SEMESTER ASSIGNMENT 2018 PART 1

Objectives

This assignment will be performed and handed in as a piece of individual work. It will determine 60% of the final grade in the course. It deals with self-learning cars that are inherently self-interested. Can they learn to get along without being instructed to do so? Can they provide the desired service as taxis without being instructed to do so?

The task

Part 1

2 self-driving cars meet at a very narrow bridge. There is only room for one at a time. It takes 10 minutes to cross. If both cars enter the bridge during the same time slot they will crash. How will the cars manage this conflict? One has to yield and therefore will be delayed for 10 minutes. The other one will be able to drive across right away. Assume that the cars have to cross the bridge very often.

a. Discuss the problem briefly and create a zero-intelligence model in Python. The resolve is achieved simply by means of a coin toss and a mixed strategy.
b. Apply a learning algorithm of your choice and implement it in Python. Study whether the two cars can reach a mutual understanding of a mixed strategy through any form of negotiation where they, on a regular basis, alternate between drive or wait in a regular fashion (e.g. drive-wait-drive-wait-drive-wait).
c. Argue that the mixed strategy developed is a form of social convention between the two cars.

Part 2

Assume that there is a traffic line going one way across the bridge. The bridge can carry 5 cars at the most. This means that max 5 cars can be "serviced" in parallel. The arrival time is Poisson[1] distributed with a mean arrival rate of λ. As before it takes 10 minutes to cross the bridge. This means that the bridge is able to "service" one car as in Part1 per 10 minutes (μ). Can an arriving car learn to stop and wait if there are already 5 cars on the bridge?

a. Apply a strategy and a learning algorithm and program this in Python to train. Vary λ and other parameters as needed to understand sensitivities and plot them.
b. Answer the question above.
c. What about the meeting car in Part 1? How will it be able to cross if there is a heavy traffic the other way?
d. How can the potential conflict be resolved?

[1] Will be explained in class

Part 3

The self-driving cars are used as taxis. Once they have crossed the bridge they are in town. There is a market for them at 3 different locations: The finest restaurant in town, the cinema and the opera. The demand at the different locations vary. The demand distribution is unknown and is therefore generated at random. However, the max capacity of the opera is 250, the restaurant can take 50 and the cinema 150. So, number of visitors at each place will vary between 0 and max capacity.

How many goes in one taxi is beta distributed[2]. This implies that min is 1, the median is 2 and max is 4.

When people are ordering a taxi they want to have a price and know the time to pick up. Long pick-up time means a less chance of getting a passenger. Short pick-up time makes the taxi competitive. When the situation in non-Pareto optimal the price is fixed at 30 NOKs per minute . When demand exceeds the availability of taxis prices surge as a consequence of which passenger is willing to pay the most. That implies that each taxi is willing to initiate an auction where the highest bidder wins – regardless of the pick-up time. When a passenger books a taxi it also needs to specify where he is going and thus enable a taxi to determine the duration of the ride that is ordered and the cost of this ride.

Passenger travels usually takes between 10 and 40 minutes one way. Hence, this can be modelled by means of a random number, r϶[10,40]. In addition to this a passenger must define a maximum price that he/she can accept. In cases where a taxi invokes an auction (English auction) due to high demand that threatens overall capacity a bazaar concept applies. A taxi and a passenger are randomly connected for negotiation. If the price asked by the taxi is less than the limit set by the passenger a deal is struck. Otherwise a deal cannot be reached. Once a deal is struck that passenger(s) and the taxi are paired up and the taxis dashes off to pick up the passenger and deliver him to the wanted address. During that period the taxi is occupied and can take no other passengers. If it receives a request it must first drop off its present passengers and return. This influences pick-up time.

If a deal is not struck the auction is repeated. This means that the taxi call for other passengers or vice versa, the passenger calls for other taxis. This time the non-occupied taxi might incrementally reduce its price, while the passenger might want to increase his limit to secure a deal. This goes on until all taxis are engaged or all passengers have a ride.

The taxi depot is equally located in terms of distance from the theater, cinema and restaurant. That implies 5 minutes. Consider different number of taxis, including the numbers 50, 200, 500 and 1000.

1. Model all this as Zero-Intelligence agents in Python. Then use the Evre-Roth model to see if it performs better with respect to the following questions/challenges. At 20:30 hours the cinema show is finished and people want taxis.
    a. What is the going price?
    b. Will supply cover demand?
    c. What if any, is the dominant strategy of the taxis? Comment.

[2] The required insight on beta distribution will be taught in class

    d. Will the system balance? (not produce enormous waiting lines for taxis or a lot of idle taxis)
2. Assume again 45 minutes later that the opera closes after the last show. Some taxis are far off at the time. 30 minutes after that again the restaurant closes and then 30 minutes after that the cinema has terminated its last flick and closes too.
    a. What is the going price?
    b. Will supply cover demand?
    c. What if any, is the dominant strategy of the taxis?
    d. Will the system balance?

Make plots to support your work and visualize your results.

Presentation

In the second week of the course, on Monday, September 17, you should present your work and preliminary results before the class. You will then prepare a power point presentation and hold a 10-minute lecture.

Final report

The final report should be in the form of a "scientific article" using two columns and an abstract. Examples will be given. A template for this will be provided. It should be between 6 and 8 pages long including images and reference list.

Submission

Submission will be in the form of a report (see above) and Python code version ?? or later. Information on submission date and form will be given later in the course