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BRANCH-BE-CSE **SECTION/GROUP-IOT-638-A**

SEMESTER-6 **DATE OF PERFORMANCE-12/02/2023**

SUBJECT NAME-AP-LAB II **SUBJECT CODE-22CSP-351**

ASSIGNMENT

PROBLEM 1: Sort Colors

Given an array nums with n objects colored red, white, or blue, sort them in-place so that objects of the same color are adjacent, with the colors in the order red, white, and blue. We will use the integers 0, 1, and 2 to represent the color red, white, and blue, respectively. You must solve this problem without using the library's sort function.

Example 1:

Input: nums = [2,0,2,1,1,0] Output: [0,0,1,1,2,2]

Example 2:

Input: nums = [2,0,1] Output: [0,1,2]

Constraints:

n == nums.length 1 <= n <= 300 nums[i] is either 0, 1, or 2.

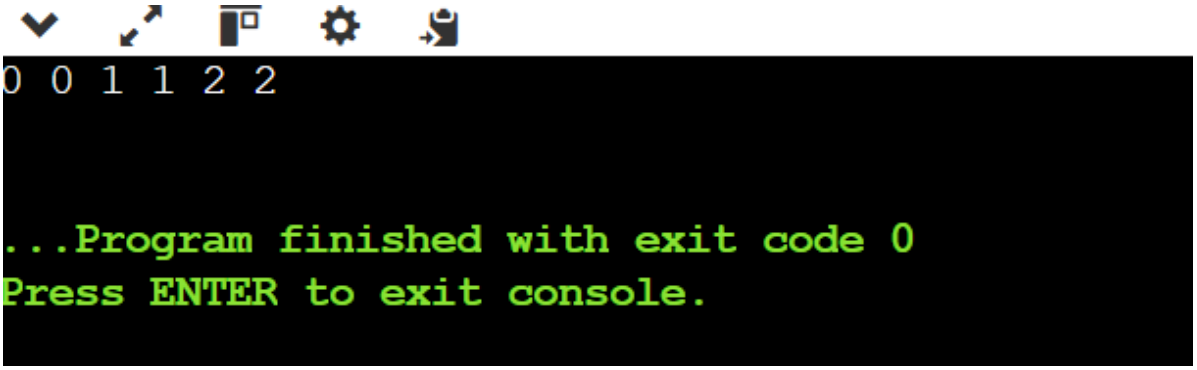
Follow up: Could you come up with a one-pass algorithm using only constant extra space?

2.CODE

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

class Solution {
public:
    void sortColors(vector<int>& nums) {
```

```
        int low = 0, mid = 0, high = nums.size() - 1;
        while (mid <= high) {
            if (nums[mid] == 0) {
                swap(nums[low], nums[mid]);
                low++;
                mid++;
            } else if (nums[mid] == 1) {
                mid++;
            } else { // nums[mid] == 2
                swap(nums[mid], nums[high]);
                high--;
            }
        }
    }
};

int main() {
    vector<int> nums = {2, 0, 2, 1, 1, 0};
    Solution sol;
    sol.sortColors(nums);

    for (int num : nums) {
        cout << num << " ";
    }
    cout << endl;
    return 0;
}
```

OUTPUT:



LEARNING OUTCOMES:

1. **Understanding the Dutch National Flag Algorithm** – Learned how to efficiently sort an array containing three distinct elements (0, 1, 2) in **one pass (O(n))** using a **three-pointer approach**.

2. **In-Place Sorting Without Extra Space** – Developed skills to sort the array **without using extra memory (O(1))**, making the solution space-efficient.

3. **Efficient Array Manipulation with Swap Operations** – Gained hands-on experience in swapping elements strategically using **low, mid, and high pointers** to ensure correct ordering.

4. **Optimizing Sorting Without Using Built-in Functions** – Learned how to manually implement sorting logic **without relying on sort()**, which is useful for interviews and competitive programming.

PROBLEM 2: Kth Largest Element in an Array

Given an integer array nums and an integer k, return the kth largest element in the array. Note that it is the kth largest element in the sorted order, not the kth distinct element. Can you solve it without sorting?

Example 1:

Input: nums = [3,2,1,5,6,4], k = 2 Output: 5

Example 2:

Input: nums = [3,2,3,1,2,4,5,5,6], k = 4 Output: 4

Constraints:

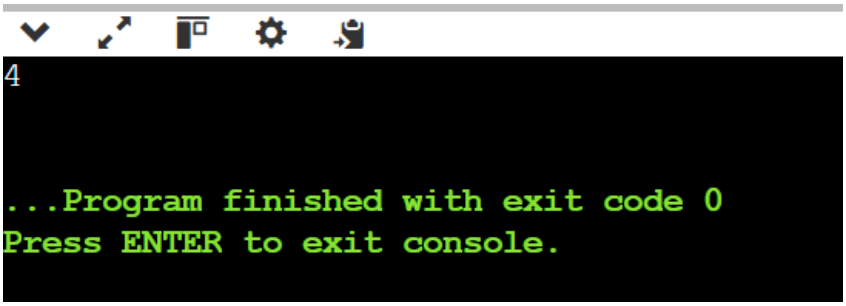
1 <= k <= nums.length <= 105 -104 <= nums[i] <= 104

CODE:

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

class Solution {
public:
    int findKthLargest(vector<int>& nums, int k) {
        priority_queue<int, vector<int>, greater<int>> minHeap;

        for (int num : nums) {
            minHeap.push(num);
            if (minHeap.size() > k) {
                minHeap.pop();  // Remove smallest element to maintain size k
            }
        }

        return minHeap.top();  // The root of the min-heap is the kth largest element
    }
};

int main() {
    vector<int> nums = {3, 2, 3, 1, 2, 4, 5, 5, 6}; int k = 4;
    Solution sol;
    cout << sol.findKthLargest(nums, k) << endl; // Output: 4 return
    0;
```

}

OUTPUT:



LEARNING OUTCOMES:

1. **Understanding Heap Data Structure –** Learned how to use a Min-Heap (Priority Queue) to efficiently find the k-th largest element in O(n log k) time complexity.

2. **Optimized Selection Without Sorting** – Developed the ability to find the k-th largest element without sorting (O(n log n)), using a more efficient approach like Heap or Quickselect (O(n) average).

3. **Efficient Space Utilization** – Gained experience in solving problems using O(k) extra space for the Min-Heap, making it memory-efficient compared to full sorting.

4. **Application of Quickselect Algorithm** – Learned how to apply the Quickselect Algorithm (O(n) average case), a variation of QuickSort, to efficiently find the k-th largest element in an unordered list.