Assignment-2

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Subject Name: Advanced Programming Lab-2 **Subject Code:** 22CSP-351

Submitted to: Ms. Pratima Sonali Horo(E18304)

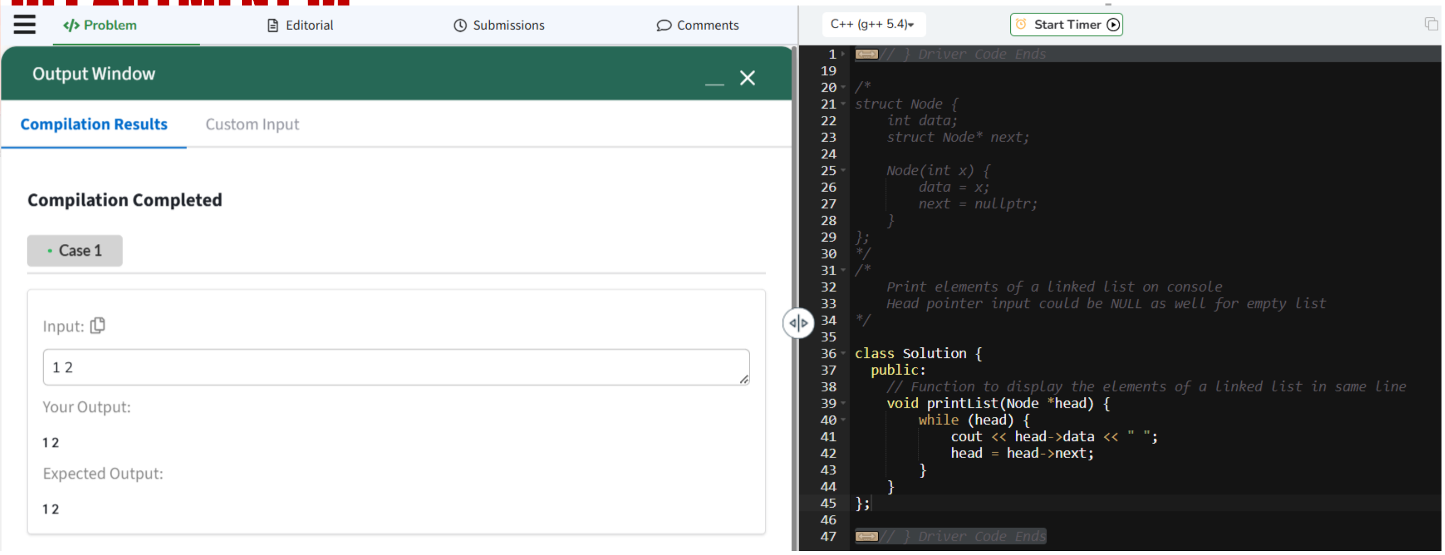
(i): Linked Lists:

Question-1: Print Linked List:

Given a linked list. Print all the elements of the linked list separated by space followed.

Answer:

```
    class Solution {
public:
  // Function to display the elements of a linked list in same line
  void printList(Node *head) {
      while (head) {
          cout << head->data << " ";
          head = head->next;
      }
  }
};
```



Compilation Completed

```
Input:
1 2
Your Output:
1 2
Expected Output:
1 2
```

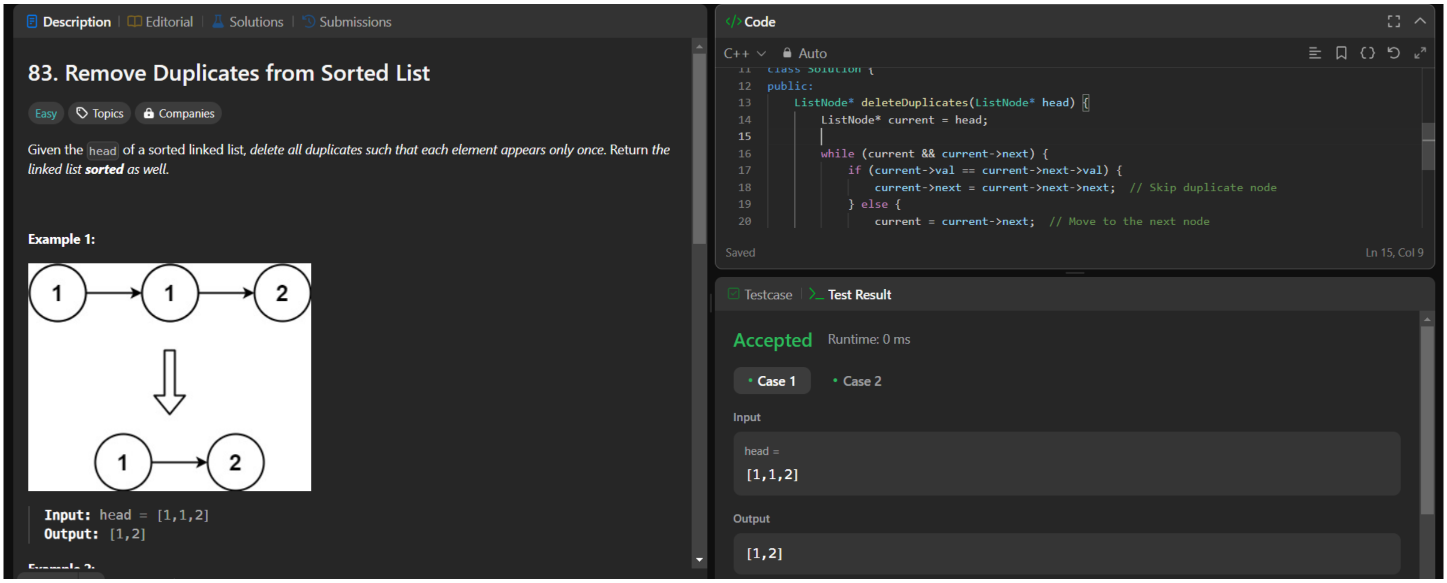
```
// } Driver Code Ends

/*
struct Node {
    int data;
    struct Node* next;

    Node(int x) {
        data = x;
        next = nullptr;
    }
};
*/
/*
    Print elements of a linked list on console
    Head pointer input could be NULL as well for empty list
*/

class Solution {
  public:
    // Function to display the elements of a linked list in same line
    void printList(Node *head) {
        while (head) {
            cout << head->data << " ";
            head = head->next;
        }
    }
};

// } Driver Code Ends
```

