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Linear ds assigenment

Task 2: Linked List Middle Element Search

You are given a singly linked list. Write a function to find the middle element without using any extra space and only one traversal through the linked list.

```
public Node findMiddle() {
    Node temp=head;
    int count=0;
    while(count!=length/2&& temp!=null)
    {
        temp=temp.next;
        count++;
    }

    return temp;
}
```

Op:

The screenshot displays the Eclipse IDE interface. The 'Package Explorer' on the left shows the project 'Data_structures' with the following structure:

- Data_structures
 - src
 - com.ds.graph
 - a.java
 - CycleDetect.java
 - DijkstraUsingList.java
 - Graph.java
 - KruskalAlgorithm.java
 - KruskalUsingArray.java
 - TwoPairShortestAlgorithm_floyeds.java
 - com.ds.linkedlist
 - DLinkedList.java
 - LinkedList.java
 - com.ds.patternAlgorithm
 - KnnAlgorithm.java
 - NaivePatternSearching.java
 - com.ds.queue
 - com.ds.searching_algorithms
 - com.ds.sortingAlgorithms
 - com.ds.stack
 - com.ds.timeAndSpaceComplexity
 - com.ds.tree
 - module-info.java

The 'Editor' in the center shows the code for 'LinkedList1.java':

```

196     append(value);
197 }
198
199     return true;
200 }
201
202 Node n= new Node(value);
203 Node temp=get(index -1);
204 n.next=temp.next;
205 temp.next=n;
206 length++;
207 return true;
208
209 }
210
211
212 public Node findMiddle() {
213     Node temp=head;
214     int count=0;
215     while(count!=length/2&& temp!=null)
216     {
217         temp=temp.next;
218         count++;
219     }
220
221     return temp;
222 }
223
224
225
226 public static void main(String[] args) {
227
228     LinkedList1 l=new LinkedList1(11);
229     l.gehead();
230 //
231 //     l.printlist();
232 //     l.append(3);
233 //
  
```

The 'Console' on the right shows the output of the program:

```

terminated> LinkedList1 Java Application C:\Users\Admin\p2\workspace\src\org.eclipse
nodecom.ds.linkedlist.LinkedList1$Node@d251891
head11
tail55
length5
--->11
--->5
--->33
--->44
--->55
middle element:-33
  
```

Task 3: Queue Sorting with Limited Space

You have a queue of integers that you need to sort. You can only use additional space equivalent to one stack. Describe the steps you would take to sort the elements in the queue.

Initialization:

Let's denote the queue as Q and the stack as S.

The goal is to transfer elements between Q and S to sort the elements in Q.

Sorting Steps:

While Q is not empty, perform the following operations:

a. Find the Minimum Element:

Initialize a variable min with a value larger than any element in Q (e.g., Integer.MAX_VALUE).

Dequeue all elements from Q one by one.

For each element, compare it with min. If it is smaller, update min with this element.

Push each dequeued element onto S.

Once all elements are transferred to S, min will hold the smallest element from Q.

b. Transfer Elements Back to Q:

Initialize a variable countMin to keep track of how many times min appears.

While S is not empty, perform the following operations:

Pop an element from S.

If the element is equal to min, increment countMin.

If the element is not equal to min, enqueue it back to Q.

c. Place the Minimum Element(s) in Sorted Position:

Enqueue the min element(s) back to Q based on the value of countMin.

Repeat Steps:Repeat the above steps until Q is sorted. In each iteration, the smallest remaining elements are placed in their correct positions in Q.

Consider the queue Q with elements: [3, 1, 4, 1, 5, 9, 2, 6, 5, 3, 5].

First pass:

Find min = 1, and enqueue two 1s to Q.

Q becomes [1, 1, 3, 4, 5, 9, 2, 6, 5, 3, 5].

Second pass:

Find min = 2, and enqueue 2 to Q.

Q becomes [1, 1, 2, 3, 4, 5, 9, 6, 5, 3, 5].

Third pass:

Find min = 3, and enqueue three 3s to Q.

Q becomes [1, 1, 2, 3, 3, 3, 4, 5, 9, 6, 5, 5].

