BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
HYDERABAD
CAMPUS,
Data Structures and Algorithms
CS F211 / IS F211

Homework Assignment – 4

1. These days lot of e-commerce websites have an option of sorting things by a field or an attribute. Consider you are looking for a **Book** whose fields or attributes are book name, author name, edition, ISBN no, price, publication, publication year. You will be having an array of Book of size n and you have to sort the array according to price. Define a structure for the Book with relevant fields mentioned and sort the array on basis of publication year using Insertion-Sort.
   Input: $1 \leq n \leq 100000$
   You need to generate the inputs randomly in a file and then read those input in your program. (Use rand() and srand() function to generate the numbers and then redirect it to the input file and use redirection to read the file and compare time taken when n = 10^3, 10^4, 10^5 and 10^6 (Use $: time ./a.out < inputFile to find time)

2. **Winner of Election:** The election in the state of Gotham is nearing. Several candidates are contesting to be the mayor of the town. The big day finally arrives and the votes are taken .The ex-mayor asks you (since you are a responsible citizen with coding skills) to find the winner of election. You are given input array A[0....n-1] where each element represents the vote in the election. Assume that each vote is an integer representing the ID of the chosen candidate. Help ex-mayor in deciding who wins the election by outputting the ID of the winner candidate. Assume only one winner be there. Solve it in O(nlogn)

3. **Peak Finder:** A peak of an array is defined as the element that is greater than or equal to each of its adjacent elements. Given an array with n elements as input, find the index of any one peak of the array in O(logn) time. Note: For a boundary element to be a peak, it should be greater than or equal to its only neighbour. The array is 0-indexed. The use of any auxiliary data structure is now allowed
   Input: n
   n integers
   Output:any peak
   Sample test case:
   a. Input: 15
      5 3 4 3 5 6 8 9 10 9 10 8 5 4
      Output: 8
   b. Input: 8
      5 4 3 5 5 6 7 3
      Output: 3

4. **Quantitative comparison of ternary and binary search:** Compare the performances of ternary and binary search by generating an array of n random integers and searching it for an integer k.
   Input: n k
   n integers of the array
   Output: Position of k (-1 if it is absent)
   Time taken to perform binary search
   Time taken to perform ternary search

5. Sam thinks he know binary search too well. But his friend already has a challenge for him. His friend gives him an ascending order sorted array which had been rotated clockwise about a pivot which is unknown to you beforehand. So for instance, 1 2 3 4 5 might become 3 4 5 1 2. His friend challenges Sam to find a given key in O(log n) time. Help Sam in completing the challenge.

6. There are **n** person playing a game. Each person owns some money which is displayed by them. And you are watching them as a spectator suddenly thought of an amount **X** and want to check if any two person combined sum of money is equal to this amount **X** or not? You have to answer Yes or No in O(nlogn). Assume money to be an integer
   Input Format:
   n X
   n integer's separated by space
   Sample Input:
   6 10
   1 5 4 19 10 6
   Sample Output:
   Yes
   Explanation: there exist two values 4 and 6 such that 4 + 6 = 10

7. Your friend recently learnt to make android apps. He made a word puzzle app. Given a word **w**, the puzzle app gives string **s** lexicographically greater than **w**. In case of multiple answers, the app outputs the lexicographically smallest one among them. If no answer exists, 'game terminated!' is printed. Your friend asks you to check if the outputs are correct. You decide not to see his code and write your own code to verify his app's results. Your code takes no. of test cases and prints the lexicographically higher word for each input.
   Eg:
   Sample input
   5
   ab
   bb
   hefg
   dhck
   dkhc

Sample output

ba

game terminated!
hegf
dhkc
hcdk

8. There are **n** person in a village. Each person own some cows which is distinct for every body and is known to you. You want to check how many triplets of 3 people are there for whom cow possessed by one person is equal to sum of cows possessed by 2 other person. In a way you have to find the total number of triplets (i,j,k) such that cows[i] = cows[j] + cows[k] and $i \neq j \neq k$. Solve this problem in $O(n^2)$

9. Write a program to reverse the order of words in a sentence. Take the sentence is given as an array of characters in the program itself. The array itself must be changed with the order of words reversed. Don't use any extra array. Assume there are no leading or trailing spaces in the sentence.
   e.g.
   array "Data structures and Algorithms" should become
   "Algorithms and structures Data".

10. During Pearl, you are in-charge of distributing stall space along a straight line to
    C (2 <= C <= N) sponsors. You have marked a total of N (2 <= N <= 100,000) potential stall-spaces where the sponsors can put their stalls. The location of these stall-spaces is $x_1,...,x_N$ (0 <= x_i <= 1,000,000,000). One sponsor can occupy one stall. Since all the sponsors are competitors, they demand that their stalls be put as far away as possible from other stalls. Since you want to please the sponsors you agree to their demand. Now your job is to maximize the minimum distance between two stalls while keeping in mind the space constraints.
    Input Format:
    Number of test cases t, followed by the test cases. Each test case has:
    Line 1: Two integers separated by a single space: N and C
    Next N Lines: Line i contains an integer stall location, x_i
    Output Format:
    For each test case output one integer: the largest minimum distance.
    For ex.
    Input:
    1
    4 3
    2

5
9
15

Output:

6

Explanation: the maximum possible min distance is 6 when the 3 stalls are put at locations 2, 9, 15.