Question-2: Remove Duplicates from Sorted List

Given the head of a sorted linked list, *delete all duplicates such that each element appears only once*. Return *the linked list **sorted** as well*.

Answer:

```
class Solution {
public:
    ListNode* deleteDuplicates(ListNode* head) {
        ListNode* current = head;

        while (current && current->next) {
            if (current->val == current->next->val) {
                current->next = current->next->next;  // Skip duplicate node
            } else {
                current = current->next;  // Move to the next node
            }
        }
                return head;
            }
};
```



83. Remove Duplicates from Sorted List

Given the `head` of a sorted linked list, *delete all duplicates such that each element appears only once*. Return *the linked list **sorted** as well.*

Example 1:

```
Input: head = [1,1,2]
Output: [1,2]
```

Example 2:

```
class Solution {
public:
    ListNode* deleteDuplicates(ListNode* head) {
        ListNode* current = head;
        
        while (current && current->next) {
            if (current->val == current->next->val) {
                current->next = current->next->next;  // Skip duplicate node
            } else {
                current = current->next;  // Move to the next node
```

Accepted Runtime: 0 ms

Input

head =

```
[1,1,2]
```

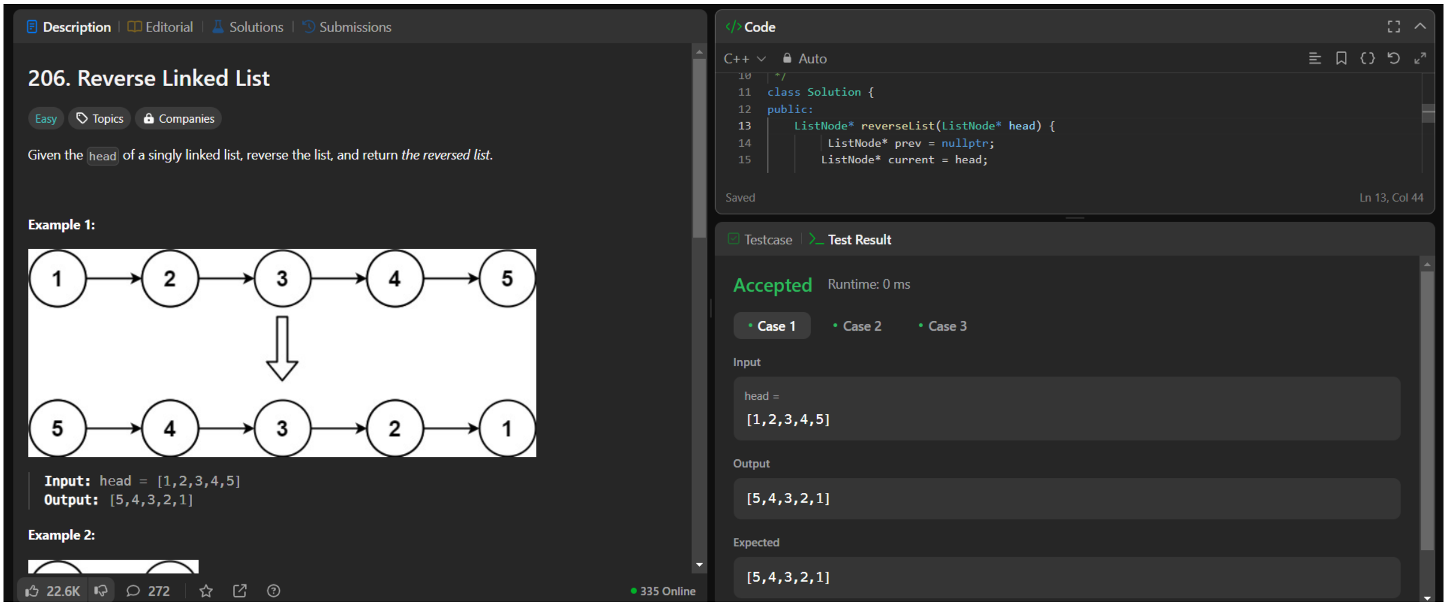
Output

```
[1,2]
```

Question-3: Reverse a linked list: Given the head of a singly linked list, reverse the list, and return *the reversed list*.

