CECS 528, In Class Assignment 5, Friday February 27th, 2026, Dr. Ebert

Student Names:

Problem

Suppose n packages are queued to be loaded on to a queue of delivery trucks, where package i consumes s_i units of space. The delivery company has concluded that the optimal (in terms of cost) loading scheme should be one that balances the load of each truck in terms of the amount of remaining empty space. Unfortunately, at most one truck can be loaded at a time due to the size of the loading platform. Each truck has a space capacity of $M > 0$ units. When loading the trucks one cannot change the order of the package queue or the truck queue, i.e. one truck is loaded at a time, and one package is loaded at a time. Also, the trucks should have roughly the same volume of packages, meaning that it is better to have all trucks partially full than to have trucks ahead in the queue become filled to capacity, while trucks later in the queue are almost empty. In other words, the penalty

$$\sum_{t=1}^{m} e_t^2,$$

should be minimized, where m is the number of trucks in the queue, and e_t denotes the amount of empty space in truck t after it is loaded.

1. Imagine yourself taking a step towards solving the problem and reducing it to one or more smaller subproblems. What are the different options that you have for this first step and what are the consequences of each option? Generalize the original problem to include the subproblems that you discover. Do this by defining an appropriate function. Hint: assume that there are always enough trucks available to optimize the problem instance, and thus the number of trucks in the queue does not matter. (10 pts)

2. Provide a dynamic-programming recurrence for your function from part a. (10 pts)

3. Apply your recurrence to the package sequence $3, 3, 4, 3, 5, 2, 2$, with $M = 10$, where the numbers in the sequence represent the package sizes. (10 pts)