CSE 321 – Fall 2023

Homework 4

Due Date: (22/12/2023) 23:55

Please note that for Questions 1, 2, and 3, you are expected to provide solutions using the decrease and conquer approach, not the divide and conquer method. In the decrease and conquer approach, the problem sizes are reduced by a constant, not by dividing a factor.

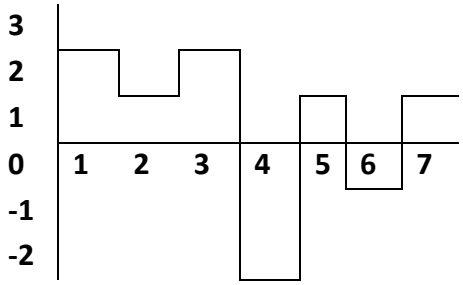
1. In a complex electronic circuit, n fuses are sequentially connected to transfer electricity to various circuit components. Unfortunately, one fuse is malfunctioning and disabling the circuit's operation. The healthy fuses function normally. Develop an algorithm to identify the flawed fuse while minimizing the number of fuses inspected. Please note that electricity can only be transferred until the broken fuse and cannot reach the remaining fuses. Provide a decrease and conquer algorithm to find the flawed fuse. Include the pseudo-code and analyze the time complexity (Big-O notation) of your proposed algorithm.

2. You are required to analyze an image represented as a 2D grid of pixels, where each pixel holds a numerical value representing its brightness level. The image possesses a unique property where the brightness of pixels follows a strictly monotonic pattern between neighboring pixels: it monotonically increases or decreases between adjacent pixels. Only one pixel in the image breaks this monotonicity and is the brightest among its neighbors.
   Design an algorithm using a decrease and conquer strategy to efficiently identify this unique brightest pixel that is brighter than all of its four immediate neighbors (top, bottom, left, and right), considering the monotonicity in brightness levels between pixels. Provide the pseudo code and analyze the time complexity (Big-Oh notation) of your proposed algorithm.

3. Imagine a discrete function $f(x)$ defined over the interval $[0, n]$, where n denotes a positive integer. This function $f(x)$ spans the range of positive and negative values within this interval. Your objective is to devise a decrease and conquer algorithm to pinpoint the subsequent interval that results in the largest total area under the function $f(x)$. Notably, this total area encompasses both positive and negative values. Negative values within the function will diminish the total area, impacting the overall calculation of the maximal area under the curve.

Develop an algorithm utilizing the decrease and conquer strategy to efficiently identify the interval within $[0, n]$ that produces the maximal total area under the discrete function $f(x)$, considering the effects of both positive and negative values on the overall area calculation. Provide the pseudo code and analyze the time complexity (Big-Oh notation) of your proposed algorithm.

Example:



The area between $[3, 5]$ is $= 2 + (-2) + 1 = 1$.
The maximum total area is $[0, 3] = 2 + 1 + 2 = 5$.

4. The network topology is represented as a graph, where each node represents a location, and edges between nodes signify possible connections or links. Each edge is associated with a certain latency. Develop an exhaustive search algorithm that exhaustively explores all possible routing paths between the source and destination nodes, evaluating the total latency incurred along each path. The algorithm must systematically examine all potential paths and determine the one with the minimum latency. Provide the pseudo code and analyze the time complexity (Big-Oh notation) of your proposed algorithm.

5. As a project manager overseeing multiple endeavors, you encounter a critical challenge in efficient resource allocation across diverse project tasks. Each task demands varying resources and contributes uniquely to project progress. Design a divide and conquer algorithm that efficiently evaluates resource distribution across project tasks, simultaneously identifying the tasks demanding the maximum and minimum resources within a single execution. Provide 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.