Degree: B.Tech
Stream: Information Technology & CSE(IoTCSBT) & CSE(IoT)
Even End Semester Lab Examination May ,2023
Paper Name: Design Analysis of Algorithm
Paper Code: PCC-CS494
Full Marks:100 **Duration: 3 Hour**

Attempt all the Question

Problem:

Suppose you are given a list of n integers, where each integer is between 1 and n-1 (inclusive). The list may contain duplicates. Your task is to find a duplicate integer in the list, or determine that no such integer exists.

Suppose we are given the list [2, 3, 1, 4, 5, 3]. We can see that the list contains duplicates, as the integer 3 appears twice. Therefore, the answer to the problem is 3.

Another example could be the list [1, 2, 3, 4, 5, 6, 7, 7, 8]. In this case, we can see that the integer 7 appears twice in the list, so the answer is 7.

If there are no duplicate integers in the list, the function should return None or any other value that represents the absence of a duplicate. For example, if we are given the list [1, 2, 3, 4, 5, 6, 7, 8], the function should return None.

Tasks:

1. Design an algorithm to solve this problem. Your algorithm should be as efficient as possible.
2. Analyze its time complexity in terms of n.

Follow these instructions for your lab examination copy.

a. Write down the question in the lab examination copy.
b. Write down the algorithm or pseudo code for you solution
c. Analysis of your solution (Time complexity).

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Attempt all the Question

Problem:

Suppose you are given a list of n integers, and your task is to find the maximum sum of a contiguous subarray within the list.

For example, if the list is [−2, 1, −3, 4, −1, 2, 1, −5, 4], then the answer is 6, which corresponds to the subarray [4, −1, 2, 1].

Tasks:

1. Design an algorithm to solve this problem. Your algorithm should be as efficient as possible.
2. Analyze its time complexity in terms of n.

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Attempt all the Question

Problem:

Suppose you are given a set of n intervals on the real line, and your task is to find the maximum number of overlapping intervals, i.e., the largest subset of intervals such that each pair of intervals in the subset has a non-empty intersection.

For example, suppose we are given a set of intervals on the real line: {[1, 5], [2, 7], [4, 9], [6, 10], [8, 11], [10, 12]}. The maximum number of overlapping intervals is 3, which corresponds to the intervals {[2, 7], [4, 9], [6, 10]}.

Tasks:

1. Design an algorithm to solve this problem. Your algorithm should be as efficient as possible.
2. Analyze its time complexity in terms of n.

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Attempt all the Question

Problem:

Suppose you are given a set of n integers, and your task is to partition the set into two subsets such that the difference between their sums is minimized. That is, you want to find a partition (A, B) of the set where |sum(A) - sum(B)| is minimized.

For example, suppose we are given the set of integers {2, 4, 6, 8, 10}. The two subsets with the minimized difference are {2, 4, 6, 8} and {10}, and their difference in sum is |30 - 2*15| = 0.

Tasks:

1. Design an algorithm to solve this problem. Your algorithm should be as efficient as possible.
2. Analyze its time complexity in terms of n.

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Attempt all the Question

Problem:

Suppose you are given a set of n integers, and your task is to find the length of the longest increasing subsequence in the set, i.e., the longest sequence of numbers where each number is greater than the previous one.

For example, suppose we are given the set of integers {4, 2, 6, 3, 8, 5}. The maximum value is 3, which represents the length of the longest increasing subsequence in the set. One possible longest increasing subsequence is {2, 6, 8}.

Tasks:

1. Design an algorithm to solve this problem. Your algorithm should be as efficient as possible.
2. Analyze its time complexity in terms of n.

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Attempt all the Question

Problem:

Suppose you are given a set of n points in the two-dimensional plane, and your task is to find the minimum spanning tree (MST) of the set, i.e., the tree that connects all the points with the minimum total edge weight (between any two points the distance is the edge weight).

For example, suppose we are given the set of points {(0,0), (1,2), (2,1), (3,3)}.

- Edge (0,1) with weight 2
- Edge (1,2) with weight 2.236
- Edge (0,2) with weight 2.236
- Edge (2,3) with weight 2.236
- Edge (1,3) with weight 3.162
- Edge (0,3) with weight 3.606

The resulting MST connects all the points with a total edge weight of 2+2.236+2.236=6.472.

Tasks:

1. Design an algorithm to solve this problem. Your algorithm should be as efficient as possible.
2. Analyze its time complexity in terms of n.

