National University of Computer and Emerging Sciences

Lahore Campus

D & A of Algorithms (CS2009)

Sessional-I Exam

Total Time (Hrs): 1
Total Marks: 20
Total Questions: 3

Date: Sep 23 2024

Course Instructor(s)

Dr. Maryam, Dr. Asim, Miss Abeeda

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Roll No Section Student Signature

Instructions: Answer in the space provided. Do not attach rough sheets with this exam.

CLO 4: **Implement** the algorithms, compare the implementations empirically, and apply fundamental algorithms knowledge to solve practical problems related to the program.

Question 1: Multiple Choice Questions [4 Marks]

a) Suppose you want to sort array of integers that takes 20 GB memory, your machine has only 16 GB RAM. Which of the following sorting algorithms should be used in this scenario?

i. Quick Sort
ii. Merge Sort
iii. Insertion Sort
iv. Bubble Sort

b) Which of the following sort algorithms should be used if the array is almost sorted?

i. Quick Sort
ii. Merge Sort
iii. Insertion Sort
iv. Bubble Sort

c) Which of the following sorting algorithms are guaranteed to be O(n log n) even in the worst case?

i. Quick Sort
ii. Merge Sort
iii. Insertion Sort

d) Suppose we are sorting an array of eight integers using Quick sort, and we have just finished the first partitioning with the array looking like this:

3 2 6 9 12 16 10 13

Which statement is correct?

i. The pivot could be either the 9 or the 12.
ii. The pivot could be the 9, but it is not the 12.
iii. The pivot is not the 9, but it could be the 12.
iv. Neither the 9 nor the 12 is the pivot.

CLO 2: **Analyze** the time and space complexity of different algorithms by using standard asymptotic notations for recursive and non-recursive algorithms.

Question 2: [2 + 4 + 4 = 10 Marks]

(a) Assume that in the partition method of quick sort you are guaranteed to find a pivot that splits the data into one portion of at most 25% data and the other of at least 75%. Using this partition, what will be the recurrence for T(n)?

(b) Consider the following recursive algorithms provide the time complexity of both algorithms in terms of Big-Θ notation. Which one is faster?

```
num Algo1(a, b) {
        if (b == 0)
                return 0;
        if (b == 1)
                return a;
        if (b%2 == 1)
                return a + Algo1(a*2, b/2)
        else
                return Algo1(a*2, b/2)
}
```

```
num Algo2(a, b) {
   if (b == 0)
           return 0;
   if (b > 0)
   return a + Algo2(a, b-1)
}
```

(c) Use recursion tree method to solve following recurrence and provide the answer in terms of Big-Θ notation.

$T(n) = T(3n/4) + T(n/4) + \Theta(n^2)$

CLO #1: Design algorithms using different algorithms design techniques i.e. Brute Force, Divide and Conquer, Dynamic Programming, Greedy Algorithms and apply them to solve problems in the domain of the program

Question 3: [6 Marks]

Given two sorted arrays of sizes m and n respectively, the task is to find the element that would be at the k-th position in the final sorted array formed by merging these two arrays. Write an efficient algorithm to solve this problem, and also write its **time and space** complexity.

Examples:

Input: arr1 = [2, 3, 6, 7, 9], arr2 = [1, 4, 8, 10], k=5
Output: 6
Explanation: The final sorted array is [1, 2, 3, 4, 6, 7, 8, 9, 10]. The 5th element is 6.

Input: arr1 = [100, 112, 256, 349, 770], arr2 = [72, 86, 113, 119, 265, 445, 892], k=7
Output: 256
Explanation: The final sorted array is [72, 86, 100, 112, 113, 119, 256, 265, 349, 445, 770, 892]. The 7th element is 256.