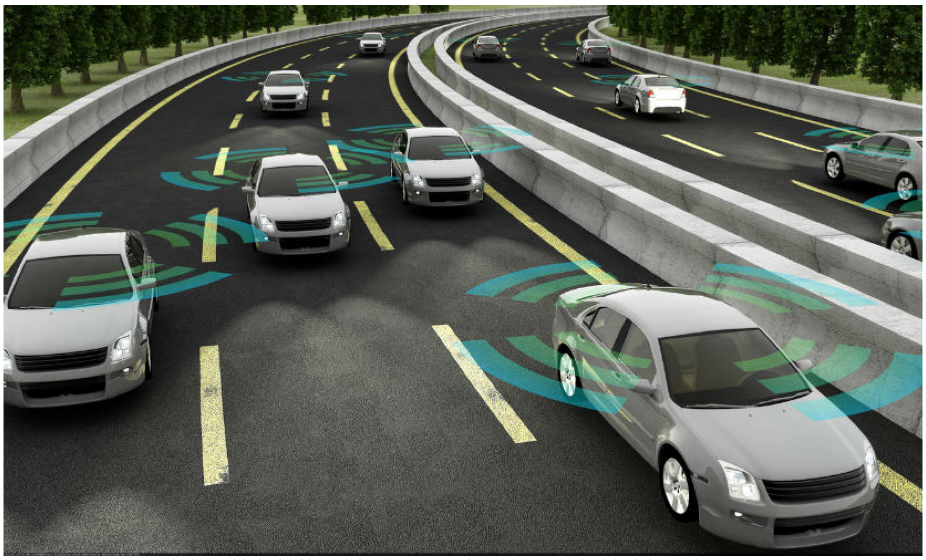
CSCI561 Fall 2018 Foundations of Artificial Intelligence

Homework 3

Due November 23, 2018 23:59:59

BONUS: 20 HW points if submitted by November 19, 2018 23:59:59



https://news.utexas.edu/sites/default/files/styles/news_article_main_image/public/photos/autonomous_vehicles_830.jpg?itok=WvKF9fpF

Problem Description:

You are the CTO of a new startup company, SpeedRacer, and you want your autonomous cars to navigate throughout the city of Los Angeles. The cars can move North, South, East, or West. The city can be represented in a grid, as below:

0,0	1,0	2,0	3,0	4,0
0,1	1,1	2,1	3,1	4,1
0,2	1,2	2,2	3,2	4,2
0,3	1,3	2,3	3,3	4,3

0,4	1,4	2,4	3,4	4,4

There will be some obstacles, such as buildings, road closings, etc. If a car crashes into a building or road closure, SpeedRacer has to pay $100. If the car successfully picks up a person, SpeedRacer makes $20. You know the locations of these, and they will not change over time. You also spend $1 for gas when at each grid location along the way. The cars will start from a given SpeedRacer parking lot, and will end at another parking lot. When you arrive at your destination parking lot, you will receive $100. **Your goal is to make the most money** over time with the greatest likelihood. Your cars have a faulty turning mechanism, so they have a chance of going in a direction other than the one suggested by your model. They will go in the correct direction 80% of the time.

The first part of your task is to design an algorithm that determines where your cars should try to go in each city grid location given your goal of making the most money. Then, to make sure that this is a good algorithm when you present it to the rest of your board, you should simulate the car moving through the city grid. To do this, you will use your policy from your start location. You will then check to see if the car went in the correct direction using a random number generator with specific seeds to make sure you can reproduce your output. You will simulate your car moving through the city grid **10 times** using the random seeds 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10. You will report the mean over these 10 simulations **as an integer after using the floor operation** (e.g., numpy.floor(meanResult)). An example of this process is given in detail below.

Input: The file `input.txt` in the current directory of your program will be formatted as follows:

> First line: strictly positive 32-bit integer s, size of grid [grid is a square of size sxs]
>
> Second line: strictly positive 32-bit integer n, number of cars
>
> Third line: strictly positive 32-bit integer o, number of obstacles
>
> Next o lines: 32-bit integer x, 32-bit integer y, denoting the location of obstacles
>
> Next n lines: 32-bit integer x, 32-bit integer y, denoting the start location of each car
>
> Next n lines: 32-bit integer x, 32-bit integer y, denoting the terminal location of each car

Next line: strictly positive 32-bit integer p, number of people to pick up for each car

Next n*p lines: the list of people x,y coordinates. The order will be p people for each car (e.g., car 1: person 1, person 2, person 3, car2: person 1, person 2, etc.)

