Name- Dependra Singh

UID- 22BCS10256

Section- 901- KPIT

Searching and Sorting QUESTIONS :-

1.Searching a Number

Given an integer k and array arr. Your task is to return the position of the first occurrence of k in the given array and if element k is not present in the array then return -1.

Note: 1-based indexing is followed here.

Example1:

Input: k = 16 , arr = [9, 7, 16, 16, 4]

Output: 3

Explanation: The value 16 is found in the given array at positions 3 and 4, with position 3 being the first occurrence.

Example2:

Input: k=98 , arr = [1, 22, 57, 47, 34, 18, 66]

Output: -1

Example2:

Input: k=9 , arr = [1, 22, 57, 47, 34, 9, 66]

Output: 6

Explanation: k = 98 isn't found in the given array.

Expected Time Complexity: O(n)

Expected Auxiliary Space: O(1)

Constraints:

- 1 <= arr.size <= 10^6
- 1 <= arr[i] <= 10^9
- 1 <= k <= 10^6

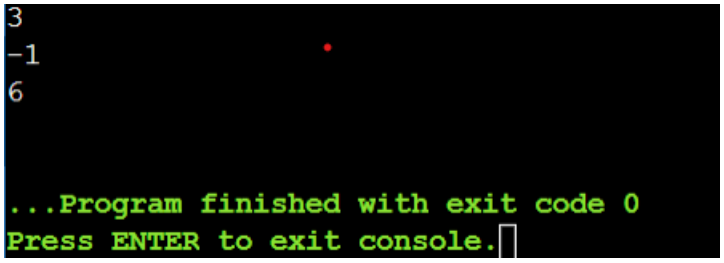
Reference:: https://www.geeksforgeeks.org/problems/searching-a-number0324/1

Code:-

```
#include <iostream>

#include <vector>

using namespace std;

int searchNumber(int k, const vector<int>& arr) {

    for (int i = 0; i < arr.size(); i++) {

        if (arr[i] == k) {

            return i + 1;

        }

    }
```

```
    return -1;
}
int main() {
    int k1 = 16;
    vector<int> arr1 = {9, 7, 16, 16, 4};
    cout << searchNumber(k1, arr1) << endl;
    int k2 = 98;
    vector<int> arr2 = {1, 22, 57, 47, 34, 18, 66};
    cout << searchNumber(k2, arr2) << endl;
    int k3 = 9;
    vector<int> arr3 = {1, 22, 57, 47, 34, 9, 66};
    cout << searchNumber(k3, arr3) << endl;
    return 0;
}
```

Output:-



6. Minimum Number of Moves to Seat Everyone

There are n available seats and n students standing in a room. You are given an array seats of length n, where seats[i] is the position of the ith seat. You are also given the array students of length n, where students[j] is the position of the jth student.

You may perform the following move any number of times:

Increase or decrease the position of the ith student by 1 (i.e., moving the ith student from position x to x + 1 or x - 1)
Return the minimum number of moves required to move each student to a seat such that no two students are in the same seat.

Note that there may be multiple seats or students in the same position at the beginning.

Example 1:

Input: seats = [3,1,5], students = [2,7,4]
Output: 4
Explanation: The students are moved as follows:
- The first student is moved from position 2 to position 1 using 1 move.
- The second student is moved from position 7 to position 5 using 2 moves.
- The third student is moved from position 4 to position 3 using 1 move.
In total, 1 + 2 + 1 = 4 moves were used.

Example 2:

Input: seats = [4,1,5,9], students = [1,3,2,6]
Output: 7
Explanation: The students are moved as follows:
- The first student is not moved.
- The second student is moved from position 3 to position 4 using 1 move.
- The third student is moved from position 2 to position 5 using 3 moves.
- The fourth student is moved from position 6 to position 9 using 3 moves.
In total, 0 + 1 + 3 + 3 = 7 moves were used.

- **Reference:** https://leetcode.com/problems/minimum-number-of-moves-to-seat-everyone/description/

Code:-

```
#include <iostream>

#include <vector>
```

```
#include <algorithm>
using namespace std;
int minMovesToSeat(vector<int>& seats, vector<int>& students) {
    sort(seats.begin(), seats.end());
    sort(students.begin(), students.end());
    int moves = 0;
    for (int i = 0; i < seats.size(); i++) {
        moves += abs(seats[i] - students[i]);
    }
    return moves;
}
int main() {
    vector<int> seats1 = {3, 1, 5};
    vector<int> students1 = {2, 7, 4};
    cout << minMovesToSeat(seats1, students1) << endl;
    vector<int> seats2 = {4, 1, 5, 9};
    vector<int> students2 = {1, 3, 2, 6};
    cout << minMovesToSeat(seats2, students2) << endl;
    return 0;
}
```

Output:-

```
4
7


...Program finished with exit code 0
Press ENTER to exit console.
```

Medium (Questions 11–15)

12. **Find First and Last Position of Element in Sorted Array.**

Given an array of integers nums sorted in non-decreasing order, find the starting and ending position of a given target value.

If target is not found in the array, return [-1, -1].

You must write an algorithm with O(log n) runtime complexity.

Example 1:

Input: nums = [5,7,7,8,8,10], target = 8

Output: [3,4]

Example 2:

Input: nums = [5,7,7,8,8,10], target = 6

Output: [-1,-1]

Example 3:

Input: nums = [], target = 0

Output: [-1,-1]

Constraints:

0 <= nums.length <= 10^5

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

nums is a non-decreasing array.