Answer:

```
class Solution {
public:




ListNode* reverseList(ListNode* head) {
         ListNode* prev = nullptr;
        ListNode* current = head;

        while (current) {
            ListNode* nextNode = current->next;  // Store next node
            current->next = prev;               // Reverse the link
            prev = current;                     // Move prev ahead
            current = nextNode;                    // Move current ahead
        }
            return prev;  // New head of reversed list
            }
};
```



206. Reverse Linked List

Given the `head` of a singly linked list, reverse the list, and return *the reversed list*.

Example 1:

```
Input: head = [1,2,3,4,5]
Output: [5,4,3,2,1]
```

Example 2:

```
 */
class Solution {
public:
    ListNode* reverseList(ListNode* head) {
        ListNode* prev = nullptr;
       ListNode* current = head;
```

Accepted Runtime: 0 ms

Input

```
head =
[1,2,3,4,5]
```

Output

```
[5,4,3,2,1]
```

Expected

```
[5,4,3,2,1]
```

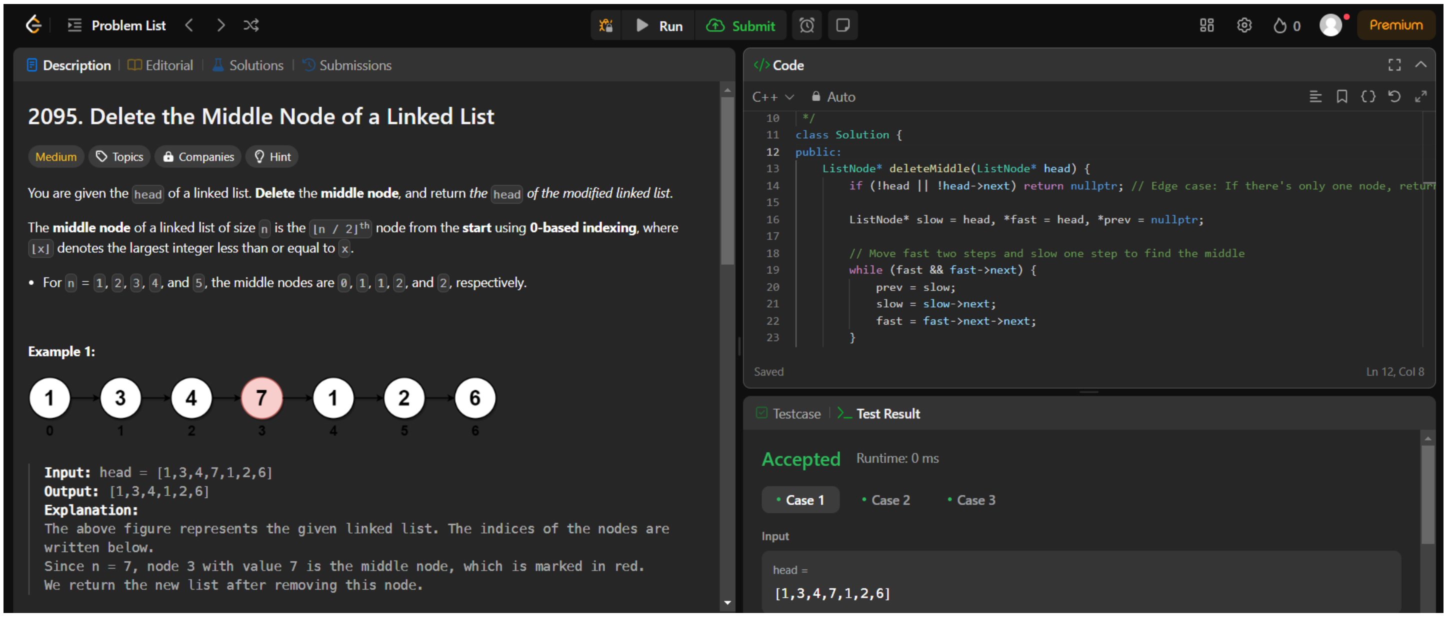
Question-4: Delete middle node of a list:

You are given the head of a linked list. **Delete** the **middle node**, and return *the* head *of the modified linked list*.

The **middle node** of a linked list of size n is the ⌊n / 2⌋th node from the **start** using **0-based indexing**, where ⌊x⌋ denotes the largest integer less than or equal to x.