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Attempt all the Question

Problem:

Suppose you are given a set of n points in the two-dimensional plane, and your task is to find the closest pair of points, i.e., the pair of points with the smallest Euclidean distance between them.

For example, suppose we are given the set of points {(0,0), (1,2), (2,1), (3,3)}.

- Distance between (0,0) and (1,2) is sqrt(5) = 2.236
- Distance between (0,0) and (2,1) is sqrt(5) = 2.236
- Distance between (0,0) and (3,3) is sqrt(18) = 4.243
- Distance between (1,2) and (2,1) is sqrt(2) = 1.414
- Distance between (1,2) and (3,3) is sqrt(5) = 2.236
- Distance between (2,1) and (3,3) is sqrt(5) = 2.236

The closest pair of points is (1,2) and (2,1), with a distance of 1.414.

Tasks:

1. Design an algorithm to solve this problem. Your algorithm should be as efficient as possible.
2. Analyze its time complexity in terms of n.

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Attempt all the Question

Problem:

Suppose you are given a set of n integers, and your task is to find the kth smallest element in the set, where 1 <= k <= n.

For example, suppose we are given the set of integers {5, 2, 9, 1, 7, 4}, and we want to find the 3rd smallest element (i.e., k = 3). The 3rd smallest element in the set {5, 2, 9, 1, 7, 4} is 4. Similarly for k=2, the value would be 2.

Tasks:

1. Design an algorithm to solve this problem. Your algorithm should be as efficient as possible.
2. Analyze its time complexity in terms of n.

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Attempt all the Question

Problem:

Suppose you are given a set of n tasks, each with a start time s[i] and a finish time f[i], where s[i] and f[i] are integers and 1 <= i <= n. Your task is to schedule as many tasks as possible such that no two scheduled tasks overlap, i.e., their time intervals do not intersect.

For example, suppose we are given the set of tasks below, each with a start time s[i] and a finish time f[i]:

- Task 1: s[1] = 1, f[1] = 4
- Task 2: s[2] = 3, f[2] = 5
- Task 3: s[3] = 0, f[3] = 6
- Task 4: s[4] = 5, f[4] = 7
- Task 5: s[5] = 3, f[5] = 8
- Task 6: s[6] = 5, f[6] = 9
- Task 7: s[7] = 6, f[7] = 10

Our task is to schedule as many tasks as possible such that no two scheduled tasks overlap. So, Task 1, 3, 5 and 7 can be scheduled for this example.

Tasks:

1. Design an algorithm to solve this problem. Your algorithm should be as efficient as possible.
2. Analyze its time complexity in terms of n.

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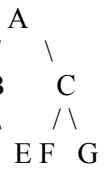
Attempt all the Question

Problem:

Suppose you are given a directed acyclic graph (DAG) G = (V, E), where V is the set of vertices and E is the set of edges. Each vertex v has a weight w(v), and your task is to find the longest path in G, which is defined as the path that maximizes the sum of the weights of its vertices.

For example, suppose we have the following DAG:



where each vertex has a weight as follows: w(A) = 2, w(B) = 4, w(C) = 1, w(D) = 5, w(E) = 3, w(F) = 2, w(G) = 6

For this example, the longest path has a sum of 15 and goes from D to G:

D -> B -> E -> F -> G

Tasks:

1. Design an algorithm to solve this problem. Your algorithm should be as efficient as possible.
2. Analyze its time complexity in terms of |V| and |E|.

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Attempt all the Question

Problem:

Suppose you are given two sorted arrays A and B of lengths m and n, respectively, and your task is to find the median of the merged array C = A+B, which is defined as the middle element of C if its length is odd, or the average of the two middle elements of C if its length is even.

For example, suppose we have two sorted arrays A and B:

A = [2, 3, 5, 8, 10], B = [1, 4, 6, 7, 9, 11]

C = [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]

m = 5, n = 6
Total length of C = m + n = 11
Middle index of C = (m+n-1)/2 = 5
Median of C = C [5] = 6
Therefore, the median of the merged array C is 6.

Tasks:

1. Design an algorithm to solve this problem. Your algorithm should be as efficient as possible.
2. Analyze its time complexity in terms of m and n.

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Attempt all the Question

Problem:

Suppose you are given a string s of length n, and your task is to find the longest palindromic substring of s.

For example, if s="babad", then the answer is "bab" or "aba", which are both palindromic substrings of s.

Tasks:

1. Design an algorithm to solve this problem. Your algorithm should be as efficient as possible.
2. Analyze its time complexity in terms of n.

Follow these instructions for your lab examination copy.

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