Experiment 4:

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

1. **Aim(a):**
   You are given two integer arrays nums1 and nums2, sorted in **non-decreasing order**, and two integers m and n, representing the number of elements in nums1 and nums2 respectively.
   Merge nums1 and nums2 into a single array sorted in **non-decreasing order**.
   The final sorted array should not be returned by the function, but instead be *stored inside the array* nums1. To accommodate this, nums1 has a length of m + n, where the first m elements denote the elements that should be merged, and the last n elements are set to 0 and should be ignored. nums2 has a length of n.

2. **Objective:** The objective of this program is to merge two sorted integer arrays, nums1 and nums2, into a single sorted array in non-decreasing order. The merged result should be stored in nums1 without using extra space, utilizing its allocated size of m + n..

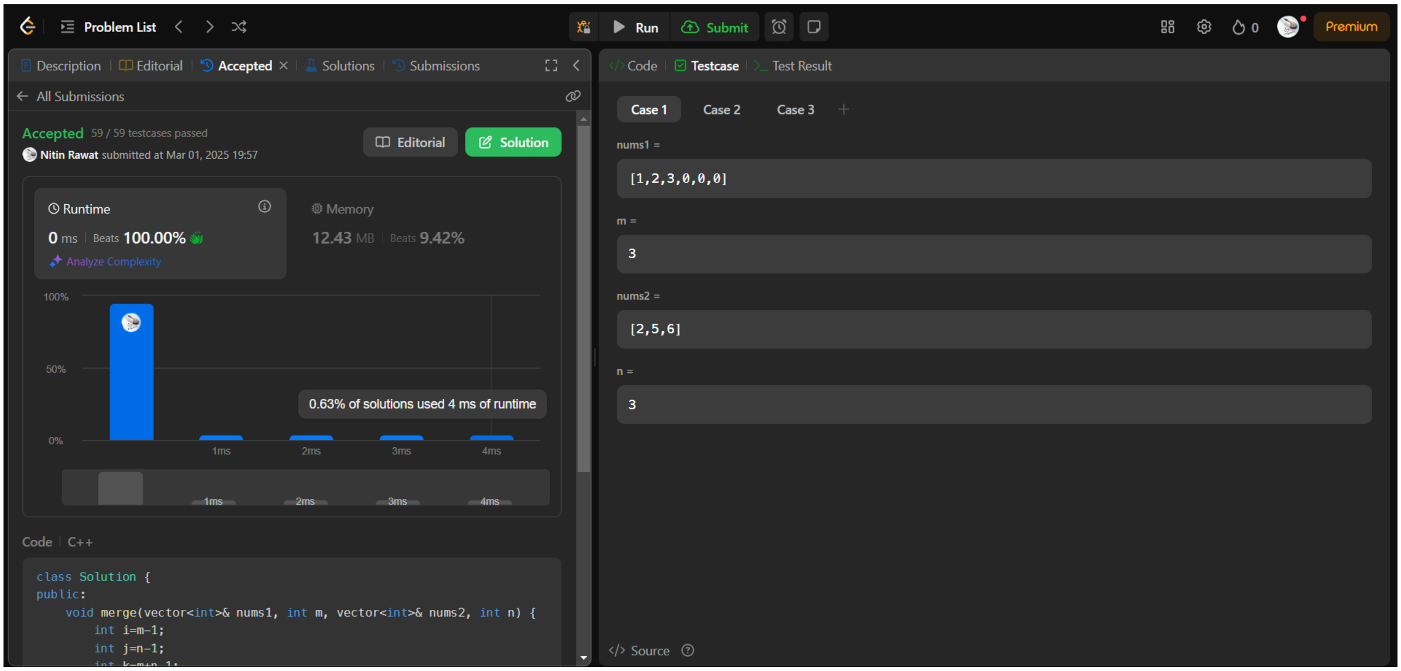
3. **Algorithm:**
   - Initialize three pointers: i = m - 1, j = n - 1, and k = m + n - 1.
   - Iterate while j>=0
     - If i >= 0 and nums1[i] > nums2[j], place nums1[i] at nums1[k], decrement i.
     - Else, place nums2[j] at nums1[k], decrement j.
     - Decrement k after each placement.

4. Code:

```
class Solution {
public:
    void merge(vector<int>& nums1, int m, vector<int>& nums2, int n) {
        int i=m-1;
        int j=n-1;
        int k=m+n-1;
        while(j>=0)
            if(i>=0 && nums1[i]>nums2[j])
                nums1[k--]=nums1[i--];
            else
            nums1[k--]=nums2[j--];
    }
};
```

Leetcode link:
https://leetcode.com/problems/merge-sorted-array/submissions/1559217600/

5. Output:



Accepted 59 / 59 testcases passed
Nitin Rawat submitted at Mar 01, 2025 19:57

Runtime
0 ms | Beats 100.00%
Analyze Complexity

Memory
12.43 MB | Beats 9.42%

0.63% of solutions used 4 ms of runtime

Code | C++

```
class Solution {
public:
    void merge(vector<int>& nums1, int m, vector<int>& nums2, int n) {
        int i=m-1;
        int j=n-1;
        int k=m+n-1;
```

nums1 =

```
[1,2,3,0,0,0]
```

m =

```
3
```

nums2 =

```
[2,5,6]
```

n =

```
3
```

6. **Time Complexity:**
   The time complexity is O(m + n), where m and n are the lengths of the given arrays.

7. **Learning Outcomes:**
   - Learnt how to merge two sorted arrays efficiently using a two-pointer approach.
   - Learnt how to traverse arrays from the end to avoid unnecessary shifting.
   - Learnt the time complexity analysis of merging sorted arrays in O(m + n) time.

