DOMAIN WINTER WINNING CAMP ASSIGNMENT

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Semester: 5th

DAY-5 [24-12-2024]

Searching and Sorting QUESTIONS :-

Searching

Very Easy

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:**

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

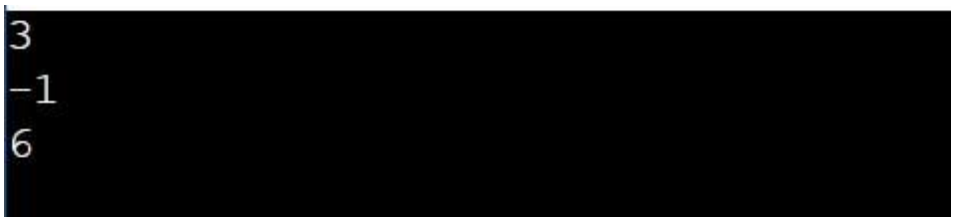
Reference:: https://www.geeksforgeeks.org/problems/searching-a-number0324/1

CODE:

```
#include  <iostream>  #include  <vector>  using
namespace  std;  int  findFirstOccurrence(int  k,
vector<int>& arr) {
    for (int i = 0; i < arr.size(); i++) { if (arr[i]
        == k) { return i + 1; // Return 1-based
        index
        } } return -1; // Return -1 if k is not
    found }
```

```
int main() { vector<int> arr1 = {9, 7, 16, 16, 4}; cout <<
    findFirstOccurrence(16, arr1) << endl; // Output: 3
    vector<int> arr2 = {1, 22, 57, 47, 34, 18, 66};
    cout << findFirstOccurrence(98, arr2) << endl; // Output: -1 vector<int>
    arr3 = {1, 22, 57, 47, 34, 9, 66};
    cout << findFirstOccurrence(9, arr3) << endl; // Output: 6
    return 0;
}
```

OUTPUT:



```
3
-1
6
```

<u>**Easy**</u>

2. Minimum Number of Moves to Seat Everyone

There are n availabe 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.

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

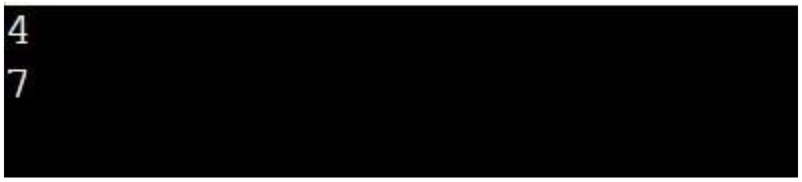
CODE:

```
#include <iostream>

#include <vector> #include

<algorithm>

using namespace std;
```

```
int minMovesToSeats(vector<int>& seats, vector<int>& students) {

   // Sort both arrays

   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]); // Calculate the moves needed for each
student }

   return moves;

}


int main() { vector<int> seats1 =

   {3, 1, 5}; vector<int> students1

   = {2, 7, 4};

   cout << minMovesToSeats(seats1, students1) << endl; // Output: 4


   vector<int> seats2 = {4, 1, 5, 9}; vector<int>

   students2 = {1, 3, 2, 6};

   cout << minMovesToSeats(seats2, students2) << endl; // Output: 7
```

```
    return 0;

}
```

OUTPUT:



```
4
7
```

Medium

3. Search in 2D Matrix.

You are given an m x n integer matrix matrix with the following two properties:

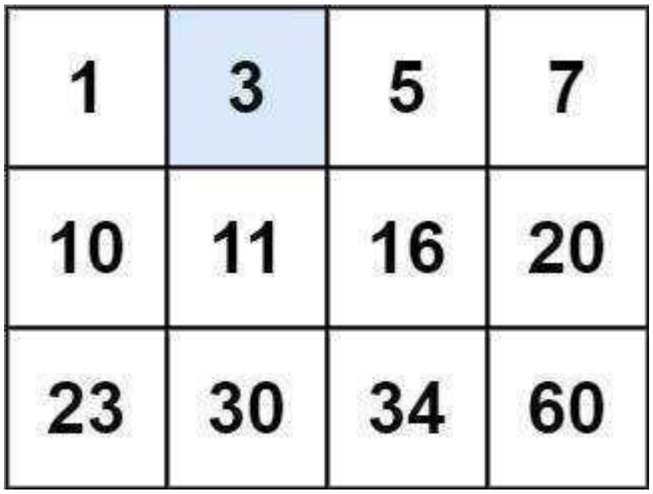
Each row is sorted in non-decreasing order.

