CS 3353 Fall 2023

Program 4

Deep see rescue

Due: 12/9 (Sat) 11:59pm. Absolutely NO late pass allowed.

You are the chief commander of "Transcontinental Rescue" (TR) and you have received an SOS that there has been a deep sea accident and they will need your organization to help rescue the people trapped in the deep sea.

For the rescue operations, TR has a set of N vehicles (labelled vehicle 0, vehicle 1, … vehicle N-1) that are to be deployed to site for the rescue operation. Each of them has a specific task to perform, and in order for the rescue to be successful, every vehicle has to perform its task successfully.

For each vehicle to perform, energy units (in integers) has to be supplied to the vehicles. Here are the rules about energy assigned to vehicles.

- The more energy a vehicle receives, the more likely that the vehicle can perform its task.
- For vehicle p, we denote Prob(p, q) to be the probability of vehicle p can perform its task if q unit of energy is supplied to it. This probability is between 0 and 1.
- Notice that each vehicle must be supplied with at least 1 unit of energy, otherwise the recuse will fail.
- The probability that a vehicle can successfully perform its task is only dependent on the energy it is supplied and is totally independent of how the other vehicles perform.
- For each vehicle, you can supply a maximum of M unit of energy to it. Any extra energy supplied to it will not increase the probability of success of that vehicle.
- TR only has E units of energy supplied for each operation. So how to distribute the energy among its vehicles is crucial.

Base case (100 points)

Your task is to write a program that given N (# of vehicles), E (total unitsof energy available), M (maximum units of energy each vehicle can take) and Prob(p, q) for 0 <= p < N and 1 <= q <= M, find the best way of assign energy to its vehicles to maximize the probability of the success of the rescue. ***You must use dynamic programming, NOT a recursive algorithm.***

Notice that the overall success probability of the rescue is the PRODUCT of the probability of success for each vehicle.

There will be a driver program "hw4test.cpp" which will read in an input file with the following format.

- The first line contains three numbers, which are N, E, M respectively
- Each of the following N lines corresponds to a vehicle. Each line with have M numbers denoting the probability of success if 1, 2, … M units of energy is supplied to that vehicle.

A sample file is as follows:

4 8 3

0.11 0.15 0.35
0.005 0.25 0.35
0.2 0.25 0.345
0.175 0.225 0.335

You are to implement the following function:

pair<vector<int>, s> assign(int N, int E, int M, float prob[][])

- N, E, M are described as above.
- prob[][] is a two dimensional array where prob[p][q] denote the probability of success for vehicle p when q+1 units of energy
- this function will return a vector of length N, where entry k corresponds to the energy to be supplied to vehicle k, and s denote the probability of success.

Bonus (40 points)

In this case, we assume TR has discovered a overload device that can be put on one vehicle, such that it will be min (x + 0.2, max(0.999, x)) where x is the original probability of success.

For example suppose the probability of success for a vehicle is as follows: [0.1, 0.2, 0.8, 0.9999]. After applying the overload device on the vehicle, the probability of success becomes [0.3, 0.4, 0.999, 0.9999}.

Notice that applying a overload device costs 1 unit of energy, and it can only be applied to at most two vehicles. (You do not have to apply any overlaod device if you don't think it will help).

You are to write a function to calculate how to maximize the success probability of the rescue. Yor need to apply the following function:

pair<vector<int>, s> assign2(int N, int E, int M, float prob[][])

where the input and output is the same, with the exception that if you apply the overload device to a vehicle, you should return the negative of the amount of energy apply to that vehicle. For example. If your output vector is [-3, 1, -1, 2], this means you are assigning 3, 1, 1, 2 units of energy to vehicles 0, 1, 2, 3 rspective3ly, and you are using the overload device on vehicles 0 and 2.

What to hand in

You are to implement the two functions in a file hw4.cpp (provide to you with only the definition. You will need to fill in the code for that. You are welcomed to add any functions to it (but none of them will be called by the main program).