PROBLEM-2

1. **Aim(b):** You are a product manager and currently leading a team to develop a new product. Unfortunately, the latest version of your product fails the quality check. Since each version is developed based on the previous version, all the versions after a bad version are also bad.
   Suppose you have n versions [1, 2, ..., n] and you want to find out the first bad one, which causes all the following ones to be bad.
   You are given an API bool isBadVersion(version) which returns whether version is bad. Implement a function to find the first bad version. You should minimize the number of calls to the API.

2. **Objective**: The objective of this program is to efficiently find the first bad version in a sequence of product versions using the isBadVersion(version) API, while minimizing the number of API calls by implementing a binary search approach.

3. **Algorithm:**
   - Initialize Pointers: Set left = 1 and right = n to define the search range.

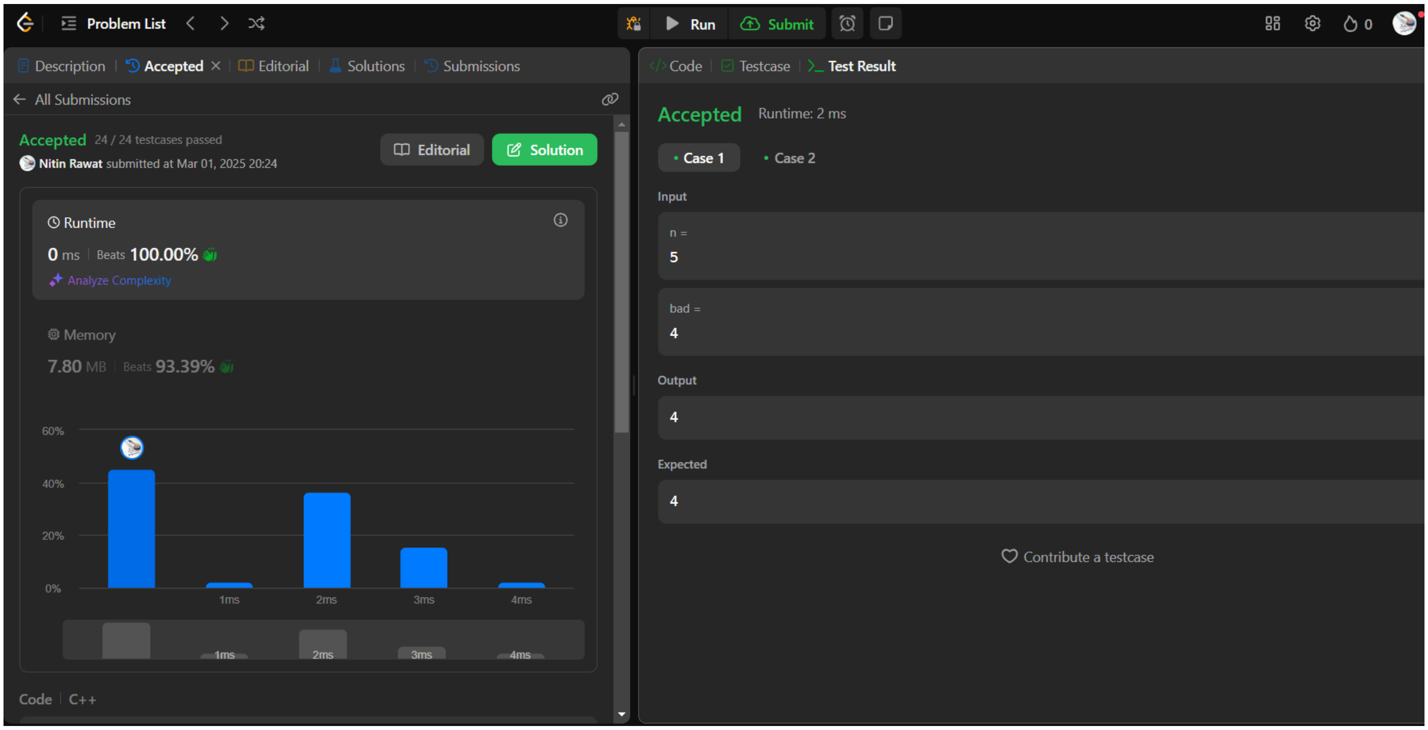
- Perform Binary Search: While left < right:
    - Compute mid = left + (right - left) / 2.
    - If isBadVersion(mid) is true, update right = mid (search in the left half).
    - Else, update left = mid + 1 (search in the right half).
- End Condition: When left == right, it points to the first bad version.
- Return the Result: Return left as the first bad version.

4. Code:

```
class Solution {
public:
    int firstBadVersion(int n)
    {
        int left = 1, right = n, mid;
        while (left < right) {
            mid = left + (right - left) / 2;
            if (isBadVersion(mid))
            {
                right = mid;
            } else
            {
                left = mid + 1;
            }
        }
        return left;
    }
};
```

LeetCode Link:
https://leetcode.com/problems/first-bad-version/submissions/1559270518/

5. Output:



Accepted 24 / 24 testcases passed
Nitin Rawat submitted at Mar 01, 2025 20:24

Runtime
0 ms | Beats 100.00%

Memory
7.80 MB | Beats 93.39%

Code | C++

Accepted Runtime: 2 ms

• Case 1 • Case 2

Input

n =
5

bad =
4

Output
4

Expected
4

6. Time Complexity:

The time complexity of this code is **O(log n)**, where n represents the total number of product versions, numbered from 1 to n.

7. Learning outcomes:

- Learnt how to apply binary search to efficiently solve problems with ordered data.
- Learnt how to identify the first occurrence of a condition in a sorted sequence.
- Learnt how to identify the first occurrence of a condition in a sorted sequence.
- Learnt how to handle real-world scenarios like version control and quality testing efficiently.