The first integer of each row is greater than the last integer of the previous row.

Given an integer target, return true if target is in matrix or false otherwise.

You must write a solution in O(log(m * n)) time complexity.

Example 1:

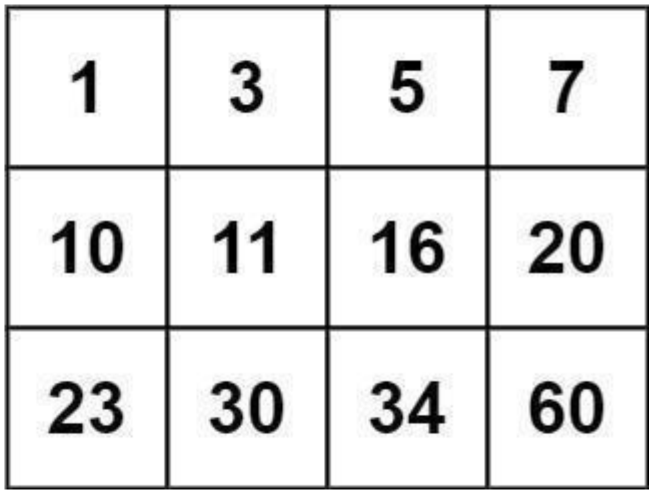


1	3	5	7
10	11	16	20
23	30	34	60

Input: matrix = [[1,3,5,7],[10,11,16,20],[23,30,34,60]], target = 3

Output: true

Example2:



1	3	5	7
10	11	16	20
23	30	34	60

Input: matrix = [[1,3,5,7],[10,11,16,20],[23,30,34,60]], target = 13

Output: false

Constraints:

m == matrix.length n

== matrix[i].length

1 <= m, n <= 10^0

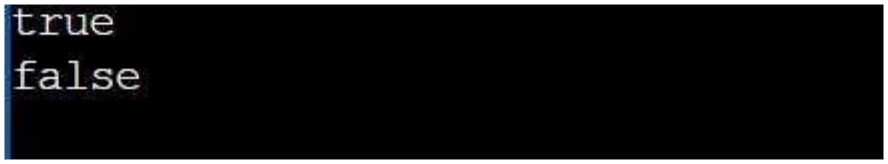
-10^4 <= matrix[i][j], target <= 10^4

Ø **Reference:** https://leetcode.com/problems/search-a-2d-matrix/description/

CODE:

```
#include <iostream>

#include     <vector>

using namespace std;

bool

searchMatrix(vector

<vector<int>>&

matrix,  int  target)  {

int m = matrix.size();

int          n          =

matrix[0].size();

    int left = 0, right = m * n - 1;


    while (left <= right) { int mid =

        left + (right - left) / 2;

        int midElement = matrix[mid / n][mid % n]; // Access the element at index
mid in 2D matrix


        if (midElement == target) { return

            true;
        } else if (midElement < target) { left
            = mid + 1;
        } else {
            right = mid - 1;
        } }
    return false;
}
int main() {
    vector<vector<int>> matrix1 = {{1, 3, 5, 7}, {10, 11, 16, 20}, {23, 30, 34,
60}}; cout << (searchMatrix(matrix1, 3) ? "true" : "false") << endl; // Output:
    true vector<vector<int>> matrix2 = {{1, 3, 5, 7}, {10, 11, 16, 20}, {23, 30,
    34,
60}};
    cout << (searchMatrix(matrix2, 13) ? "true" : "false") << endl; // Output:
false

return 0;
}
```

OUTPUT:



```
true
false
```

Hard

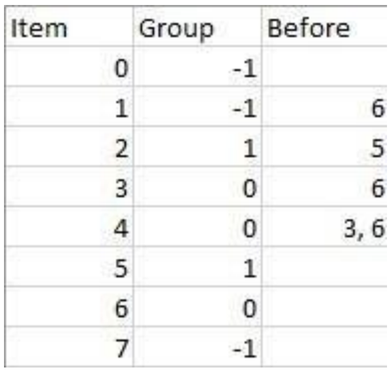
4.Sort Items by Groups Respecting Dependencies

There are n items each belonging to zero or one of m groups where group[i] is the group that the i-th item belongs to and it's equal to -1 if the i-th item belongs to no group. The items and the groups are zero indexed. A group can have no item belonging to it.