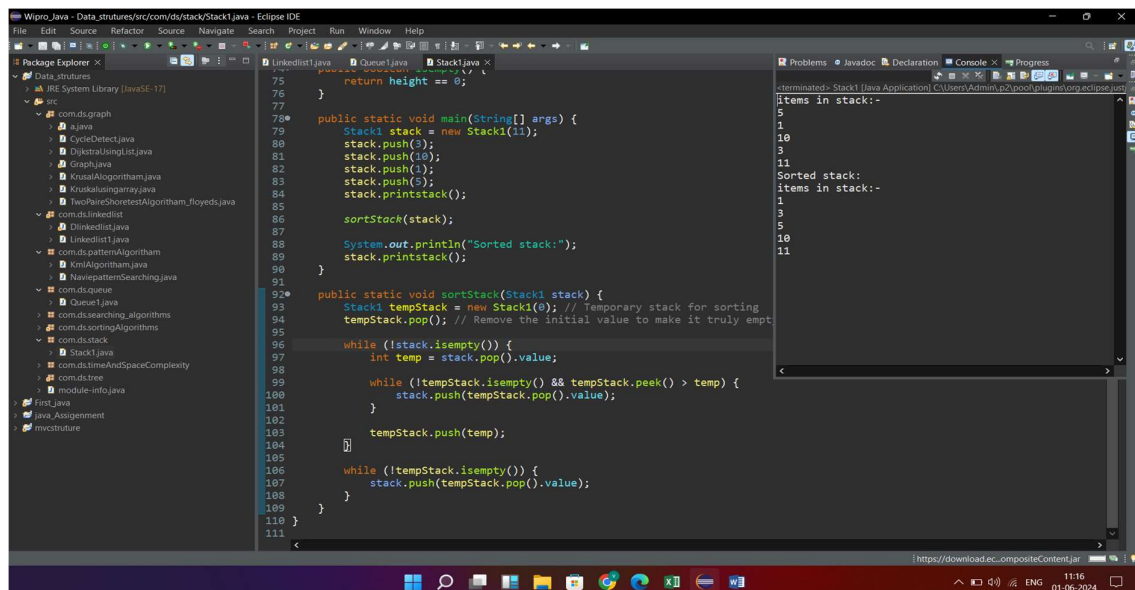
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Task 4: Stack Sorting In-Place

You must write a function to sort a stack such that the smallest items are on the top. You can use an additional temporary stack, but you may not copy the elements into any other data structure such as an array. The stack supports the following operations: push, pop, peek, and isEmpty.

```
public static void sortStack(Stack1 stack) {  
    Stack1 tempS = new Stack1(0);  
    tempS.pop();  
  
    while (!stack.isEmpty()) {  
        int temp = stack.pop().value;  
  
        while (!tempS.isEmpty() && tempS.peek() > temp) {  
            stack.push(tempS.pop().value);  
        }  
  
        tempS.push(temp);  
    }  
  
    while (!tempS.isEmpty()) {  
        stack.push(tempS.pop().value);  
    }  
}
```

Op:



The screenshot shows the Eclipse IDE with the following components:

- Package Explorer:** Displays the project structure with packages like `com.ds.graph`, `com.ds.linkedlist`, `com.ds.queue`, `com.ds.searching.algorithms`, `com.ds.sorting.algorithms`, `com.ds.stack`, and `com.ds.timeAndSpaceComplexity`.
- Editor:** Shows the `Stack1.java` file with the `sortStack` function implementation. The code is as follows:

```
75  
76  
77  
78  
79 public static void main(String[] args) {  
80     Stack1 stack = new Stack1(11);  
81     stack.push(3);  
82     stack.push(10);  
83     stack.push(1);  
84     stack.push(5);  
85     stack.printstack();  
86  
87     sortStack(stack);  
88     System.out.println("Sorted stack:");  
89     stack.printstack();  
90 }  
91  
92  
93 public static void sortStack(Stack1 stack) {  
94     Stack1 tempStack = new Stack1(0); // Temporary stack for sorting  
95     tempStack.pop(); // Remove the initial value to make it truly empty  
96  
97     while (!stack.isEmpty()) {  
98         int temp = stack.pop().value;  
99  
100        while (!tempStack.isEmpty() && tempStack.peek() > temp) {  
101            stack.push(tempStack.pop().value);  
102        }  
103  
104        tempStack.push(temp);  
105    }  
106  
107    while (!tempStack.isEmpty()) {  
108        stack.push(tempStack.pop().value);  
109    }  
110 }  
111
```
- Console:** Displays the output of the program:

```
<terminated> Stack1 [Java Application] C:\Users\Admin\p2\workspace\org.eclipse.just  
Items in stack:-  
5  
1  
10  
3  
11  
Sorted stack:  
items in stack:-  
1  
3  
5  
10  
11
```