Answer:

```
class Solution {
public:
    ListNode* deleteMiddle(ListNode* head) {




if (!head || !head->next) return nullptr; // Edge case: If there's only one node, return NULL

        ListNode* slow = head, *fast = head, *prev = nullptr;

        // Move fast two steps and slow one step to find the middle
        while (fast && fast->next) {
            prev = slow;
            slow = slow->next;
            fast = fast->next->next;
        }

        // Remove the middle node
        prev->next = slow->next;
        delete slow;
            return head;
          }
};
```



2095. Delete the Middle Node of a Linked List

You are given the `head` of a linked list. **Delete** the **middle node**, and return *the* `head` *of the modified linked list.*

The **middle node** of a linked list of size `n` is the `⌊n / 2⌋`th node from the **start** using **0-based indexing**, where `⌊x⌋` denotes the largest integer less than or equal to `x`.

- For `n` = `1`, `2`, `3`, `4`, and `5`, the middle nodes are `0`, `1`, `1`, `2`, and `2`, respectively.

Example 1:

```
Input: head = [1,3,4,7,1,2,6]
Output: [1,3,4,1,2,6]
Explanation:
The above figure represents the given linked list. The indices of the nodes are
written below.
Since n = 7, node 3 with value 7 is the middle node, which is marked in red.
We return the new list after removing this node.
```

```
 */
class Solution {
public:
    ListNode* deleteMiddle(ListNode* head) {
        if (!head || !head->next) return nullptr; // Edge case: If there's only one node, retur

        ListNode* slow = head, *fast = head, *prev = nullptr;

        // Move fast two steps and slow one step to find the middle
        while (fast && fast->next) {
            prev = slow;
            slow = slow->next;
            fast = fast->next->next;
        }
```

Accepted Runtime: 0 ms

Input

```
head =
[1,3,4,7,1,2,6]
```

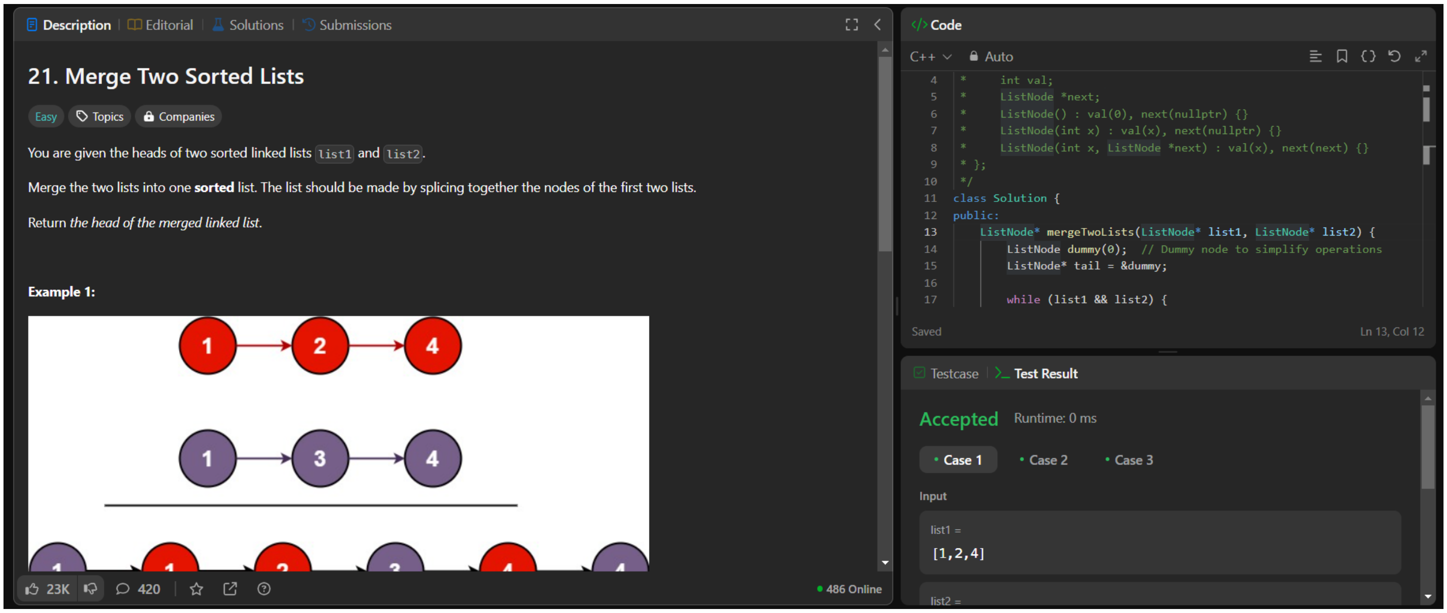
Question-5: Merge two sorted linked lists: You are given the heads of two sorted linked lists list1 and list2.

Merge the two lists into one sorted list. The list should be made by splicing together the nodes of the first two lists.