Return a sorted list of the items such that:

The items that belong to the same group are next to each other in the sorted list. There are some relations between these items where beforeItems[i] is a list containing all the items that should come before the i-th item in the sorted array (to the left of the i-th item).
Return any solution if there is more than one solution and return an empty list if there is no solution.

Example 1:



Item	Group	Before
0	-1	
1	-1	6
2	1	5
3	0	6
4	0	3, 6
5	1	
6	0	
7	-1	

Input: n = 8, m = 2, group = [-1,-1,1,0,0,1,0,-1], beforeItems = [[],[6],[5],[6],[3,6],[],[],[]]

Output: [6,3,4,1,5,2,0,7]

Example 2:

Input: n = 8, m = 2, group = [-1,-1,1,0,0,1,0,-1], beforeItems = [[],[6],[5],[6],[3],[],[4],[]]
Output: []

Explanation: This is the same as example 1 except that 4 needs to be before 6 in the sorted list.

Constraints:

- 1 <= m <= n <= 3 * 10^4
- group.length == beforeItems.length == n
- -1 <= group[i] <= m - 1
- 0 <= beforeItems[i].length <= n - 1
- 0 <= beforeItems[i][j] <= n - 1
- i != beforeItems[i][j]
- beforeItems[i] does not contain duplicates elements.

Reference:-https://leetcode.com/problems/sort-items-by-groups-respecting-dependencies/
CODE:

```
#include <iostream>

#include <vector>
```

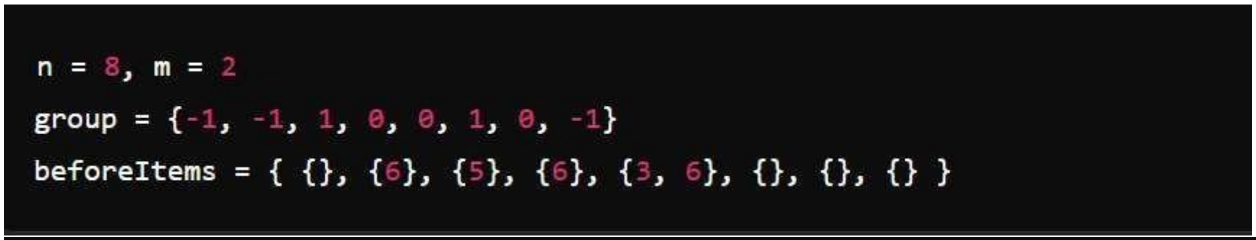
```
#include <deque>

#include <unordered_map>

#include <unordered_set>


using namespace std;


vector<int> topologicalSort(const unordered_map<int, vector<int>>& graph,
vector<int>& inDegree, int n) { deque<int> queue; vector<int> result;


    for (int i = 0; i < n; ++i) {

        if (inDegree[i] == 0) { queue.push_back(i);

        }

    }


    while (!queue.empty()) { int

        node     =     queue.front();

        queue.pop_front();

        result.push_back(node);


        for (int neighbor : graph.at(node)) {

            if (--inDegree[neighbor] == 0) {

            queue.push_back(neighbor);
            }
        }
    }

    if (result.size() != n) { return
        {}; // Cycle detected
    }

    return result;
}

vector<int> sortItems(int n, int m, vector<int>& group, vector<vector<int>>&
beforeItems) {
    // Step 1: Create item graph and group graph
    unordered_map<int,                vector<int>>
    itemGraph; vector<int> itemInDegree(n, 0);
    unordered_map<int,                vector<int>>
    groupGraph; vector<int> groupInDegree(m,
    0);

    // Step 2: Process the beforeItems to build the graph for
    (int i = 0; i < n; ++i) {
```

```
    for (int before : beforeItems[i]) {

        itemGraph[before].push_back(i);

        itemInDegree[i]++; if (group[i] != group[before])

        {

        groupGraph[group[before]].push_back(group[i]);

        groupInDegree[group[i]]++;

        }

    }

}


// Step 3: Topological sort for items vector<int> itemOrder =

topologicalSort(itemGraph, itemInDegree, n); if (itemOrder.empty()) {

return {}; // No valid ordering for items

}


// Step 4: Group items by their group unordered_map<int,

vector<int>> groupItems; for (int item : itemOrder) { if

(group[item] == -1) { groupItems[-1].push_back(item);

    } else {

        groupItems[group[item]].push_back(item);

    }

}
```