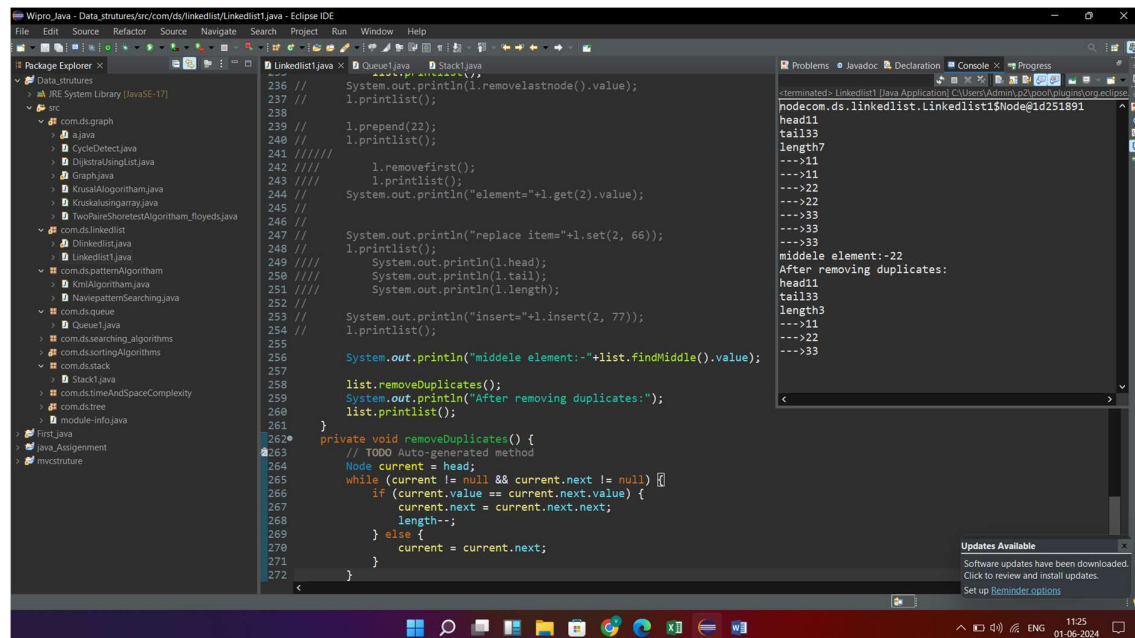
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Task 5: Removing Duplicates from a Sorted Linked List

A sorted linked list has been constructed with repeated elements. Describe an algorithm to remove all duplicates from the linked list efficiently.

```
private void removeDuplicates() {  
    Node current = head;  
    while (current != null && current.next != null) {  
        if (current.value == current.next.value) {  
            current.next = current.next.next;  
            length--;  
        } else {  
            current = current.next;  
        }  
    }  
}
```

Op:



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Task 6: Searching for a Sequence in a Stack

Given a stack and a smaller array representing a sequence, write a function that determines if the sequence is present in the stack.

