UNITED INTERNATIONAL UNIVERSITY
Department of Computer Science and Engineering (CSE)

Course Title: **Data Structure & Algorithm Lab II** **Course Code:** **CSE 2218**
Trimester & Year: **Spring 2024** **Section:** **A** **Credit Hours:** **1.0** **(MdMH)**

ASSIGNMENT 01

Q1: The Perfectionist (Divide & Conquer)

Alif is a perfectionist about numbers. He loves to arrange things in order and sticks to his "Golden rule" that every set of numbers must be in ascending order. Unfortunately, that is not always the case. Alif defines that when a smaller number comes after a larger number in the set then number of violations are required to fix the order.

Given a set of integers, Alif needs to find out the total number of such violations.

Input:

- The first line contains **n**, the number of integers.
- The second line contains n space separated integers $a_0 \ldots a_{n-1}$

Output: The output is an integer indicating the total number of violations.

Bonus: Time Complexity should be less than or equals to **`O(nlogn)`**

Example:

Sample Input	Sample Output	Explanation
5 4 5 6 7 1	4	1 violates which requires 4 violation to be fixed as 1 4 5 6 7.
5 5 4 3 2 1	10	4 violates which requires 1 violation to be fixed as 4 5 3 2 1. Then again 3 violates which requires 2 violation to be fixed as 3 4 5 2 1. Then again 2 violates which requires 3 violation to be fixed as 2 3 4 5 1. Then again 1 violates which requires 4 violation to be fixed as 1 2 3 4 5. Total violations required = 1+2+3+4 =10

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Q2: Kth Largest Element in an Array (Divide & Conquer)

Given an integer array `nums` and an integer `k`, return *the* `k^th` *largest element in the array*.

Note that it is the `k^th` largest element in the sorted order, not the `k^th` distinct element.

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 <= 10^4`
- `-10^4 <= nums[i] <= 10^4`

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Q3: Check if it is possible to survive on an Island. (Greedy)

Jarif got stuck on an island. There is only one shop on this island, and it is open on all days of the week except for Sunday. Consider following constraints:

N – The maximum unit of food you can buy each day.

S – Number of days you are required to survive.

M – Unit of food required each day to survive.

Currently, it's Monday, and he needs to survive for the next **'S'** days.

Find the minimum number of days on which you need to buy food from the shop so that he can survive the next '**S'** days or determine that it isn't possible to survive.

Example 1:

Input: S = 10, N = 16, M = 2

Output: 2

Explanation: One possible solution is to buy a box on the first day (Monday), it's sufficient to eat from this box up to 8th day (Monday) inclusive. Now, on the 9th day (Tuesday), you buy another box and use the chocolates in it to survive the 9th and 10th day.

Example 2:

Input: S = 10, N = 20, M = 30

Output: -1

Explanation: She can't survive even if she buy food because the maximum number of units she can buy in 1 day is less the required food for 1 day.

Primary Task: Create a function minimumDays() which takes S, N, and M as input parameters and returns the minimum number of days Ishika needs to buy food. Otherwise, returns -1 if she cannot survive.

Constraints:

$1 \leq N, S \leq 50$

$1 \leq M \leq 30$

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Q4: Chocolate Distribution Problem (Greedy)

Given an array A[ ] of positive integers of size N, where each value represents the number of chocolates in a packet. Each packet can have a variable number of chocolates. There are M students, the task is to distribute chocolate packets among M students such that :

1. Each student gets exactly one packet.

2. The difference between maximum number of chocolates given to a student and minimum number of chocolates given to a student is minimum.

Example 1:

Input: N = 8, M = 5

A = {3, 4, 1, 9, 56, 7, 9, 12}

Output: 6

Explanation: The minimum difference between maximum chocolates and minimum chocolates is 9 - 3 = 6 by choosing following M packets: {3, 4, 9, 7, 9}.

Example 2:

Input: N = 7, M = 3

A = {7, 3, 2, 4, 9, 12, 56}

Output: 2

Explanation: The minimum difference between maximum chocolates and minimum chocolates is 4 - 2 = 2 by choosing following M packets: {3, 2, 4}.

Primary Task: Create a function findMinDiff() which takes array A[ ], N and M as input parameters and returns the minimum possible difference between maximum number of chocolates given to a student and minimum number of chocolates given to a student.

Constraints:

$1 \le T \le 100$

$1 \le N \le 105$

$1 \le Ai \le 109$

$1 \le M \le N$