

DS501 – Homework 1

Deadline 13.11.2024

Problem 1: Optimal String Segmentation with Constraints

You are given a long string S and a list of forbidden substrings F . The goal is to segment the string S into the minimum number of non-empty parts such that:

1. No segment contains any forbidden substring from F .
2. The segmentation must minimize the total number of parts.
3. The difference between the size of the segments is minimum.
4. Handle cases where no valid segmentation is possible, and output a message indicating failure.
5. Consider strings with repetitive patterns or strings that contain every forbidden substring.

Example

- **Input:** $S = \text{"abcdeabc"}$, $F = [\text{"bc"}, \text{"de"}, \text{"abcd"}]$
 - **Output:** Segmentation into $[\text{"a"}, \text{"bcd"}, \text{"eabc"}]$ is invalid, so the minimum valid segmentation is $[\text{"abc"}, \text{"deabc"}]$.
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Problem 2: Pathfinding in a Weighted Grid with Obstacles

You are given a 2D grid of size $n \times m$ where each cell contains an integer representing the cost to enter that cell. Some cells contain obstacles and cannot be entered. Your task is to find the least costly path from the top-left corner to the bottom-right corner, using only valid moves (up, down, left, right).

1. Use an efficient pathfinding algorithm (e.g., Dijkstra's or A* algorithm).
2. Implement your algorithm and discuss the heuristic used (if applicable).
3. Consider grids with no valid paths, grids where all cells have the same cost, and grids with multiple optimal paths.

Problem 3: Custom Scheduling Algorithm

Design an algorithm to solve a custom job scheduling problem:

1. You have N jobs, each with a start time, end time, and profit. You must choose a subset of non-overlapping jobs to maximize the total profit.
2. Additionally, each job has a priority level, and you must always choose a higher-priority job over a lower-priority one if there is a conflict.
3. Explain your approach and why it is optimal or near-optimal.
4. Handle cases where all jobs overlap or where multiple jobs have the same priority.