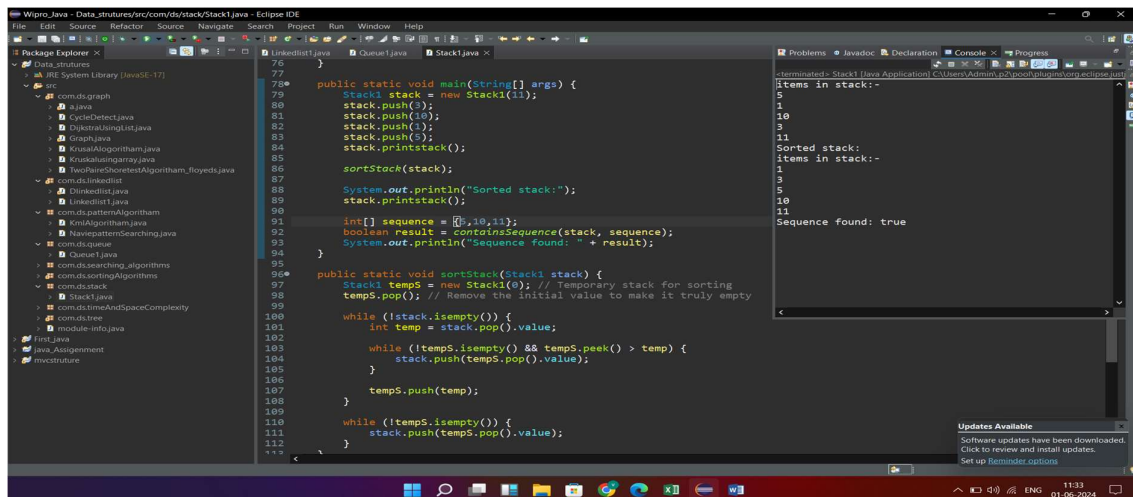
Consider the sequence present if, upon popping the elements, all elements of the array appear consecutively in the stack

```
public static boolean containsSequence(Stack1 stack, int[] sequence)
{
    Stack1 reversedStack = new Stack1(0);
    reversedStack.pop();
    while (!stack.isEmpty()) {
        reversedStack.push(stack.pop().value);
    }
    for (int i = sequence.length - 1; i >= 0; i--) {
        if (reversedStack.isEmpty() || reversedStack.pop().value
        != sequence[i]) {
            while (!reversedStack.isEmpty()) {
                stack.push(reversedStack.pop().value);
            }
            return false;
        }
    }

    while (!reversedStack.isEmpty()) {
        stack.push(reversedStack.pop().value);
    }

    return true;
}
```

Op:



Task 7: Merging Two Sorted Linked Lists

You are provided with the heads of two sorted linked lists. The lists are sorted in ascending order. Create a merged linked list in ascending order from the two input lists without using any extra space (i.e., do not create any new nodes).

```
public static Linkedkist1 mergeLists(Linkedkist1 l1, Linkedkist1 l2)
{
    if (l1.head == null) return l2;
    if (l2.head == null) return l1;

    Node dummy = new Node(0); // dummy node to simplify merge
    Node tail = dummy;

    Node h1 = l1.head;
    Node h2 = l2.head;

    while (h1 != null && h2 != null) {
        if (h1.value < h2.value) {
            tail.next = h1;
            h1 = h1.next;
        } else {
            tail.next = h2;
            h2 = h2.next;
        }
        tail = tail.next;
    }

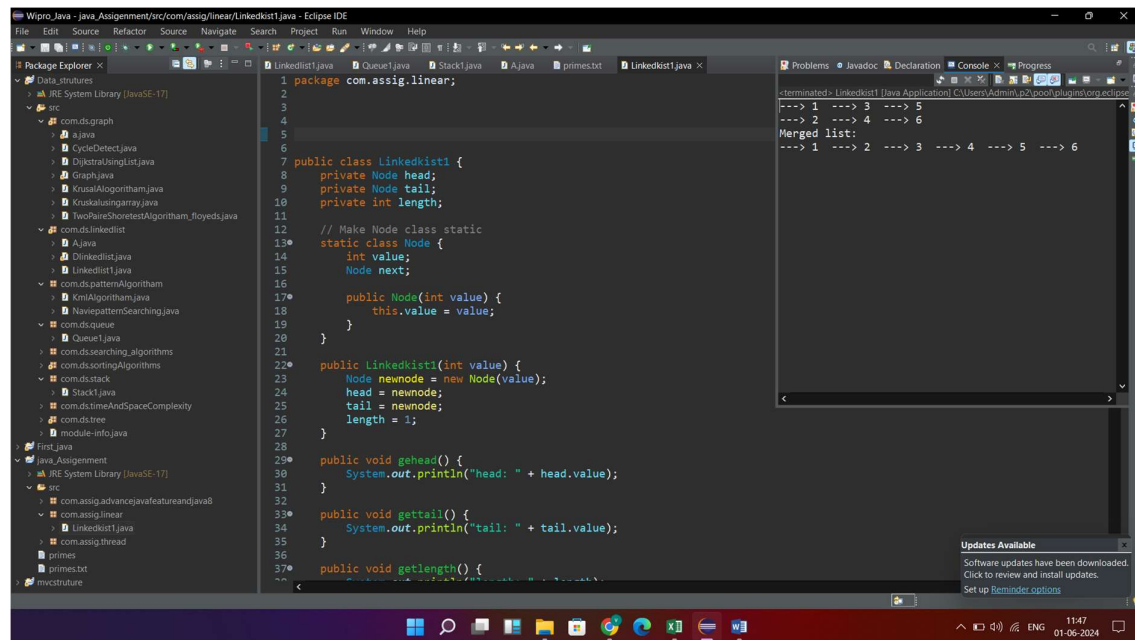
    if (h1 != null) {
        tail.next = h1;
    } else {
        tail.next = h2;
    }

    l1.head = dummy.next;
    l1.tail = l1.head;
    l1.length = 0;
    Node temp = l1.head;
    while (temp != null) {
        l1.length++;
        if (temp.next == null) {
            l1.tail = temp;
        }
        temp = temp.next;
    }
}
```

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```
        return 11;
    }
```

Op:



Task 8: Circular Queue Binary Search

Consider a circular queue (implemented using a fixed-size array) where the elements are sorted but have been rotated at an unknown index. Describe an approach to perform a binary search for a given element within this circular queue.

```
package com.assig.linear;

public class CircularQueueBinarySearch {

    public static int search(int[] array, int target) {
        int low = 0;
        int high = array.length - 1;

        while (low <= high) {
            int mid = low + (high - low) / 2;

            if (array[mid] == target) {
```


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```
        return mid;
    }

    if (array[low] <= array[mid]) {
        if (array[low] <= target && target < array[mid]) {
            high = mid - 1;
        } else {
            low = mid + 1;
        }
    } else {
        if (array[mid] < target && target <= array[high]) {
            low = mid + 1;
        } else {
            high = mid - 1;
        }
    }
}

return -1;
}

public static void main(String[] args) {
    int[] array = { 6, 7, 8, 9, 1, 2, 3, 4, 5 };
    int target = 3;
    int index = search(array, target);

    if (index != -1) {
        System.out.println("Element " + target + " found at
index: " + index);
    } else {
        System.out.println("Element " + target + " not found.");
    }
}
}
```

Op:

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```
14  
15  
16  
17 // Check if the left half is sorted  
18 if (array[low] <= array[mid]) {  
19 // Target is in the left half  
20 if (array[low] <= target && target < array[mid]) {  
21 high = mid - 1;  
22 } else {  
23 low = mid + 1;  
24 }  
25 } else { // Right half is sorted  
26 // Target is in the right half  
27 if (array[mid] < target && target <= array[high]) {  
28 low = mid + 1;  
29 } else {  
30 high = mid - 1;  
31 }  
32 }  
33 }  
34 return -1; // Target not found  
35  
36  
37 public static void main(String[] args) {  
38 int[] array = { 6, 7, 8, 9, 1, 2, 3, 4, 5 };  
39 int target = 3;  
40 int index = search(array, target);  
41  
42 if (index != -1) {  
43 System.out.println("Element " + target + " found at index: " + index);  
44 } else {  
45 System.out.println("Element " + target + " not found.");  
46 }  
47  
48 }  
49  
50
```

Element 3 found at index: 6

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