CSE 321 – Fall 2023

Homework 5

Due Date: (14/01/2024) 23:55

1. A robotics company is designing a swarm of drones for efficient parcel delivery in a city. Each drone is equipped with a sensor array that helps it avoid collisions with other drones. The challenge is to design an algorithm that ensures the minimum distance between any two drones to prevent collisions during their operations. Given the coordinates of *n* drones on a 2D plane, devise a divide-and-conquer algorithm that efficiently determines the minimum distance between any pair of drones. Your algorithm should find this minimum distance without exhaustively comparing every pair of drones. Provide a detailed explanation of your algorithm, including the pseudo code, and analyze the time complexity (Big-Oh notation) of your proposed algorithm.

2. Imagine a team of researchers exploring a remote region with limited access to power resources. They have strategically placed sensors across the area to detect potential hazards and threats to their campsite. However, these sensors consume significant power when activated. The challenge is to design an algorithm that efficiently selects the minimum number of sensors needed to establish a secure perimeter around their camp while conserving power. Propose a divide-and-conquer algorithm that, given the coordinates of *n* sensors placed in the region, determines the fewest number of sensors needed to be activated to create a secure perimeter around the campsite. This perimeter should encompass critical exploration areas, ensuring maximum security coverage while conserving sensor power. Explain your algorithm in detail. Give the pseudo code and analyze the time complexity (Big-Oh notation) of your proposed algorithm.

3. In a state-of-the-art genetics laboratory, scientists are analyzing DNA sequences from various organisms. They are investigating the correlation between two specific DNA sequences obtained from separate species. These sequences are represented by strings of nucleotides (A, C, G, T). The objective is to align these sequences by converting one into the other using the fewest possible operations. Permitted operations include insertion (adding a nucleotide), deletion (removing a nucleotide), or substitution (changing one nucleotide to another). Insertions and deletions are of the same cost, while substitutions incur a cost three times higher than them.

Propose a dynamic programming algorithm to determine the sequence of operations with the minimum cost required to align these DNA sequences while ensuring similarity between the sequences. Explain your algorithm in detail. Give the pseudo code and analyze the time complexity (Big-Oh notation) of your proposed algorithm.

4. In Homework 3, Question 1, you were tasked with determining the highest achievable discount for a sequence of stores visited in a shopping mall loyalty program. The initial question involved an exhaustive search algorithm to calculate the maximum discount for every possible combination of stores visited. In this question, you are asked to revisit Homework 3, Question 1, and solve the same problem using a dynamic programming algorithm. Develop a dynamic programming solution that efficiently calculates the maximum achievable discount for a given sequence of stores visited. Explain your algorithm in detail. Give the pseudo code and analyze the time complexity (Big-Oh notation) of your proposed algorithm.

5. A wireless service provider deploys antennas on rooftops along a street to cover various segments of the area. Each rooftop hosts an antenna, and each antenna has a coverage range that begins at a single point on the street and extends to another point. While the coverage ranges of neighboring antennas may overlap, it is undesirable to have intersecting antennas causing interference. Design a greedy algorithm to determine the maximum number of antennas that can be activated, ensuring that the coverage areas of any two activated antennas do not intersect. Explain your algorithm in detail. Give the pseudo code and analyze the time complexity (Big-Oh notation) of your proposed algorithm.

Notes:

- Your answer must be handwritten and submitted via the Course MS Teams page.
- Pseudocodes should be submitted as actual Python code and submitted as separate files together with your handwritten solutions.
- If you have any questions, you can send an email to b.koca@gtu.edu.tr
- Please complete your homework individually; group studies will be regarded as cheating.