Department of CSE-AI & ML

III Year II Sem

MR22-1 CS0208- DESIGN AND ANALYSIS OF ALGORITHMS

Holiday Assignment Questions

LEETCODE DAA Challenges

Name: P. Manik Tanay Reddy

Roll No: 2211cs020308

Section: AIML Zeta

You are expected to work through the DAA exercises and challenges available at the following link: https://leetcode.com/problem-list/linked-list/

Q1. Find the Index of the First occurrence in a String:
Given two strings needle and haystack, return the index of the first occurrence of needle in haystack, or -1 if needle is not part of haystack.
Input: haystack = "sadbutsad", needle = "sad"
Output: 0
Explanation: "sad" occurs at index 0 and 6.
The first occurrence is at index 0, so we return 0.
Example 2:
Input: haystack = "leetcode", needle = "leeto"
Output: -1
Explanation: "leeto" did not occur in "leetcode", so we return -1.

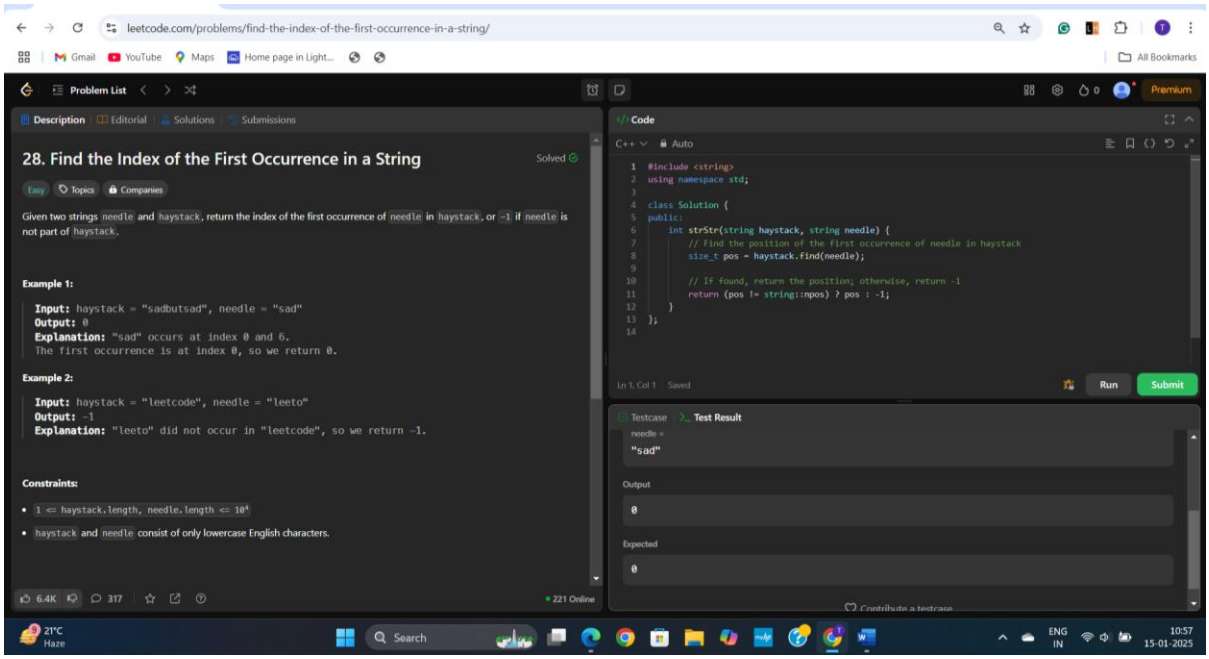
Constraints:

- **1 <= haystack.length, needle.length <= 10^4**
- **haystack and needle consist of only lowercase English characters.**

1A. Code:

```
#include <string>
using namespace std;

class Solution {
public:
    int strStr(string haystack, string needle) {
        // Find the position of the first occurrence of needle in haystack
        size_t pos = haystack.find(needle);

        // If found, return the position; otherwise, return -1
        return (pos != string::npos) ? pos : -1;
    }
};
```

Output:



Q2. Bitwise and of Number Range e

201. Bitwise AND of Numbers Range

Given two integers left and right that represent the range [left, right], return *the bitwise AND of all numbers in this range, inclusive*.

Example 1:

Input: left = 5, right = 7

Output: 4

Example 2:

Input: left = 0, right = 0

Output: 0

Example 3:

Input: left = 1, right = 2147483647

Output: 0

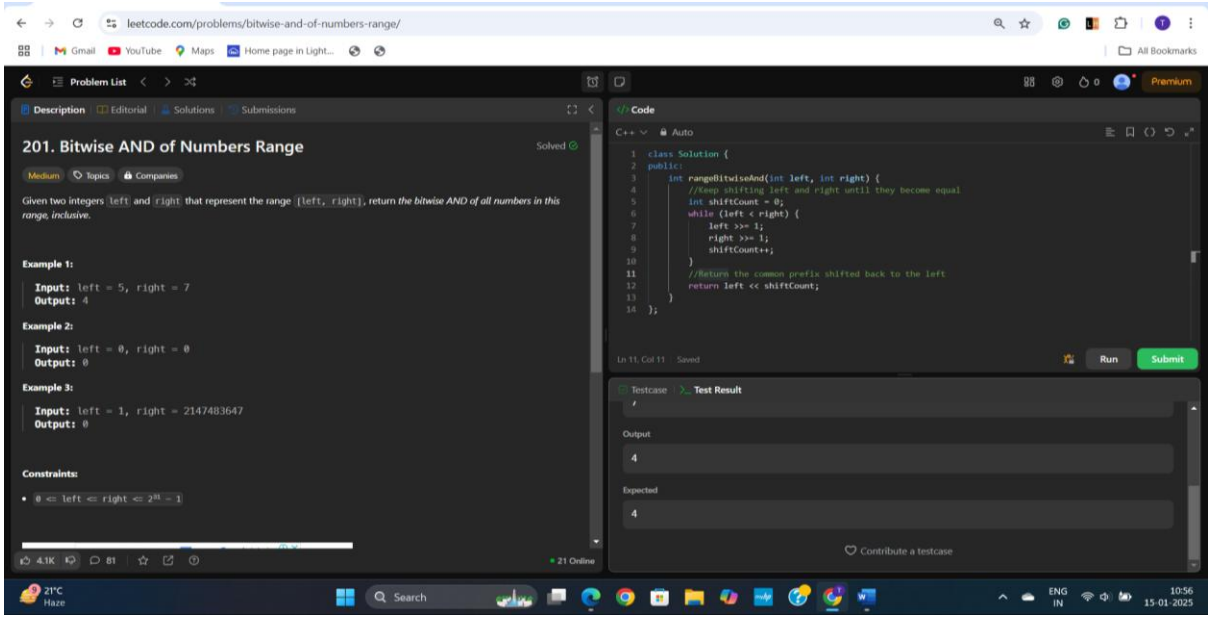
Constraints:

- **0 <= left <= right <= 2^{31} - 1**

2A. Code:

```
class Solution {
public:
   int rangeBitwiseAnd(int left, int right) {
      //Keep shifting left and right until they become equal
      int shiftCount = 0;
      while (left < right) {
         left >>= 1;
         right >>= 1;
         shiftCount++;
      }
      //Return the common prefix shifted back to the left
      return left << shiftCount;
   }
};
```

Output:



Q3. Square Root
69. Sqrt(x)

Given a non-negative integer x, return *the square root of* x *rounded down to the nearest integer*. The returned integer should be non-negative as well.
You must not use any built-in exponent function or operator.

- **For example, do not use pow(x, 0.5) in c++ or x ** 0.5 in python.**

Example 1:
Input: x = 4
Output: 2
Explanation: The square root of 4 is 2, so we return 2.
Example 2:
Input: x = 8
Output: 2
Explanation: The square root of 8 is 2.82842..., and since we round it down to the nearest integer, 2 is returned.

Constraints:

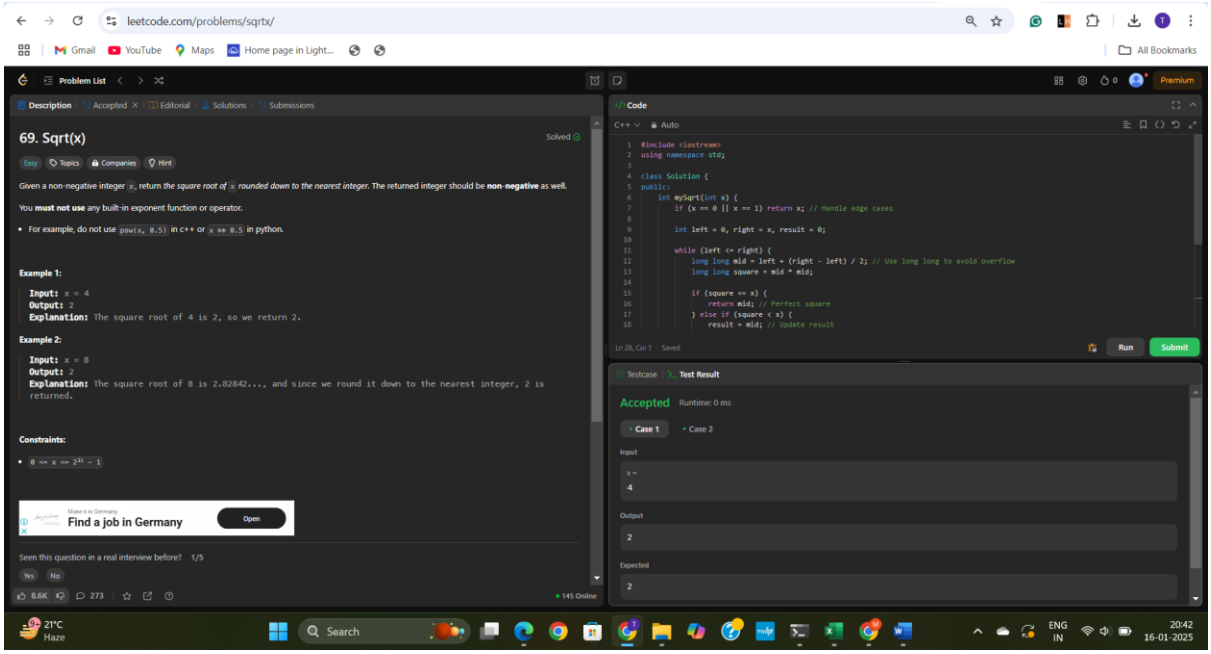
- **$0 <= x <= 2^{31} - 1$**

<u>3A. Code:</u>

```
#include <iostream>
using namespace std;

class Solution {
public:
  int mySqrt(int x) {
    if (x == 0 || x == 1) return x; // Handle edge cases

    int left = 0, right = x, result = 0;

    while (left <= right) {
      long long mid = left + (right - left) / 2; // Use long long to avoid overflow
```

```
            long long square = mid * mid;

            if (square == x) {
                return mid; // Perfect square
            } else if (square < x) {
                result = mid; // Update result
                left = mid + 1; // Search in the right half
            } else {
                right = mid - 1; // Search in the left half
            }
        }

        return result; // Return the largest integer whose square <= x
    }
};
```

Output:



Q4. Largest Number
179. Largest Number
Given a list of non-negative integers nums, arrange them such that they form the largest number and return it.
Since the result may be very large, so you need to return a string instead of an integer.