Return *the head of the merged linked list*.

Answer:

```
class Solution {
public:
    ListNode* mergeTwoLists(ListNode* list1, ListNode* list2) {
        ListNode dummy(0);  // Dummy node to simplify operations
        ListNode* tail = &dummy;
        while (list1 && list2) {
            if (list1->val < list2->val) {
                tail->next = list1;
                list1 = list1->next;
            } else {
                tail->next = list2;
                list2 = list2->next;
            }
            tail = tail->next;
        }

        // Append remaining nodes
        tail->next = list1 ? list1 : list2;

        return dummy.next;

    }
};
```



21. Merge Two Sorted Lists

You are given the heads of two sorted linked lists `list1` and `list2`.

Merge the two lists into one **sorted** list. The list should be made by splicing together the nodes of the first two lists.

Return *the head of the merged linked list.*

Example 1:

```
 *     int val;
 *     ListNode *next;
 *     ListNode() : val(0), next(nullptr) {}
 *     ListNode(int x) : val(x), next(nullptr) {}
 *     ListNode(int x, ListNode *next) : val(x), next(next) {}
 * };
 */
class Solution {
public:
    ListNode* mergeTwoLists(ListNode* list1, ListNode* list2) {
        ListNode dummy(0);  // Dummy node to simplify operations
        ListNode* tail = &dummy;

        while (list1 && list2) {
```

Accepted Runtime: 0 ms

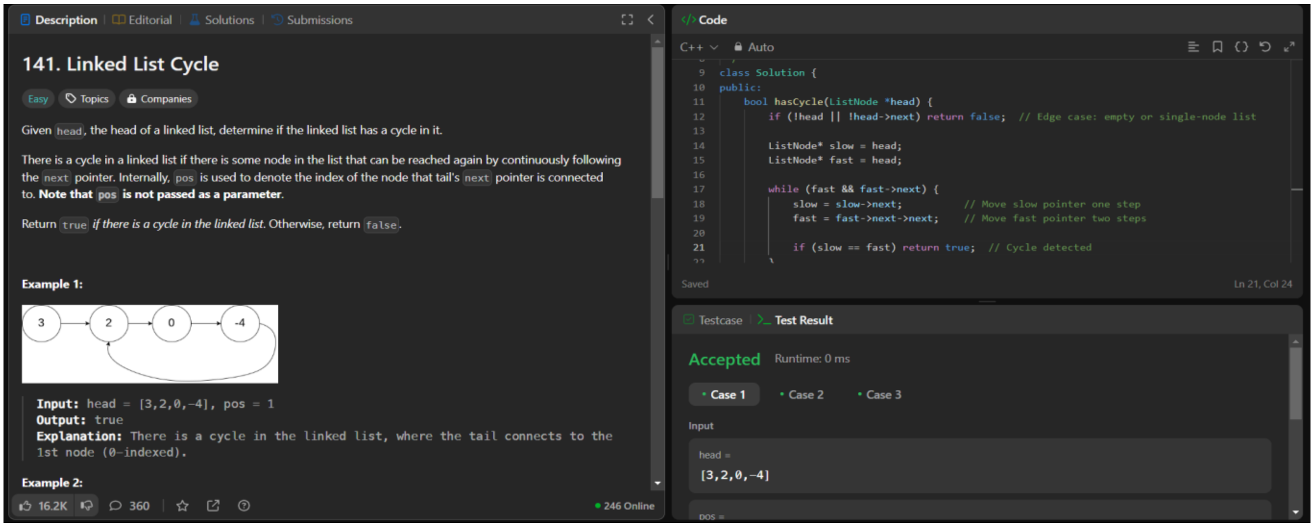
Input

list1 =
[1,2,4]

list2 =

Question-6: Detect a cycle in a linked list:
Given head, the head of a linked list, determine if the linked list has a cycle in it.
There is a cycle in a linked list if there is some node in the list that can be reached again by continuously following the next pointer. Internally, pos is used to denote the index of the node that tail's next pointer is connected to. **Note that pos is not passed as a parameter**.
Return true *if there is a cycle in the linked list*. Otherwise, return false.
Answer:

```
class Solution {
public:
    bool hasCycle(ListNode *head) {
        if (!head || !head->next) return false;  // Edge case: empty or single-node list

        ListNode* slow = head;
        ListNode* fast = head;

        while (fast && fast->next) {
            slow = slow->next;          // Move slow pointer one step
            fast = fast->next->next;    // Move fast pointer two steps

            if (slow == fast) return true;  // Cycle detected
        }

        return false;  // No cycle found

    }
};
```



141. Linked List Cycle

Given head, the head of a linked list, determine if the linked list has a cycle in it.

There is a cycle in a linked list if there is some node in the list that can be reached again by continuously following the next pointer. Internally, pos is used to denote the index of the node that tail's next pointer is connected to. **Note that pos is not passed as a parameter**.

Return true *if there is a cycle in the linked list*. Otherwise, return false.

