Mock MID 2 Exam – Algo Fall 2023

Q1: **Example: Find a minimum number of multiplications required to multiply: A [1 × 5], B [5 × 4], C [4 × 3], D [3 × 2], and E [2 × 1]. Also, give optimal parenthesization.**

$$m[i,j] = \begin{cases} 0 & , \text{if } i = j \\ \min\limits_{i \le k < j} \{m[i,k] + m[k+1,j] + d_{i-1} \times d_k \times d_j\} & , \text{if } i < j \end{cases}$$

Q2: You are tasked with using the Graham Scan algorithm to find the convex hull of hazardous areas in a given maritime region. The algorithm takes a set of points representing the positions of underwater hazards, and it returns a set of points that outline the convex hull of the hazardous area. The hazardous points include (2, 3), (5, 5), (6, 1), (1, 1), (4, 4), (3, 2), (7, 3).

Q3: Provide a dry run of the Knuth-Morris-Pratt (KMP) algorithm on the following: Text: abcab abcabcab abcabcabc abcbabcbbc, Pattern: abcbabcbbc

Q4: Design a divide-and-conquer algorithm to find the closest pair of drone launch sites while considering altitude and weather constraints. The launch sites are represented as geographical coordinates with altitude and weather conditions.

The launch sites are:

Launch Site A: (36.1551, -115.1590), Altitude: 1200 meters, Weather: Sunny

Launch Site B: (37.7749, -122.4194), Altitude: 900 meters, Weather: Cloudy

Launch Site C: (34.0522, -118.2437), Altitude: 1000 meters, Weather: Clear

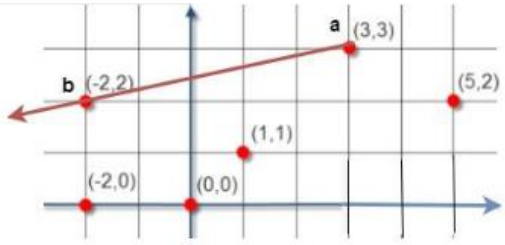
Launch Site D: (41.8781, -87.6298), Altitude: 1100 meters, Weather: Overcast

Launch Site E: (40.7128, -74.0060), Altitude: 800 meters, Weather: Sunny

Your algorithm should have a time complexity of O(nlogn) and must consider:

1. Distance Constraint: Find the closest pair of launch sites, ensuring that the distance between them is minimal to minimize drone flight time.
2. Altitude Constraint: The altitude of the chosen pair of launch sites must not differ by more than 100 meters to ensure safe drone flights.
3. Weather Constraint: The selected pair of launch sites must have favorable weather conditions (e.g., clear sky) for accurate data collection.

Q5: Given the line segment (a, b) in below figure, design a brute force algorithm to determine whether this line will be the part of convex hull. Hint: use counterclockwise turn technique.



Q6: You are responsible for organizing students in an exam hall for a university examination. Each student is identified by a unique registration number. Your task is to ensure that they are seated in the exam hall in ascending order of registration numbers. However, there's a catch: The registration numbers are in the format "U-XXXXX" where 'U' represents the university code, and 'XXXXX' represents a five-digit number. The exam hall has multiple rows, and each row can accommodate 10 students. To maintain order, you need to allocate seats row by row, ensuring that students within the same row are sorted by their registration numbers. Write a function that allocates the seats to each student in linear time.