Experiment 5

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

Problem -1

1. Aim: Merge Sorted Array

2. Objective:

- Understand Merging of Sorted Arrays: The goal is to combine two sorted arrays into one sorted array. This helps in learning how to correctly place elements while maintaining order.
- Efficient In-Place Merging:-The merging should be done within nums1 without using extra space. This improves efficiency and helps in solving problems that require modifying arrays directly.
- Using Two-Pointer Technique: The two-pointer approach helps merge arrays efficiently by placing larger elements first. This reduces unnecessary shifts and improves the merging process.
- Handling Edge Cases: It is important to consider cases like an empty nums2 or extra zeros in nums1. This ensures that the algorithm works for all possible inputs.
- Improving Problem-Solving Skills:- Solving this problem enhances logical thinking and coding skills. It also prepares you for technical interviews that require optimizing solutions.

3. Implementation/Code:

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

```
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nums1[k] = nums2[j];

j--;
k--;
}
};
```

4. Output:



Figure 1

5. Learning Outcome:

- **Ability to Merge Sorted Arrays**: You will learn to merge two sorted arrays efficiently while maintaining their order in a single array. This helps in understanding how to correctly insert elements in the given space without using extra memory.
- Understanding of Two-Pointer Approach: The two-pointer method allows efficient merging without extra space. This improves problem-solving skills and helps in solving other array-related problems.
- Handling Edge Cases Confidently: You will understand how to manage cases like an
 empty nums2 or trailing zeros in nums1. This ensures that your solution is reliable and works
 in all scenarios.
- Writing Optimized Code: Learning this method helps in writing optimized code with minimal time complexity. This makes your solutions more efficient and improves performance.
- **Problem-Solving for Interviews**: This problem is commonly asked in coding interviews. Practicing it will improve your logical thinking and help you solve similar array-based problems quickly.

Problem-2

1. Aim: Sort Colors

2. Objectives:

- Sorting Colors Without Sorting Function: The goal is to sort an array containing 0s, 1s, and 2s without using built-in sorting. This helps in learning efficient ways to organize data manually.
- Using the Dutch National Flag Algorithm: The algorithm helps in sorting the array in a single pass. This improves understanding of how to arrange elements using multiple pointers.
- Efficient In-Place Sorting: The sorting is done without extra space, modifying the array directly. This teaches how to optimize memory usage in coding problems.
- Handling Different Cases Easily: The method ensures that all numbers are placed in the correct order. It helps in dealing with cases where numbers are shuffled randomly.
- Improving Logical Thinking and Speed: Understanding this approach improves coding skills and speed. It is useful for solving interview questions and competitive programming problems.

3. Implementation/Code:

```
class Solution {
public:
  void sortColors(vector<int>& nums) {
     int low = 0, mid = 0, high = nums.size() - 1;
    while (mid \le high) {
       if (nums[mid] == 0) {
          swap(nums[low], nums[mid]);
         low++;
         mid++;
       } else if (nums[mid] == 1) {
         mid++;
       } else {
         swap(nums[mid], nums[high]);
         high--;
       }
};
```

4. Output:

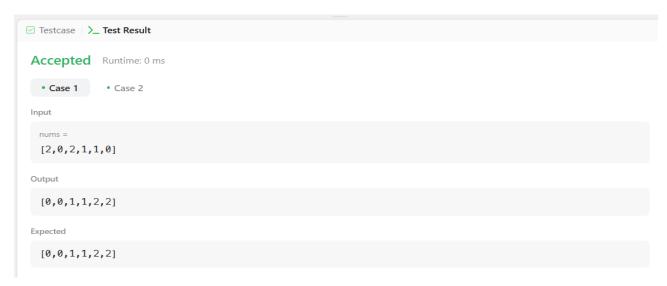


Figure 2

5. Learning Outcomes:

- Sorting Arrays Without Extra Space:-You will learn how to sort an array without using extra memory. This helps in understanding space-efficient solutions.
- Mastering the Two-Pointer Approach: The two-pointer method helps in arranging elements quickly. It makes solving similar sorting problems easier.
- Handling Complex Sorting Problems: You will gain confidence in solving sorting problems efficiently. This improves your problem-solving ability in technical interviews.
- Writing Optimized Code: The approach ensures sorting is done in one pass. This makes the code faster and reduces unnecessary computations.
- **Better Preparation for Interviews**: This problem is commonly asked in coding interviews. Practicing it will strengthen your ability to solve sorting-based challenges.

Problem - 3

1. Aim: Find Peak Element

2. Objectives:

- Understanding Peak Elements: The objective is to identify a peak element in an array where each element is compared with its neighbors. This helps in recognizing patterns within arrays and solving related problems.
- Implementing Binary Search: The goal is to apply the binary search approach to find a peak element efficiently. This ensures that the solution runs in O(log n) time instead of a linear scan.

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 - Optimizing Problem-Solving Skills: This problem helps in improving logical reasoning by teaching how to make decisions based on comparisons. Understanding how to narrow down the search space efficiently is a key takeaway.
 - Handling Special Cases: The objective is to handle various scenarios, such as peaks
 appearing at the start, middle, or end of the array. This ensures a complete and robust
 solution.
 - Enhancing Algorithmic Thinking: By working on this problem, you will strengthen your ability to design and implement optimized algorithms. This contributes to developing better coding and debugging skills.

3. Implementation/Code:

```
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;
    }
};
```

4. Output:

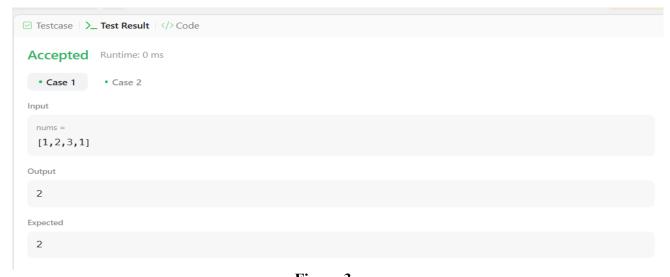


Figure 3

5. Learning Outcomes

- Efficient Peak Finding: You will learn how to locate a peak element without scanning the entire array, using a smarter approach with binary search.
- Mastering Binary Search Variations: You will understand how binary search can be adapted for different problems beyond simple number searching.
- **Developing a Logical Approach**: You will improve your ability to break down problems logically, making it easier to apply efficient solutions in coding interviews and real-world tasks.
- Understanding Search Space Reduction: You will gain insights into how reducing the search space step by step can lead to significant performance improvements.
- **Building Optimized and Scalable Solutions:** You will develop the skills to write code that is both time-efficient and scalable, a crucial requirement for competitive programming and software development.