Example 1:

```
Input: head = [3,2,0,-4], pos = 1
Output: true
Explanation: There is a cycle in the linked list, where the tail connects to the
1st node (0-indexed).
```

Example 2:

```
class Solution {
public:
    bool hasCycle(ListNode *head) {
        if (!head || !head->next) return false;  // Edge case: empty or single-node list

        ListNode* slow = head;
        ListNode* fast = head;

        while (fast && fast->next) {
            slow = slow->next;          // Move slow pointer one step
            fast = fast->next->next;    // Move fast pointer two steps

            if (slow == fast) return true;  // Cycle detected
```

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Ln 21, Col 24

Accepted Runtime: 0 ms

Input

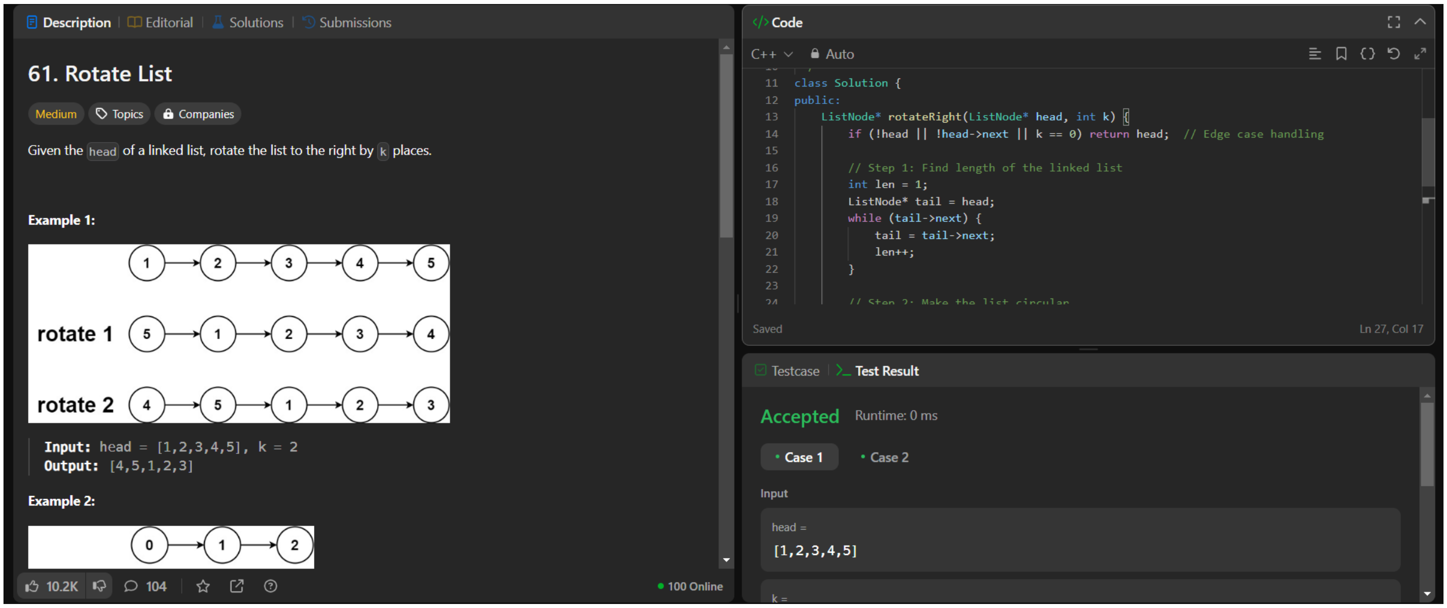
head =
[3,2,0,-4]

pos =

Question-7: Rotate List: Given the head of a linked list, rotate the list to the right by k places.

Answer:

```
class Solution {
public:
    ListNode* rotateRight(ListNode* head, int k) {
        if (!head || !head->next || k == 0) return head;  // Edge case handling

        // Step 1: Find length of the linked list
        int len = 1;
        ListNode* tail = head;
        while (tail->next) {
            tail = tail->next;
            len++;
        }

        // Step 2: Make the list circular
        tail->next = head;

        // Step 3: Compute the new tail position
        k = k % len;  // Optimize k (rotation beyond length is redundant)
        int stepsToNewHead = len - k;  // Find the new head position
        ListNode* newTail = head;

        for (int i = 1; i < stepsToNewHead; i++) {
            newTail = newTail->next;
        }

        // Step 4: Break the cycle and set the new head
        head = newTail->next;
        newTail->next = nullptr;

        return head;

    }
};
```



61. Rotate List

Given the head of a linked list, rotate the list to the right by k places.

