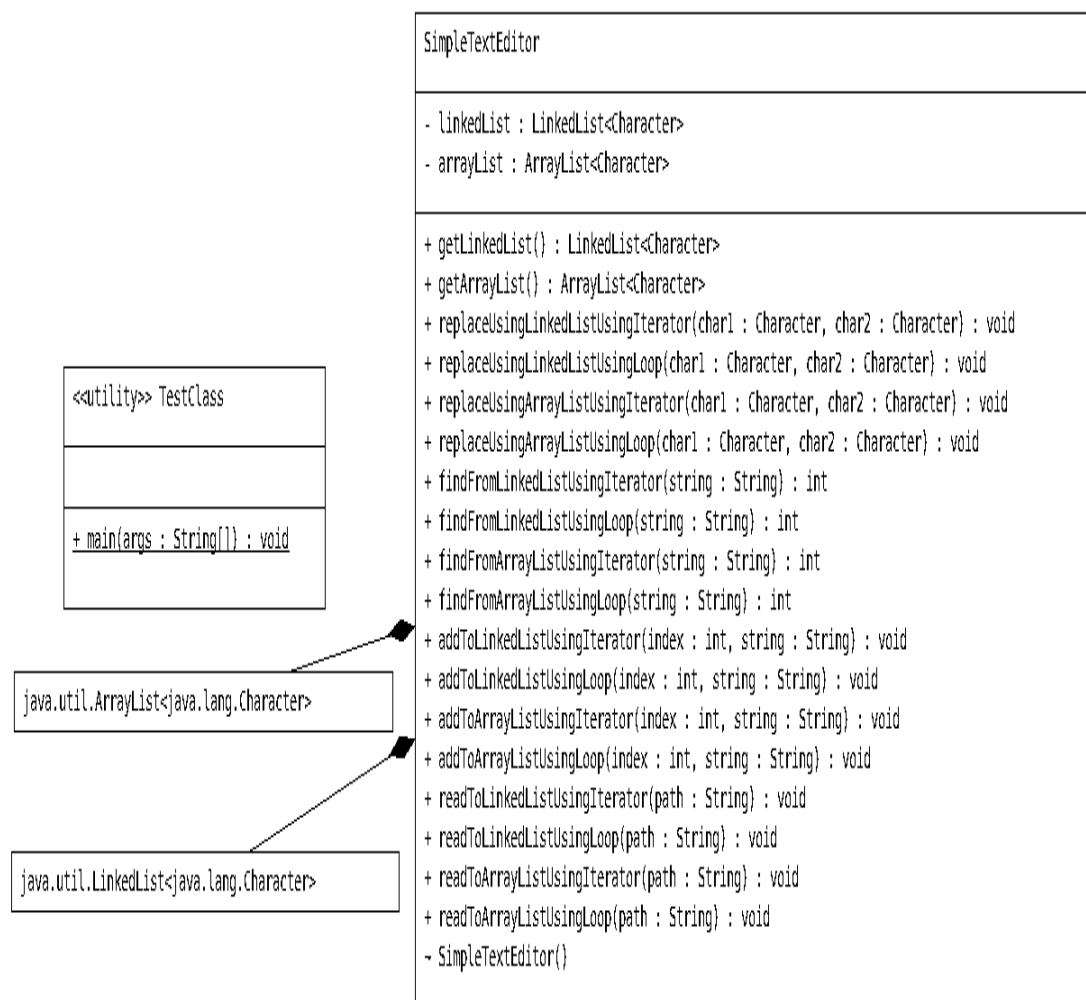
System.out.println("using linkedList Iterator version :");
result = obj1.findFromLinkedListUsingIterator("Ashraf");
result = obj1.findFromLinkedListUsingIterator("ashraf");

System.out.println("Using arrayList:");
obj1.replaceUsingArrayListUsingLoop('a','z');