-10^9 <= target <= 10^9

- **Reference:** https://leetcode.com/problems/find-first-and-last-position-of-element-in-sorted-array/description/

Code:-

```
#include <iostream>

#include <vector>

using namespace std;


vector<int> searchRange(vector<int>& nums, int target) {

    int left = -1, right = -1;

    int low = 0, high = nums.size() - 1;

    while (low <= high) {

        int mid = low + (high - low) / 2;

        if (nums[mid] >= target) high = mid - 1;

        else low = mid + 1;

    }

    if (low < nums.size() && nums[low] == target) left = low;

    low = 0, high = nums.size() - 1;

    while (low <= high) {
```

```
        int mid = low + (high - low) / 2;
        if (nums[mid] <= target) low = mid + 1;
        else high = mid - 1;
    }
    if (high >= 0 && nums[high] == target) right = high;
    return {left, right};
}
int main() {
    vector<int> nums1 = {5, 7, 7, 8, 8, 10};
    int target1 = 8;
    vector<int> res1 = searchRange(nums1, target1);
    cout << "[" << res1[0] << ", " << res1[1] << "]" << endl;
    vector<int> nums2 = {5, 7, 7, 8, 8, 10};
    int target2 = 6;
    vector<int> res2 = searchRange(nums2, target2);
    cout << "[" << res2[0] << ", " << res2[1] << "]" << endl;
    return 0;
}
```

Output:-

```
[3, 4]
[-1, -1]

...Program finished with exit code 0
Press ENTER to exit console.
```

Hard (Questions 16–20)

15. Find the Kth Smallest Sum of a Matrix With Sorted Rows.

You are given an m x n matrix mat that has its rows sorted in non-decreasing order and an integer k.

You are allowed to choose exactly one element from each row to form an array.

Return the kth smallest array sum among all possible arrays.

Example 1:

Input: mat = [[1,3,11],[2,4,6]], k = 5
Output: 7
Explanation: Choosing one element from each row, the first k smallest sum are:
[1,2], [1,4], [3,2], [3,4], [1,6]. Where the 5th sum is 7.

Example 2:

Input: mat = [[1,3,11],[2,4,6]], k = 9
Output: 17

Example 3:

Input: mat = [[1,10,10],[1,4,5],[2,3,6]], k = 7
Output: 9
Explanation: Choosing one element from each row, the first k smallest sum are:
[1,1,2], [1,1,3], [1,4,2], [1,4,3], [1,1,6], [1,5,2], [1,5,3]. Where the 7th sum is 9.

Constraints:

- m == mat.length
- n == mat.length[i]
- 1 <= m, n <= 40

- 1 <= mat[i][j] <= 5000
- 1 <= k <= min(200, n^m)
- mat[i] is a non-decreasing array.

Reference:-

https://leetcode.com/problems/find-the-kth-smallest-sum-of-a-matrix-with-sorted-rows/description/

Code:-

```
#include <iostream>
#include <vector>
#include <queue>
#include <algorithm>
using namespace std;
int kthSmallestSum(vector<vector<int>>& mat, int k) {
    priority_queue<int> pq;
    pq.push(0);
    for (auto& row : mat) {
        priority_queue<int> nextPq;
        while (!pq.empty()) {
            int sum = pq.top(); pq.pop();
            for (int num : row) {
                nextPq.push(sum + num);
                if (nextPq.size() > k) nextPq.pop();
            }
        }
        swap(pq, nextPq);
    }
    return pq.top();
}
int main() {
    vector<vector<int>> mat1 = {{1, 3, 11}, {2, 4, 6}};
    int k1 = 5;
    cout << kthSmallestSum(mat1, k1) << endl;
    vector<vector<int>> mat2 = {{1, 10, 10}, {1, 4, 5}, {2, 3, 6}};
    int k2 = 7;
    cout << kthSmallestSum(mat2, k2) << endl;
    return 0;
}
```

Output:-

```
7
9

...Program finished with exit code 0
Press ENTER to exit console.
```

Very Hard (Questions 21–25)

21.Find Minimum in Rotated Sorted Array II.

Suppose an array of length n sorted in ascending order is rotated between 1 and n times. For example, the array nums = [0,1,4,4,5,6,7] might become:

[4,5,6,7,0,1,4] if it was rotated 4 times.
[0,1,4,4,5,6,7] if it was rotated 7 times.
Notice that rotating an array [a[0], a[1], a[2], ..., a[n-1]] 1 time results in the array [a[n-1], a[0], a[1], a[2], ..., a[n-2]].

Given the sorted rotated array nums that may contain duplicates, return the minimum element of this array.

You must decrease the overall operation steps as much as possible.

Example 1:

Input: nums = [1,3,5]
Output: 1

Example 2:

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

Constraints:

- n == nums.length
- 1 <= n <= 5000
- -5000 <= nums[i] <= 5000
- nums is sorted and rotated between 1 and n times.

Reference:-

https://leetcode.com/problems/find-minimum-in-rotated-sorted-array-ii/description/

Code:-

```
#include <iostream>
#include <vector>
using namespace std;
int findMin(vector<int>& nums) {
    int low = 0, high = nums.size() - 1;
    while (low < high) {
        int mid = low + (high - low) / 2;
        if (nums[mid] > nums[high]) {
            low = mid + 1;
        } else if (nums[mid] < nums[high]) {
            high = mid;
        } else {
            high--;
        }
    }
    return nums[low];
}
int main() {
    vector<int> nums1 = {1, 3, 5};
    cout << findMin(nums1) << endl;
    vector<int> nums2 = {2, 2, 2, 0, 1};
```

```
    cout << findMin(nums2) << endl;
    return 0;
}
```

Output:-

```
1
0


...Program finished with exit code 0
Press ENTER to exit console.
```