Example 1:

```
Input: head = [1,2,3,4,5], k = 2
Output: [4,5,1,2,3]
```

Example 2:

```
class Solution {
public:
    ListNode* rotateRight(ListNode* head, int k) {
        if (!head || !head->next || k == 0) return head;  // Edge case handling

        // Step 1: Find length of the linked list
        int len = 1;
        ListNode* tail = head;
        while (tail->next) {
            tail = tail->next;
            len++;
        }

        // Step 2: Make the list circular
```

Saved

Ln 27, Col 17

Accepted Runtime: 0 ms

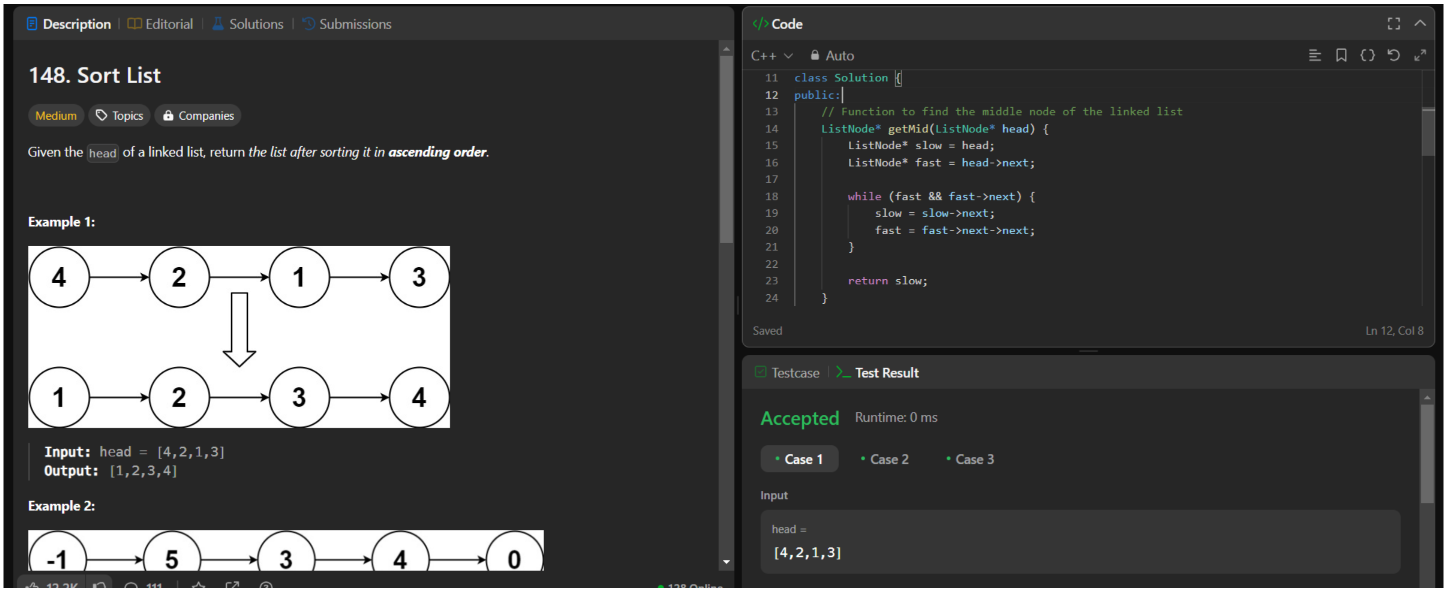
Input

```
head =
[1,2,3,4,5]
k =
```

Question-8: Sort List: Given the head of a linked list, return *the list after sorting it* in **ascending order**.

Answer:

```
class Solution {
public:
    // Function to find the middle node of the linked list
    ListNode* getMid(ListNode* head) {
        ListNode* slow = head;
        ListNode* fast = head->next;

        while (fast && fast->next) {
            slow = slow->next;
            fast = fast->next->next;
        }

        return slow;
    }

    // Function to merge two sorted lists
    ListNode* merge(ListNode* l1, ListNode* l2) {
        ListNode dummy(0);
        ListNode* tail = &dummy;
while (l1 && l2) {
            if (l1->val < l2->val) {
                tail->next = l1;
                l1 = l1->next;
            } else {
                tail->next = l2;
                l2 = l2->next;
            }
            tail = tail->next;
        }

        if (l1) tail->next = l1;
        if (l2) tail->next = l2;

        return dummy.next;
    }

    // Function to sort the linked list using Merge Sort
    ListNode* sortList(ListNode* head) {
        if (!head || !head->next) return head;

        ListNode* mid = getMid(head);
        ListNode* rightHead = mid->next;
        mid->next = nullptr;

        ListNode* left = sortList(head);
        ListNode* right = sortList(rightHead);

        return merge(left, right);
    }
};
```



148. Sort List

Given the `head` of a linked list, return *the list after sorting it in* ***ascending order***.