System.out.println("Using linkedList :");
obj1.replaceUsingLinkedListUsingLoop('a','z');

obj1.replaceUsingArrayListUsingIterator('a','z');

obj1.replaceUsingLinkedListUsingIterator('a','z');
```

PROBLEM SOLUTION APPROACH:

in this part we have main purpose as comparing the time complexity and performance measurement of arraylist comparing to linkedlist using loops and iterator I have used the time package to measure the elapsed time starting from calling the particular function until the return time and print elapsed time comparatively to the screen.

>> Read function reads from file into arraylist with four different functions for various test purposes.

>> add function adds the given string to the corresponding index. before adding the string since our arraylist and linked is type of Character Object we convert the string into character array and traverse each char and insert accordingly.

>> to find a string in the specific position we traverse linkedlist or arraylist char by char and until the need is satisfied.

>> Replace works better to the Arraylist and linked list size.

BigO:

I will compare each of 16 functions that I have used :

1) function **readToArrayListUsingLoop** has bigO of $O(n)$:

```
try (FileReader fr = new FileReader(file)) {
    int content;
    while ((content = fr.read()) != -1) {
        this.arrayList.add((char) content);
    }
} catch (IOException e) { e.printStackTrace(); }
```

2) function **readToArrayListUsingIterator** has bigO of $O(n)$:

```
try (FileReader fr = new FileReader(file)) {
    int content;
    while ((content = fr.read()) != -1) {

        itr.add((char) content);
    }
} catch (IOException e) { e.printStackTrace(); }
```

3) function **readToLinkedListUsingLoop** has bigO of $O(n)$:

```
try (FileReader fr = new FileReader(file)) {
    int content;
    while ((content = fr.read()) != -1) {
        this.linkedList.add((char) content);
    }
} catch (IOException e) { e.printStackTrace(); }
```

4) function **readToLinkedListUsingIterator** has bigO of $O(n)$:

```
try (FileReader fr = new FileReader(file)) {
    int content;
    while ((content = fr.read()) != -1) {
        itr.add((char) content);
    }
}
```

```

    }
} catch (IOException e) { e.printStackTrace(); }

```

5) function **addToArrayListUsingLoop** has bigO of $O(n^2)$:

```

try {
    ArrayList<Character> charArray = new ArrayList<>(); // these three lines convert the
given string to char arraylist
    for (char ch : string.toCharArray()) {
        charArray.add(ch);
    }

    for (int i = 0; i < charArray.size(); i++) {
        this.arrayList.add(index, charArray.get(i));
        index++;
    }
} catch (IndexOutOfBoundsException e) {
    System.out.println("Oops! index is out of bound try to give valid index!!! ");
}

```

6) function **addToArrayListUsingIterator** has bigO of $O(n^2)$:

```

try {

    ArrayList<Character> charArray = new ArrayList<>(); // these three lines convert the
given string to char arraylist
    for (char ch : string.toCharArray()) {
        charArray.add(ch);
    }

    ListIterator<Character> arrayListItr = arrayList.listIterator();
    ListIterator<Character> charArrayItr = charArray.listIterator();

    for (int i = 0; i < index - 1; i++) {
        arrayListItr.next();
    }
    while (charArrayItr.hasNext()) {
        arrayListItr.add(charArrayItr.next());
    }
} catch (IndexOutOfBoundsException e) {
    System.out.println("Oops! index is out of bound try to give valid index!!! ");
}

```

7) function **addToLinkedListUsingLoop** has bigO of $O(n^2)$:

```

try{
    ArrayList<Character> charArray = new ArrayList<>(); // these three lines convert the
given string to char arraylist
    for (char ch: string.toCharArray()) { charArray.add(ch); }

    for (int i = 0; i < charArray.size(); i++) {
        this.linkedList.add(index, charArray.get(i));
        index++;
    }
}
catch (IndexOutOfBoundsException e) {
    System.out.println("Oops! index is out of bound try to give valid index!!! ");
}

```

8) function **addToLinkedListUsingLoop** has bigO of $O(n^2)$:

```
try{
    ArrayList<Character> charArray = new ArrayList<>(); // these three lines convert the
given string to char arraylist
    for (char ch: string.toCharArray()) { charArray.add(ch); }

    ListIterator <Character> linkedListItr = linkedList.listIterator();
    ListIterator <Character> charArrayItr = charArray.listIterator();

    for (int i = 0; i < index-1 ; i++) { linkedListItr.next(); }
    while(charArrayItr.hasNext()){ linkedListItr.add(charArrayItr.next()); }
} catch (IndexOutOfBoundsException e) {
    System.out.println("Oops! index is out of bound try to give valid index!!! ");
}
```

9) function **findFromArrayListUsingLoop** has bigO of $O(n^2)$:

```
boolean found = false;

try {

    ArrayList<Character> charArray = new ArrayList<>(); // these three lines convert the
given string to char arraylist
    for (char ch : string.toCharArray()) {
        charArray.add(ch);
    }

    while ((found == false) && (index < (arrayList.size() - charArray.size())) {

        count = index; found = true;
        for (int i = 0; i < charArray.size(); i++) {
            if (charArray.get(i) != arrayList.get(count)) {
                found = false;
            }
            count++;
        }
        index++;
    }
    if (found == true)
        return index;
    else
        return -1;
}
catch (NullPointerException e) {
    System.out.println("Oops! string points to Null !!! ");
}
return index;
```

10) function **findFromArrayListUsingIterator** has bigO of $O(n^2)$:

```
int index = 0, count = 0;
boolean found = false;
try {
```

```

    ArrayList<Character> charArray = new ArrayList<>(); // these two lines convert the given
string to char arraylist
    for (char ch : string.toCharArray()) {
        charArray.add(ch);
    }

    ListIterator<Character> charArrayItaretor = charArray.listIterator();
    while ((found == false) && (index < (arrayList.size() - charArray.size()))) {

        count = index; found = true;
        while (charArrayItaretor.hasNext()) {
            if (charArrayItaretor.next() != arrayList.get(count)) {
                found = false;
            }
            count++;
        }
        charArrayItaretor = charArray.listIterator();
        index++;
    }
    if (found == true)
        return index;
    else
        return -1;
}
catch (NullPointerException e) {
    System.out.println("Oops! string points to Null !!! ");
}
return index;

```

11) function **findFromLinkedListUsingLoop** has bigO of $O(n^2)$:

```

int index = 0, count = 0 ;
boolean found = false;
try{

    ArrayList<Character> charArray = new ArrayList<>(); // these three lines convert the
given string to char arraylist
    for (char ch: string.toCharArray()) { charArray.add(ch); }

    while((found == false) && (index < (linkedList.size() - charArray.size()))){

        count = index; found = true;
        for (int i = 0; i < charArray.size(); i++) {
            if(charArray.get(i) != linkedList.get(count)){
                found = false;
            }
            count++;
        }
        index++;
    }
    if (found == true)
        return index;
    else
        return -1;
}
catch (NullPointerException e) {
    System.out.println("Oops! string points to Null !!! ");
}
return index;

```

12) function **findFromLinkedListUsingIterator** has bigO of $O(n^2)$:

```
int index = 0, count = 0;
boolean found = false;
try{
    ArrayList<Character> charArray = new ArrayList<>(); // these two lines convert the given
string to char arraylist
    for (char ch: string.toCharArray()) { charArray.add(ch); }

    ListIterator <Character> charArrayItaretor = charArray.listIterator();

    while((found == false) && (index < (linkedList.size() - charArray.size()))){
        count = index;
        found = true;

        while(charArrayItaretor.hasNext()) {
            if(charArrayItaretor.next() != linkedList.get(count)){
                found = false;
            }
            count++;
        }
        charArrayItaretor = charArray.listIterator();
        index++;
    }
    if (found == true)
        return index;
    else
        return -1;
}
catch (NullPointerException e) {
    System.out.println("Oops! string points to Null !!! ");
}
return index;
```

13) function **replaceUsingArrayListUsingLoop** has bigO of $O(n)$:

```
for (int i = 0; i < arrayList.size() ; i++)
    if(arrayList.get(i) == char1)
        arrayList.set(i, char2);
```

14) function **replaceUsingArrayListUsingIterator** has bigO of $O(n)$:

```
ListIterator <Character> itr = arrayList.listIterator();
while (itr.hasNext()){
    if(itr.next() == char1){
        itr.set(char2);
    }
}
```

15) function **replaceUsingLinkedListUsingLoop** has bigO of $O(n)$:

```
for (int i = 0; i < linkedList.size() ; i++)
    if(linkedList.get(i) == char1)
        linkedList.set(i, char2);
```

16) function replaceUsingLinkedListUsingIterator has bigO of $O(n)$:

```
ListIterator <Character> itr = linkedList.listIterator();
while (itr.hasNext()){
    if(itr.next() == char1){
        itr.set(char2);
    }
}
```

17) function getArrayList has bigO of $O(1)$:

```
return arrayList;
```

18) function getLinkedList has bigO of $O(1)$:

```
return linkedList;
```