

National University of Computer and Emerging Sciences, Lahore Campus



Course:	Design and Analysis of Algorithms	Course Code:	CS-2009
Program:	BS (CS, SE)	Semester:	Spring 2024
Due Date:	March 5, 2024 (before 5 PM)	Total Marks:	50
Sections:	CS-4(G,H,K), SE-6A		
Exam:	Assignment#2		

Instruction/Notes:

Instructions: **Attempt any five questions.** Plagiarism in any form will not be tolerated. Only handwritten, hard copy assignments will be accepted.

Q#1:

You are given two sorted arrays A[] and B[] of size "N" each. Your task is to design an in-place algorithm using divide and conquer technique to determine the median of both the arrays in $O(\log N)$. Median is the value located at the central position of sorted data.

Sample input and output:

Ar1[] = {5,12,15,26,38}
Ar2[] = {3,13,17,30,45}
Median: 16
Reason: overall sorted data 3,5,12,13,15,17,26,30,38,45 (total size = 10, even so median = (5 th term + 6 th term)/2)
Sample input and output#2
Ar1[] = {35,45,50,60}
Ar2[] = {10,15,20,25}
Median: 30
Reason: (overall sorted data) 10,15,20,25,35,45,50,60 Median => (4 th term + 5 th term)/2

Q#2:

Given an array of integers Arr[] of length "N". Your task is to design an algorithm using divide and conquer technique to determine the majority element in the array. A majority element is an element that appears more than half ($N/2$) times in the array. Your algorithm must return the majority element if it exists in an array, otherwise return -1.

Note: You are not allowed to sort the array.

Sample input and output:

Input: Ar1[] = {48, 92, 35, 48, 48, 35, 48, 17, 48}
Majority Element: 48 (total size= 9), occurrences of the value 48 in the array = 5 (more than half)
Sample input and output#2:
Ar1[] = {48, 92, 35, 48, 92, 35, 48, 35, 48}
Majority Element: -1 (there is no element having occurrences more than half times)

Q#3:

Consider an array of distinct integers Arr[] of size "N" was sorted in ascending order. The array has been rotated clockwise "K" number of times. Given such an array, your task is to find the value of "K". Design an algorithm using divide and conquer technique to get the value of "K" in $O(\log N)$.

Sample input and output:

Input: Ar1[] = {78, 85, 92, 25, 34, 48, 56, 62} // after "K" times clockwise rotation
Output: K = 3
Reason: Since original array was sorted so initial contents were Ar1[] = {25, 34, 48, 56, 62, 78, 85, 92}

Q#4:

Assume that you are given an unsorted array of integers `Arr[]` of size “N” and two integers “x” and “y”. It is guaranteed that the values of both the integers are from the original array. Your task is to find the distance between “x” and “y”. The distance between two elements of the array is the number of elements that lie between them in sorted order. Design an efficient algorithm using the divide and conquer approach to get the distance between two elements of the array.

Sample input and output:

<code>Ar1[] = {30, 55, 40, 20, 50, 45, 10, 60, 25, 58}, x = 20, y = 50</code>
Output: 4 => since after sorting the data we have (10, 20, 25, 30, 40, 45, 50, 55, 58, 60)

Q#5:

Consider an unsorted array of integers `Arr[]` of size “N” and an integer “y”. Your task is to determine whether there exists any pair of indices whose absolute difference is equal to “y”. Design an algorithm using divide and conquer approach to solve this problem in $O(N * \log N)$.

Sample input and output:

Input: <code>Ar1[] = {3, 7, 2, 1, 4, 10}</code>, <code>y = 1</code>
Since we are talking about Abs Difference so $3-4 = 1$ and also $2-1 = 1$ so your algorithm must return true

Q#6:

Given two sorted arrays “A[]”, and “B[]” of size “M” and “N” respectively and integer value “K”. Your task is to find the element that would be at Kth position of the final sorted array. Design an efficient in-place algorithm using divide and conquer approach to find the element at kth position of the final sorted array.

Sample input and output:

Input: <code>Ar1[] = {20, 30, 60, 70, 90}</code>, <code>Ar2[] = {10, 40, 80, 100}</code>, <code>K = 5</code>
Output: 60 the final sorted array would be like {10,20,30,40,60, 70, 80, 90, 100}