Example 1:
Input: nums = [10,2]
Output: "210"
Example 2:
Input: nums = [3,30,34,5,9]
Output: "9534330"

Constraints:

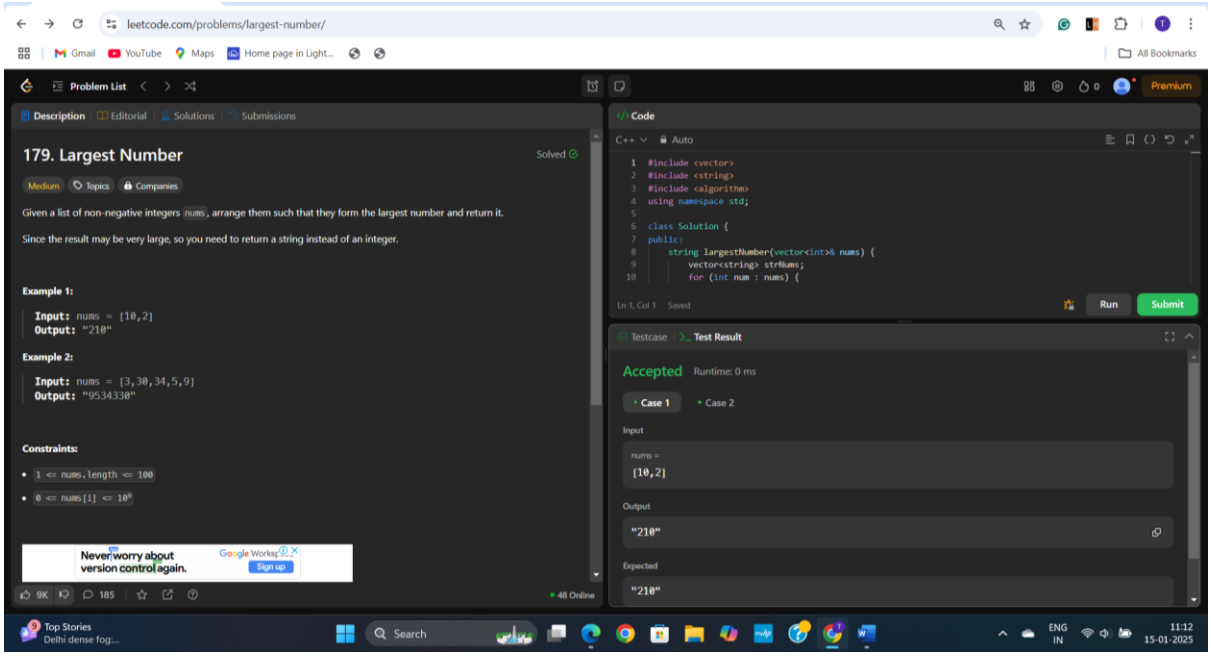
- **1 <= nums.length <= 100**

- **0 <= nums[i] <= 10^9**

4A. Code:

```
#include <vector>
#include <string>
#include <algorithm>
using namespace std;

class Solution {
public:
   string largestNumber(vector<int>& nums) {
      vector<string> strNums;
      for (int num : nums) {
         strNums.push_back(to_string(num));
      }

      auto compare = [](const string& a, const string& b) {
         return a + b > b + a;
      };

      sort(strNums.begin(), strNums.end(), compare);

      string result;
      for (const string& str : strNums) {
         result += str;
      }

      if (result[0] == '0') {
         return "0";
      }

      return result;
   }
};
```

Output:



Q5. Valid Parenthesis

20. Valid Parentheses

Given a string s containing just the characters '(', ')', '{', '}', '[' and ']', determine if the input string is valid.

An input string is valid if:

1. Open brackets must be closed by the same type of brackets.
2. Open brackets must be closed in the correct order.
3. Every close bracket has a corresponding open bracket of the same type.

Example 1:

Input: s = "()"

Output: true

Example 2:

Input: s = "()[]{}"

Output: true

Example 3:

Input: s = "(]"

Output: false

Example 4:

Input: s = "([])"

Output: true

Constraints:

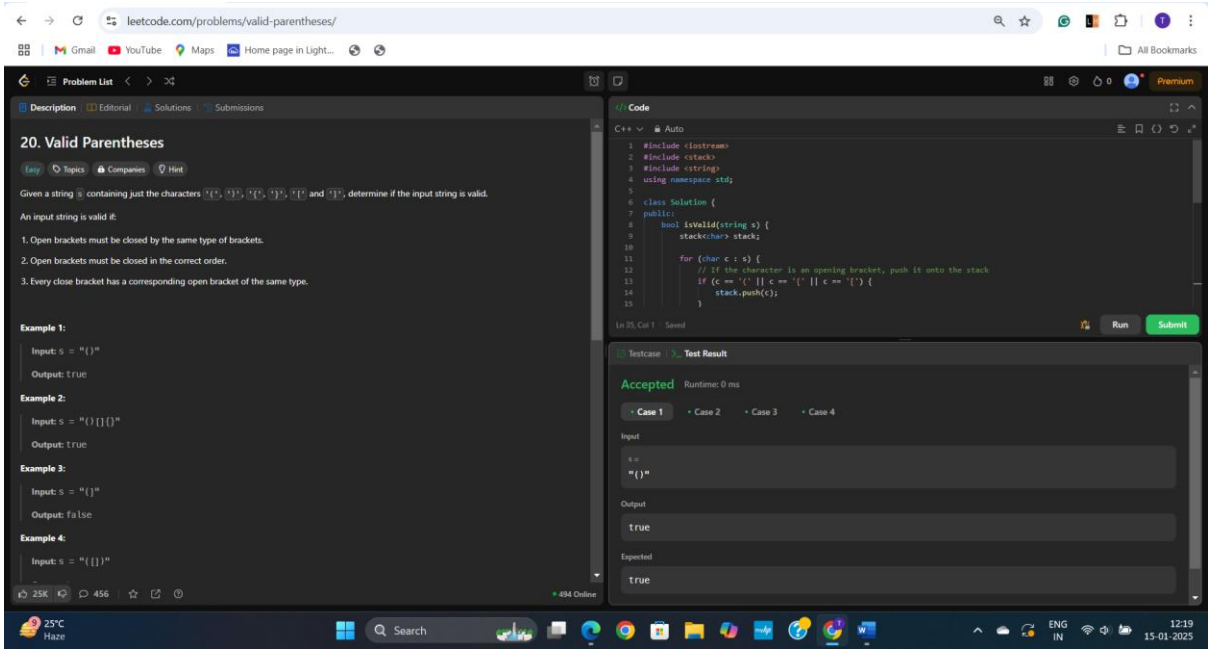
- 1 <= s.length <= 10^4
- s consists of parentheses only '()[]{}'.