Output:

n lines: 32-bit integer, denoting the mean money earned in simulation for each car, **integer result of floor operation**

Example:

Input.txt
3
1
1
0,1
2,0
0,0

Output.txt
95

For example, say you have a 3x3 grid, as follows, with 1 car in start position 1,0 (green):

99	-1	-1
-101	-1	-1
-1	-1	-1

You determine that based on the locations of certain obstacles and people, you should move in these directions in each cell:

99	←	←
↑	↑	↑
→	↑	↑

Then, you should do simulation using this policy. Beginning at the start position, move in the direction suggested by your start policy. There is a 10% chance that you will move South, so check your direction using random generation with random seed = 1 (e.g., random.random()). In this case, you actually move South, so you will receive -$1. You will now try to move North based on your policy. With the random seed = 1, you successfully move North. Therefore, you now have -$2. Repeat at your next locations, until you end at your terminal state. Record the total money you have at the end. Let's say that the total is $91. Then, repeat this process 9 more times. You will average $91 with the 9 other results, and report the number. If the result is 91.65093, for example, you should record 91 in your output file. Standard rounding rules apply. (draw random sample from a distribution: if value is <= 0.7 make the correct transition, otherwise randomly pick uniformly alternative direction) (rounding) Some code demonstrating how to do this is given below:

```
for i in range(len(cars)):
  for j in range(10):
    pos = cars[i]
    np.random.seed(j)
    swerve = np.random.random_sample(1000000)
    k=0
    while pos != ends[i]:
      move = policies[i][pos]
      if swerve[k] > 0.7:
        if swerve[k] > 0.8:
          if swerve[k] > 0.9:
            move = turn_left(turn_left(move))
          else:
            move = turn_left(move)
        else:
          move = turn_right(move)
```

Guidelines

This is a programming assignment. You are provided sample input and output files. Please understand that the goal of these samples is to check that you can correctly parse the problem definitions, and generate a correctly formatted output. The samples are very simple and it should not be assumed that if your program works on the samples it will work on all test cases. There will be more complex test cases and it is ***your task to make sure that your program will work correctly on any valid input***. You are encouraged to try your own test cases to check how your program would behave in some complex special case that you might think of. Since **each homework is checked via an automated A.I. script**, your output should match the specified format *exactly*. Failure to do so will most certainly cost points. The output format is simple and examples are provided. You should upload and test your code on vocareum.com, and you will submit it there.

Grading

Your code will be tested as follows: Your program must not require any command-line argument. It should read a text file called "input.txt" in the current directory that contains a problem definition. It should write a file "output.txt" with your solution to the same current directory. Format for input.txt and output.txt is specified below. End-of-line character is LF (since Vocareum is a Unix system and follows the Unix convention).

The grading A.I. script will

- Create an input.txt file, delete any old output.txt file.
- Run your code.
- Test your output.txt file

Academic Honesty and Integrity

All homework material is checked vigorously for dishonesty using several methods. All detected violations of academic honesty are forwarded to the Office of Student Judicial Affairs. To be safe you are urged to err on the side of caution. Do not copy work from another student or off the web. Keep in mind that sanctions for dishonesty are reflected in *your permanent record* and can negatively impact your future success. As a general guide:

- **Do not copy** code or written material from another student. Even single lines of code should not be copied.
  Do not collaborate on this assignment. The assignment is to be solved individually.
  Do not copy code off the web. This is easier to detect than you may think.
- **Do not share** any custom test cases you may create to check your program's behavior in more complex scenarios than the simplistic ones considered below.
  Do not copy code from past students. We keep copies of past work to check for this.
- **Do** ask the professor or TA if you are unsure about whether certain actions constitute dishonesty. It is better to be safe than sorry.

Homework Rules

1. Use Python 2.7 to implement your homework assignment. You are allowed to use standard libraries only. You have to implement any other functions or methods by yourself.

2. Create a file named "hw3cs561f2018.py". When you submit the homework on labs.vocareum.com, the following commands will be executed:

   python hw3cs561f2018.py

3. Create a file named "output.txt" and print its output there. For each test case, the grading script will put an "input.txt" file in your work folder, runs your program (which reads "input.txt"), and check the "output.txt" file generated

by your code. The grading script will replace the files automatically, so you do NOT need to do anything for that part.

4. Homework must be submitted through Vocareum. Please only upload your code to the "/work" directory. **Don't create any subfolder or upload any other files**. Please refer to http://help.vocareum.com/article/30-getting-started-students to get started with Vocareum.

5. Your program must handle all test cases within a maximum runtime of **3 minutes** per test case on Vocareum.

6. It is recommended to submit your program 24 hours ahead of the deadline to avoid any submission issues on Vocareum. **Late submissions will not be graded.**

Helpful Hints:

1. **Tie breaking.** If values are the same for your available moves, choose to move in directions in this order of preference: North, South, East, West.
2. **Cars can be in the same grid cell at the same time.** There is no need to consider multi-agent coordination.
3. **Calculating expected value.** When considering future moves, make sure to give them a lesser weight, specifically 0.9. You can stop calculating when you are within 0.1 of the optimal value.
4. **<u>It is very important to use the exact parameters we provide for your simulation, as different answers will be marked as incorrect.</u>**
5. **We will not give unsolvable inputs.** This means that we won't give any irregular inputs that don't conform to the format we've described in this document.
6. **Think about representing the problem.**
    a. What is a good representation of states and operators?
    b. How can you use this to simplify the problem representation?
    c. How will you evaluate the "score" of a state?
7. **Think about complexity.**
    a. How can you use the input parameters to determine which algorithm will be able to generate a solution within 3 minutes?