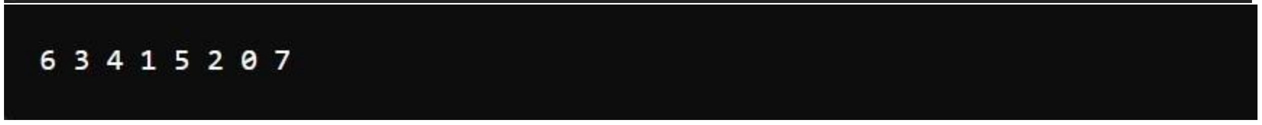
```
    // Step 5: Topological sort for groups vector<int> groupOrder =
    topologicalSort(groupGraph, groupInDegree, m); if (groupOrder.empty()) {
    return {}; // No valid ordering for groups
    }

    // Step 6: Collect items in sorted order according to group order vector<int>
    result;
    for (int g : groupOrder) { for (int
        item : groupItems[g]) {
        result.push_back(item);
        }
    }

    return result;
}

int main() { //
    Example 1 int n1
    = 8, m1 = 2;
    vector<int> group1 = {-1, -1, 1, 0, 0, 1, 0, -1};
```

```
vector<vector<int>> beforeItems1 = { {}, {6}, {5}, {6}, {3, 6}, {}, {}, {} };


vector<int> result1 = sortItems(n1, m1, group1, beforeItems1);


if (!result1.empty()) { for
    (int item : result1) {
        cout << item << " ";
    }
} else {
    cout << "[]";
}
cout << endl;


// Example 2 int n2 = 8, m2 = 2; vector<int> group2 = {-1, -1, 1, 0, 0, 1, 0,
-1}; vector<vector<int>> beforeItems2 = { {}, {6}, {5}, {6}, {3}, {}, {4},
{} }; vector<int> result2 = sortItems(n2, m2, group2, beforeItems2);


if (!result2.empty()) { for
    (int item : result2) {
        cout << item << " ";
    }
    }  else  {  cout

       << "[]";

    }

    cout << endl;



    return 0;

}
```

OUTPUT:



```
n = 8, m = 2
group = {-1, -1, 1, 0, 0, 1, 0, -1}
beforeItems = { {}, {6}, {5}, {6}, {3, 6}, {}, {}, {} }
```



```
6 3 4 1 5 2 0 7
```

<u>Very Hard</u>

5. 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:-

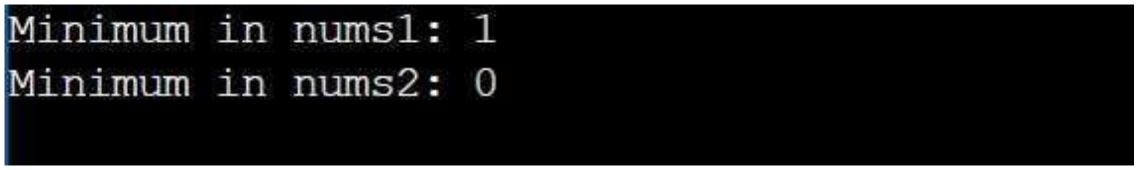
https://leetcode.com/problems/find-minimum-in-rotated-sorted-array-ii/description/

CODE:

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

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

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

    // Compare mid with the rightmost element if
    (nums[mid] < nums[right]) {
      // Minimum lies to the left of mid, including mid right
      = mid;
```

```
        } else if (nums[mid] > nums[right]) {
            // Minimum lies to the right of mid
            left = mid + 1;
        } else {
            // nums[mid] == nums[right], reduce the search space right--
            ;
        }
    }

    return nums[left];
}

int main() { vector<int> nums1 =
    {1, 3, 5};
    cout << "Minimum in nums1: " << findMin(nums1) << endl; // Output: 1

    vector<int> nums2 = {2, 2, 2, 0, 1};
    cout << "Minimum in nums2: " << findMin(nums2) << endl; // Output: 0

    return 0;
}
```

OUTPUT:



```
Minimum in nums1: 1
Minimum in nums2: 0
```