5A. Code:

```
#include <iostream>
#include <stack>
#include <string>
using namespace std;

class Solution {
public:
```

```
    bool isValid(string s) {
        stack<char> stack;

        for (char c : s) {
            // If the character is an opening bracket, push it onto the stack
            if (c == '(' || c == '{' || c == '[') {
                stack.push(c);
            }
            // If the character is a closing bracket, check if it matches the top of the stack
            else if (c == ')' || c == '}' || c == ']') {
                if (stack.empty()) {
                    return false; // No opening bracket to match with
                }
                char top = stack.top();
                stack.pop();

                // Check if the top of the stack matches the corresponding opening bracket
                if ((c == ')' && top != '(') || (c == '}' && top != '{') || (c == ']' && top != '[')) {
                    return false;
                }
            }
        }

        // If the stack is empty, all brackets were matched, otherwise return false
        return stack.empty();
    }
};
```

Output:

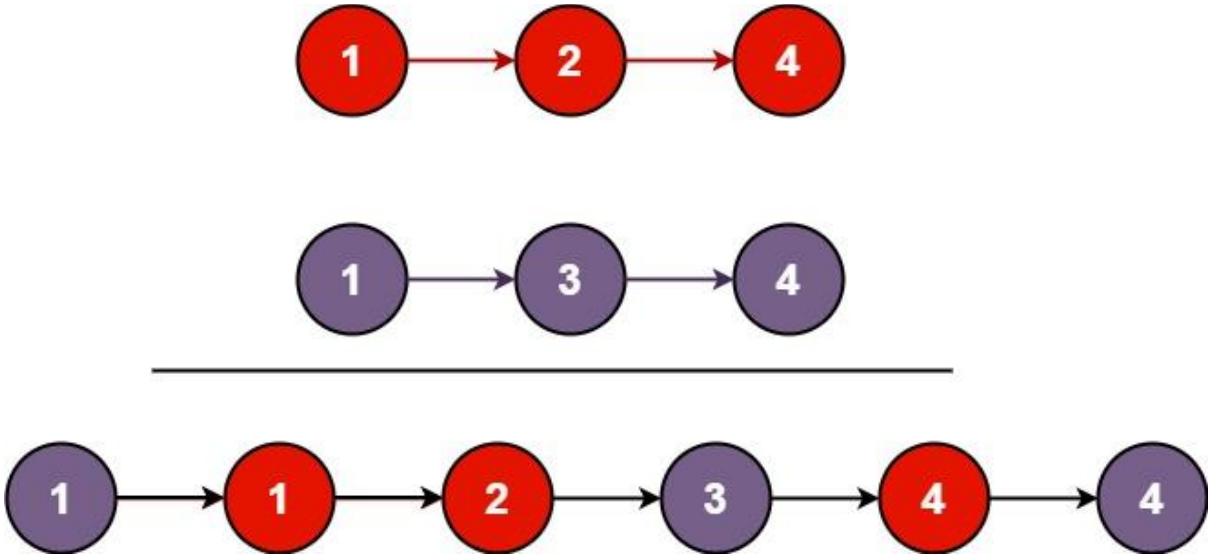


Q6. Merge two Sorted List

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:



Input: list1 = [1,2,4], list2 = [1,3,4]
Output: [1,1,2,3,4,4]
Example 2:
Input: list1 = [], list2 = []
Output: []
Example 3:
Input: list1 = [], list2 = [0]
Output: [0]

Constraints:

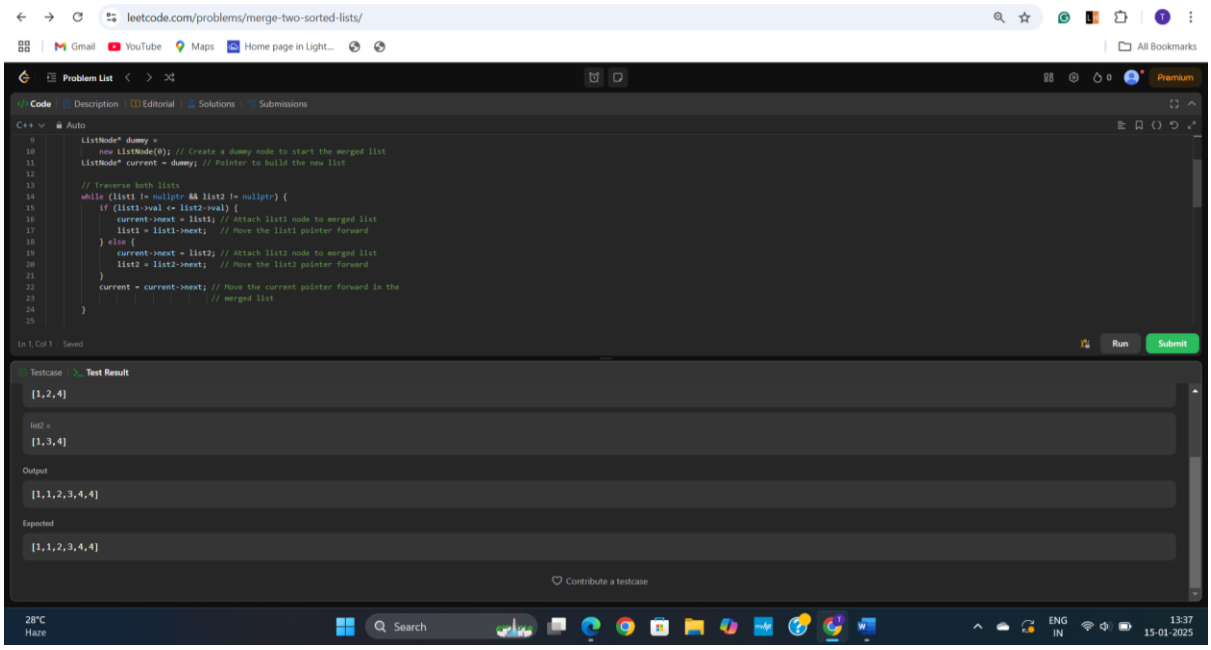
- **The number of nodes in both lists is in the range [0, 50].**
- **-100 <= Node.val <= 100**
- **Both list1 and list2 are sorted in non-decreasing order.**

6A. Code:

```
#include <iostream>
#include <vector>
 // Include the ListNode header
using namespace std;

class Solution {
public:
   ListNode* mergeTwoLists(ListNode* list1, ListNode* list2) {
      ListNode* dummy = new ListNode(0);  // Create a dummy node to start the merged list
      ListNode* current = dummy;  // Pointer to build the new list

      // Traverse both lists
      while (list1 != nullptr && list2 != nullptr) {
         if (list1->val <= list2->val) {
            current->next = list1;  // Attach list1 node to merged list
            list1 = list1->next;     // Move the list1 pointer forward
```

```
            } else {
                current->next = list2;  // Attach list2 node to merged list
                list2 = list2->next;     // Move the list2 pointer forward
            }
            current = current->next;  // Move the current pointer forward in the merged list
        }

        // If there are remaining nodes in list1 or list2, attach them
        if (list1 != nullptr) {
            current->next = list1;
        } else if (list2 != nullptr) {
            current->next = list2;
        }

        return dummy->next;  // Return the merged list starting from the first node
    }
};

// Helper function to create a linked list from a vector
ListNode* createList(const vector<int>& nums) {
    ListNode* head = nullptr;
    ListNode* current = nullptr;
    for (int num : nums) {
        if (!head) {
            head = new ListNode(num);
            current = head;
        } else {
            current->next = new ListNode(num);
            current = current->next;
        }
    }
    return head;
}

// Helper function to print the linked list
void printList(ListNode* head) {
    while (head != nullptr) {
        cout << head->val << " ";
        head = head->next;
    }
    cout << endl;
}
```

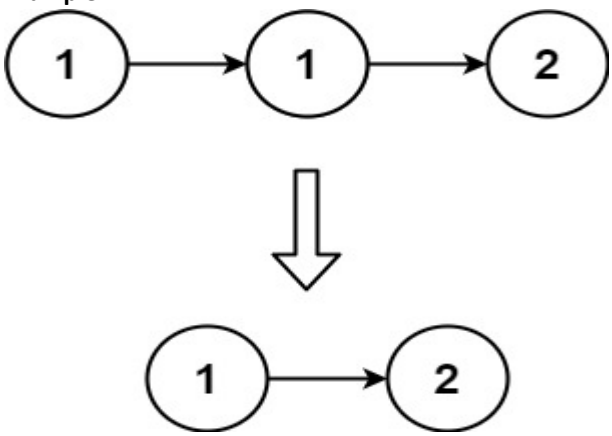
Output:



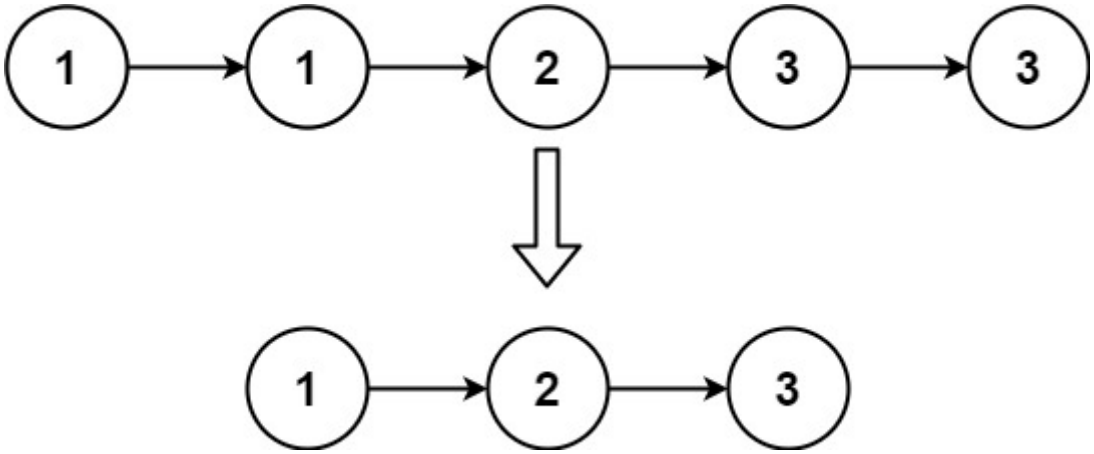
Q7. Remove duplicates from sorted list
83. Remove Duplicates from Sorted List

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:



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

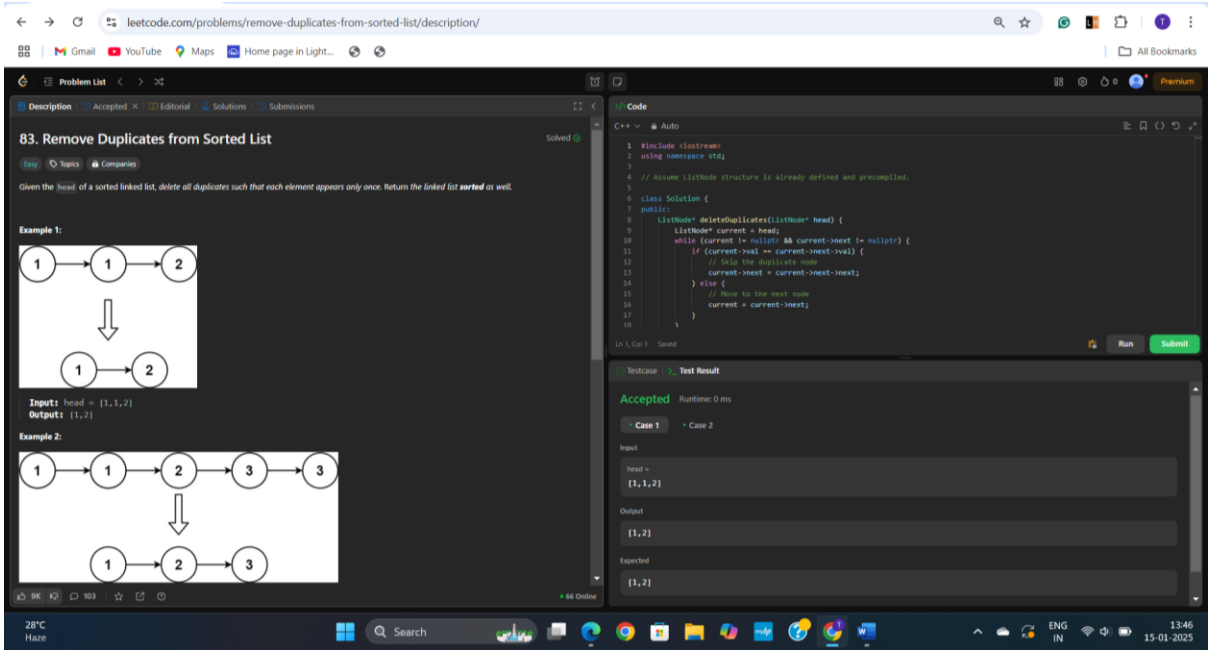
Constraints:

- **The number of nodes in the list is in the range [0, 300].**
- **-100 <= Node.val <= 100**
- **The list is guaranteed to be sorted in ascending order.**

7A. Code:

```
#include <iostream>
using namespace std;

// Assume ListNode structure is already defined and precompiled.

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

// Helper function to print the linked list
void printList(ListNode* head) {
   while (head != nullptr) {
      cout << head->val << " ";
      head = head->next;
   }
   cout << endl;
}
```

Output:



Q8. Find a Peek Element
162. Find Peak Element

A peak element is an element that is strictly greater than its neighbors.
Given a 0-indexed integer array nums, find a peak element, and return its index. If the array contains multiple peaks, return the index to any of the peaks.
You may imagine that nums[-1] = nums[n] = -∞. In other words, an element is always considered to be strictly greater than a neighbor that is outside the array.
You must write an algorithm that runs in O(log n) time.

Example 1:
Input: nums = [1,2,3,1]
Output: 2
Explanation: 3 is a peak element and your function should return the index number 2.
Example 2:
Input: nums = [1,2,1,3,5,6,4]
Output: 5
Explanation: Your function can return either index number 1 where the peak element is 2, or index number 5 where the peak element is 6.

Constraints:

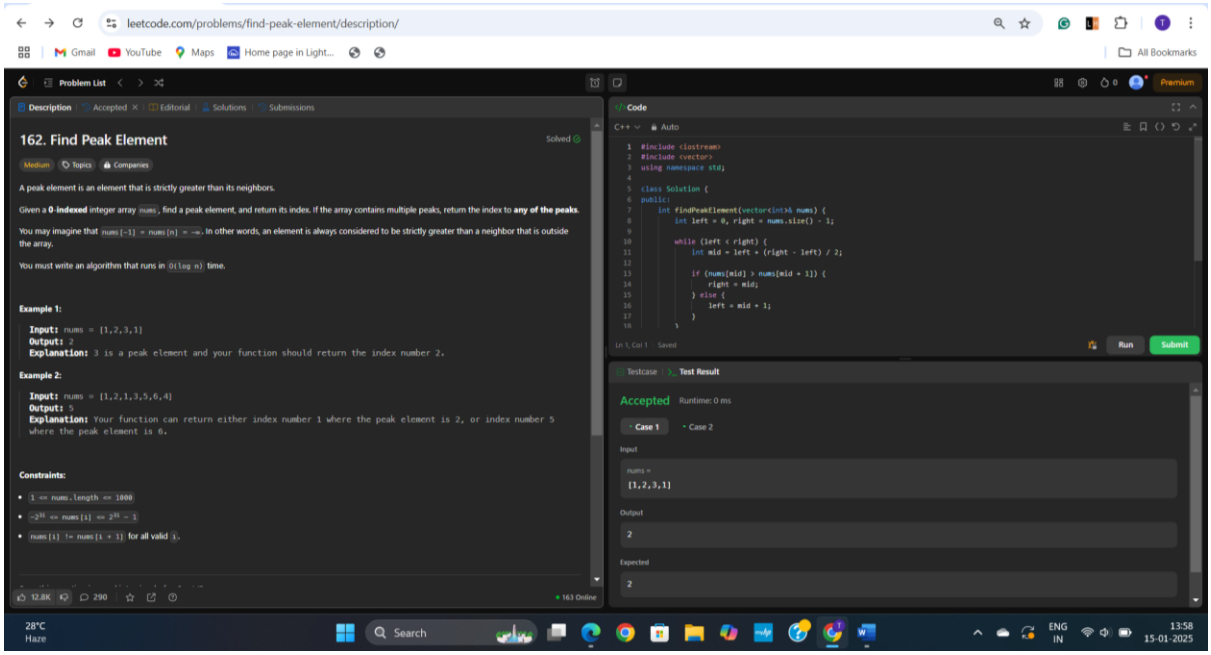
- **1 <= nums.length <= 1000**
- **-2^{31} <= nums[i] <= 2^{31} - 1**
- **nums[i] != nums[i + 1] for all valid i.**