Example 1:

```
Input: head = [4,2,1,3]
Output: [1,2,3,4]
```

Example 2:

```
class Solution {
public:
    // Function to find the middle node of the linked list
    ListNode* getMid(ListNode* head) {
        ListNode* slow = head;
        ListNode* fast = head->next;

        while (fast && fast->next) {
            slow = slow->next;
            fast = fast->next->next;
        }

        return slow;
    }
```

Accepted Runtime: 0 ms

Input

head =
[4,2,1,3]

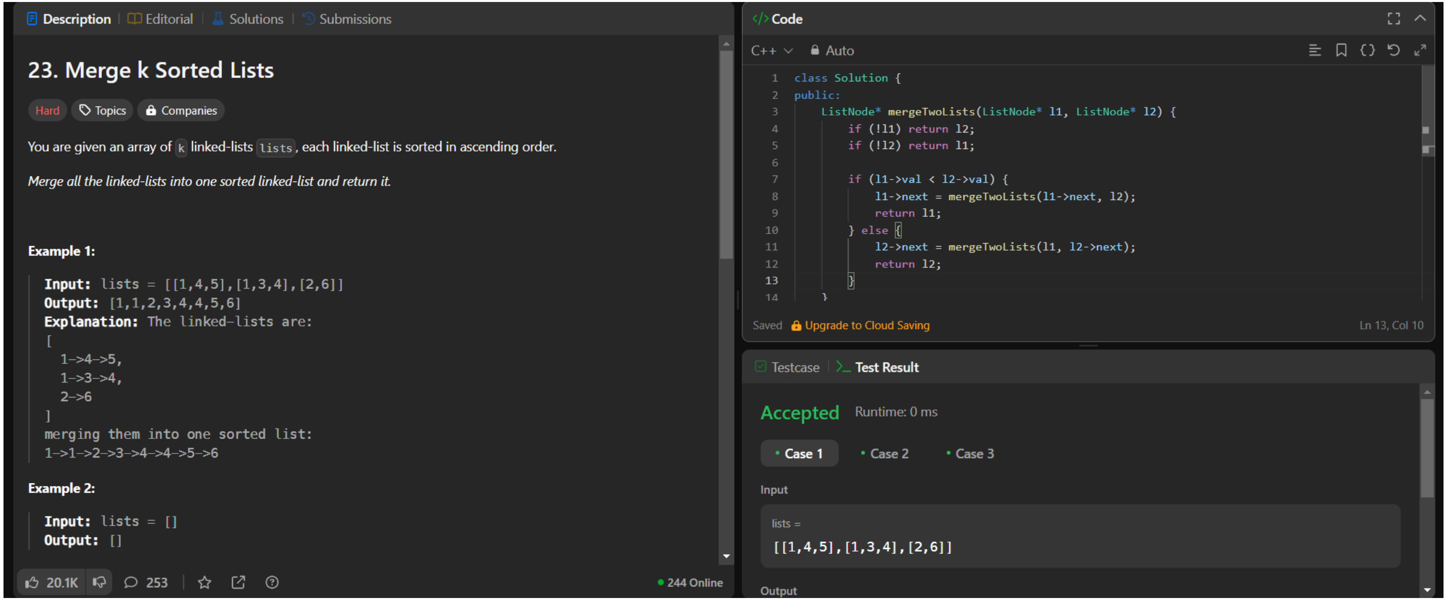
Question-9: Merge k sorted lists:

You are given an array of k linked-lists lists, each linked-list is sorted in ascending order.
Merge all the linked-lists into one sorted linked-list and return it.

Answer:

```
class Solution {
public:
    ListNode* mergeTwoLists(ListNode* l1, ListNode* l2) {
        if (!l1) return l2;
        if (!l2) return l1;

        if (l1->val < l2->val) {
            l1->next = mergeTwoLists(l1->next, l2);
            return l1;
        } else {
            l2->next = mergeTwoLists(l1, l2->next);
            return l2;
        }
    }

    ListNode* mergeKLists(vector<ListNode*>& lists) {
        if (lists.empty()) return nullptr;
        int n = lists.size();

        while (n > 1) {
```

```
int j = 0;
            for (int i = 0; i < n / 2; i++) {
                lists[i] = mergeTwoLists(lists[i], lists[n - i - 1]);
            }
            n = (n + 1) / 2; // Reduce the number of lists
        }

        return lists[0];
    }
};
```



23. Merge k Sorted Lists

You are given an array of `k` linked-lists `lists`, each linked-list is sorted in ascending order.

Merge all the linked-lists into one sorted linked-list and return it.

Example 1:

```
Input: lists = [[1,4,5],[1,3,4],[2,6]]
Output: [1,1,2,3,4,4,5,6]
Explanation: The linked-lists are:
[
  1->4->5,
  1->3->4,
  2->6
]
merging them into one sorted list:
1->1->2->3->4->4->5->6
```

Example 2:

```
Input: lists = []
Output: []
```

```
class Solution {
public:
    ListNode* mergeTwoLists(ListNode* l1, ListNode* l2) {
        if (!l1) return l2;
        if (!l2) return l1;

        if (l1->val < l2->val) {
            l1->next = mergeTwoLists(l1->next, l2);
            return l1;
        } else {
            l2->next = mergeTwoLists(l1, l2->next);
            return l2;
        }
    }
```

Accepted Runtime: 0 ms

Input

lists =
[[1,4,5],[1,3,4],[2,6]]

Output