Data Structures and Algorithms

Assignment 03: Analysis of Algorithms and Searching

You need to submit your code to the https://www.hackerearth.com. Email invitation will be sent to your school account. Deadline for program submission: **April 13, 2025 (Sunday) 11.59 pm.**

Programming Question 1: First occurrence in a sorted array

You're given a sorted array of integers (possibly with duplicates). Write a function to find the index of the first occurrence of a given target number. If the target is not present, return -1.

The method header is:

```
def first_occurrence(arr, target):
```

where arr is the sorted array given, and target is the number we are looking for.

For example, for the input:

6 2

1 2 2 2 3 4

where the first line indicates two integers n (size of array) and x (target value), and the second line contains space-separated integers (sorted in non-decreasing order).

The output will be 1.

Consider using binary-search based algorithm. Brute-force algorithm will report "Time limit exceeded" for some test cases.

Programming Question 2: Find the smallest number greater than the target

You are given a sorted list of integers (no duplicates) and a target number. Your task is to find the smallest number in the list that is greater than the target.

If such a number does not exist, return -1.

The method header is:

```
def find_smallest_greater(arr, x):
```

where arr is the sorted list and x is the target.

For example, for the input:

5 9

1 2 3 4 5

where the first line indicates two integers n and x — the number of elements and the target, and the second line contains n sorted integers.

The output will be -1.

Consider using the binary-search based algorithm. The brute-force algorithm will report "Time limit exceeded" error for some test cases.

Programming Question 3: The Kth smallest number in a sorted matrix (row and column-wise sorted)

Given an n by n matrix (2D array) where each row and column is sorted in non-decreasing order, find the k-th smallest element. For example, given the 3 by 3 matrix:

1 5 9

10 11 13

12 13 15

The 5th smallest number is 11. The 7th and 8th smallest numbers are both 13.

The method header is:

```
def kth_smallest_linear(matrix, k):
```

For example, for the input

3 5

1 5 9

10 11 13

12 13 15

where the first line contains two integers n (i.e., the number of columns and rows) and k. Each of the next n lines contains n integers (each line represents a row).

The output will be 11.