<u>8A. Code:</u>

```
#include <iostream>
#include <vector>
using namespace std;

class Solution {
public:
```

```
    int findPeakElement(vector<int>& nums) {
        int left = 0, right = nums.size() - 1;

        while (left < right) {
            int mid = left + (right - left) / 2;

            if (nums[mid] > nums[mid + 1]) {
                right = mid;
            } else {
                left = mid + 1;
            }
        }

        return left;
    }
};
```

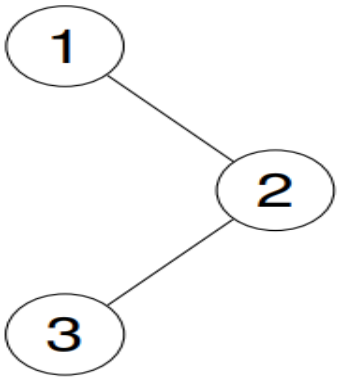
Output:



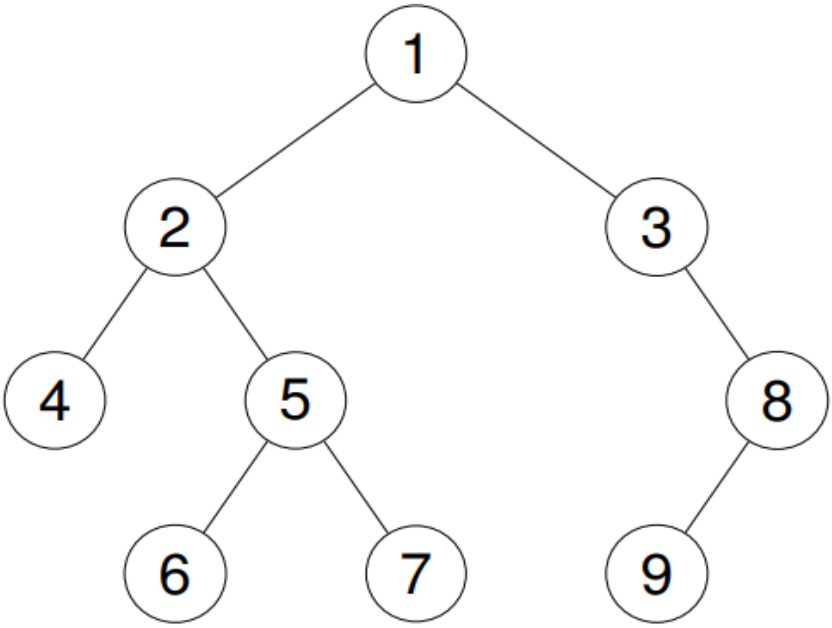
Q9. Binary Tree: IN order Traversal
94. Binary Tree Inorder Traversal

Given the root of a binary tree, return *the inorder traversal of its nodes' values*.

Example 1:
Input: root = [1,null,2,3]
Output: [1,3,2]
Explanation:



Example 2:
Input: root = [1,2,3,4,5,null,8,null,null,6,7,9]
Output: [4,2,6,5,7,1,3,9,8]
Explanation:



Example 3:
Input: root = []
Output: []
Example 4:
Input: root = [1]
Output: [1]

Constraints:

- The number of nodes in the tree is in the range [0, 100].
- -100 <= Node.val <= 100

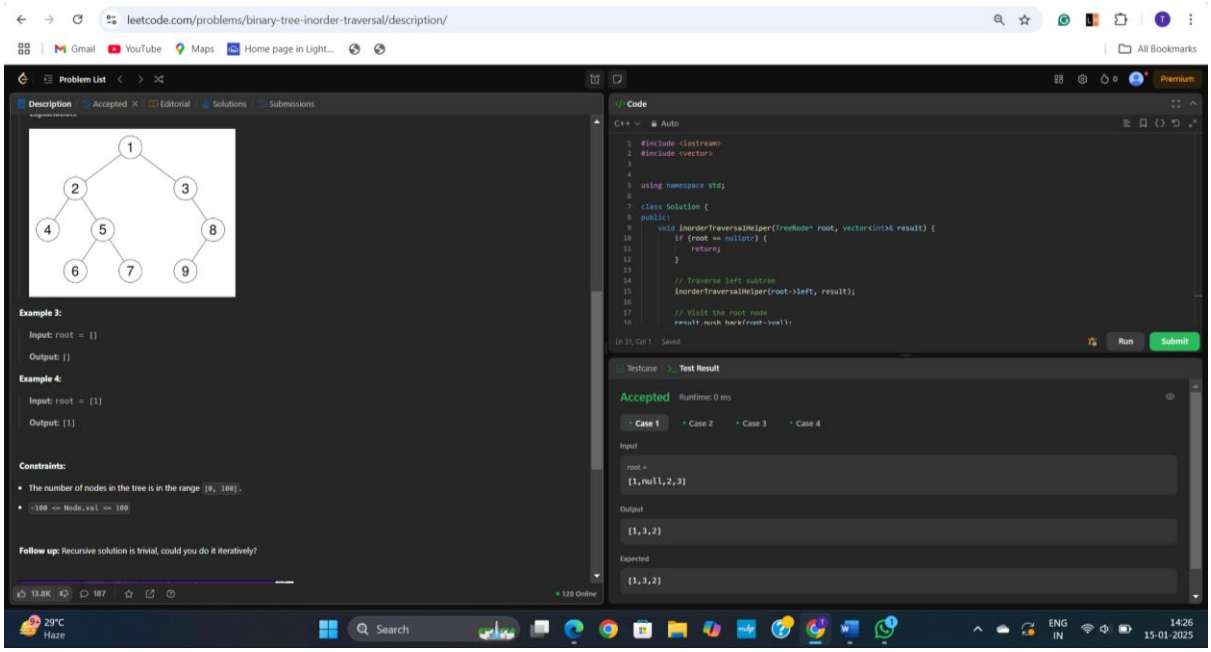
Follow up: Recursive solution is trivial, could you do it iteratively?

9A. Code:

```
#include <iostream>
```

```
#include <vector>

using namespace std;

class Solution {
public:
    void inorderTraversalHelper(TreeNode* root, vector<int>& result) {
        if (root == nullptr) {
            return;
        }

        // Traverse left subtree
        inorderTraversalHelper(root->left, result);

        // Visit the root node
        result.push_back(root->val);

        // Traverse right subtree
        inorderTraversalHelper(root->right, result);
    }

    vector<int> inorderTraversal(TreeNode* root) {
        vector<int> result;
        inorderTraversalHelper(root, result);
        return result;
    }
};
```

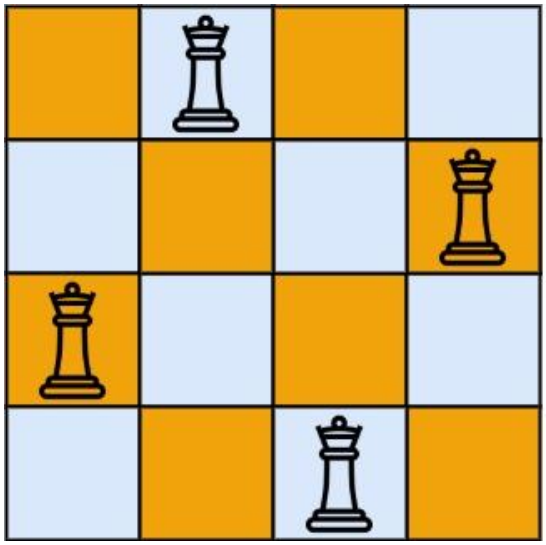
Output:

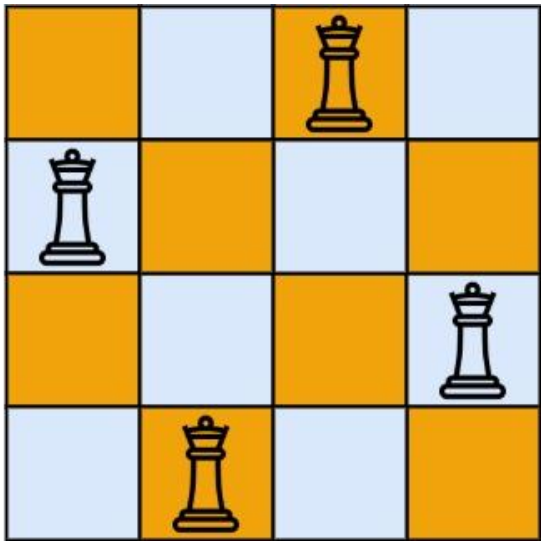


Q10. N-Queens
51. N-Queens

The n-queens puzzle is the problem of placing n queens on an n x n chessboard such that no two queens attack each other.
Given an integer n, return *all distinct solutions to the n-queens puzzle*. You may return the answer in any order.
Each solution contains a distinct board configuration of the n-queens' placement, where 'Q' and '.' both indicate a queen and an empty space, respectively.

Example 1:





Input: n = 4
Output: [[".Q..","...Q","Q...","..Q."],["..Q.","Q...","...Q",".Q.."]]
Explanation: There exist two distinct solutions to the 4-queens puzzle as shown above
Example 2:
Input: n = 1
Output: [["Q"]]

Constraints:

- **1 <= n <= 9**

10A. Code:

```
#include <vector>
#include <string>
using namespace std;

class Solution {
public:
   vector<vector<string>> solveNQueens(int n) {
      vector<vector<string>> solutions;
      vector<string> board(n, string(n, '.')); // Initialize an empty n x n board
      vector<int> leftRow(n, 0), upperDiag(2 * n - 1, 0), lowerDiag(2 * n - 1, 0);
      backtrack(0, n, board, solutions, leftRow, upperDiag, lowerDiag);
      return solutions;
   }
```

```
private:
    void backtrack(int col, int n, vector<string>& board, vector<vector<string>>& solutions,
                   vector<int>& leftRow, vector<int>& upperDiag, vector<int>& lowerDiag) {
        if (col == n) {
            solutions.push_back(board);
            return;
        }

        for (int row = 0; row < n; ++row) {
            if (leftRow[row] == 0 && upperDiag[row + col] == 0 && lowerDiag[row - col + n - 1] == 0) {
                board[row][col] = 'Q';
                leftRow[row] = upperDiag[row + col] = lowerDiag[row - col + n - 1] = 1;

                backtrack(col + 1, n, board, solutions, leftRow, upperDiag, lowerDiag);

                // Undo the current placement
                board[row][col] = '.';
                leftRow[row] = upperDiag[row + col] = lowerDiag[row - col + n - 1] = 0;
            }
        }
    }
};
```

Output: