Term project 2017 agent course at NTHU CS-department

This project is to implement a simulation of market-oriented auction mechanism that may be used by a call-center of a taxi-company to coordinate a team of taxi-drivers that are running at V-city. Assume all agents are all rational, namely, the taxi company agent wishes to maximize the total profit of the company and each taxi driver agent wishes to maximize its own profit earned.

Given the map of the V-city that shows all the streets that are connected as a network with nodes represent intersections where customers are supposed to call a taxi. The numbers attached to edges e represent the distance in terms of kilo meters between intersections both horizontal and vertical. The arrow points the taxi company’s location in V-city.

Assume the average speed of a car at the street is 30 kilometers per hour any time of a day.

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Suppose all the customers would make a request call to the call center for a taxi ride to travel from a node (intersection) x to another node y in the V-city based on the probability of a Poisson distribution as:

p(k) =

Where k is the number of customer calls at a given intersection in a hour, while λ is the average number of calls in one hour which is set at 1, 2, and 3 respectively for this simulation experiment. The average number of calls may vary according to time in a day. We assume thatλwill be 3 from 7AM-9AM and 5PM to 7PM while, 2 from 9AM-5PM as well as 7PM to 11PM, and 1 is for the rest of the time in a day. This means that from 7-9AM and 5Pm-7Pm there will be average about 3\*4= 12 calls, while 9AM-5PM and 7Pm-11PM there will be about 22 calls, and the rest of the time period will have about 11 calls.

Assume all intersection nodes have the same parameterλfor average customer calls for the time period in a day. Also assume the probability of a customer request to travel from x to y in the V-city is based on a Normal distribution over the distance d = shortest\_travel\_distance(y, x) that is expressed as:

P(d) =

Where the mean m is set at 2 kilometers while sigma s is set at 1.5 respectively.

Namely, the distance the customer request that is close to 2 kilometers is more likely, while far less than 2 kilometers or more than 2 kilometers is less likely.

[Note: Before you design an auction based request allocation protocol. You should first design a program routine based on the probability distribution to generate the possible customer’s calls of a day at each node of intersection in V-city. The generating a customer request event by Poisson distribution at any intersection can be simulated by how calculating much time generate a customer request. You can consult the web page:

<http://preshing.com/20111007/how-to-generate-random-timings-for-a-poisson-process/>

To implement the generation of a Normal distribution of the distance of a customer request from a given node, you should convert from a uniform random number generator into a normal distribution that is with mean 0 and standard deviation 1. And then use Box-Muller transform method to obtain a distance d at the desired mean m and deviation sigma s. You could consult webpage:

<https://en.wikipedia.org/wiki/Box–Muller_transform>

Once you obtain the normal distributive distance d for each request call, you then generate a possible route based on the distance on the map. The route generation of a customer request is assumed to be a route(x,d) that starts at node x and makes a random direction of turns according to the city map to any destination that is the shortest path as d. [Note the shortest distance destination is to avoid the route become cycling, or turning backward.] The driver can rest at the destination if he has no more tasks or continue to take the next customer’s request that he has just successfully win in the bid.

You should then implement the call-center agent of the taxi company who conducts the auctions to allocate each time of the call requests from a customer to each taxi driver agent in the company that is running in the V-city. Whenever a request is called, the call-center will hold an auction that is based on the bids from taxi-driver agents to allocate the request to the winner.

The taxi driver agent should base on the customer’s request to bid for the service. He should calculate the cost of his current position traveling to the requested customer’s position and take the customer to the destination and bid for the service.

In order to making a bid of the cost, the rational taxi driver agent would maximize his expected payoff. We assume each taxi can only take one customer at a time for simplification. When the call-center agent holds an auction and asks for a request bid, if taxi-driver’s car is empty (without taking a customer) he can bid based on his current location. If the taxi driver is taking a customer, he should compute the starting position of a coming bid as his current customer’s destination. If a taxi driver agent completes a journey after taking a customer to her destination, he will rest at the destination for the next service unless he has finished his duty then he will return to the company within his shift. If he cannot carry out task of the customer’s request for some reasons, due to the time bound of his duty shift or others (too much cost), he will have to give up the bid.

His payoff of taking a customer to the destination is equal to:

chargeable distance \* (charge\_rate\_per\_kilometer) - total\_traveling\_distance \* gas-cost-per-kilometer – payment\_to\_the\_auction.

Note: The total traveling distance is different from the chargeable distance which is d = shortest\_distance(x, y). The total traveling distance must consider the driver’s current position to the customer’s position plus the chargeable distance and sometimes the returning distance to company at the end of the shift.

Suppose

charge\_rate\_per\_kilometer is 60 NT dollars/per kilometer,

gas\_cost\_per\_kilometer is 4 NT dollars,

payment\_to\_the\_auction is according to the auction mechanism of the

winning paying price.

The winning payment = 30% \*(60 - 4)\* requested\_distance – {lowest bidding-price or second lowest bidding price}

The payments are going to the Taxi-company as profit of the company; the taxi driver has the 70% of charge fee minus the cost and payment as profit.

[In the auctions, the winner is the lowest bidding price while the actual paying price depends on the auction:

e.g.

Suppose the lowest winner’s bidding price is 0, then the winner has to pay (30% \*56\* requested\_distance – 0) **at the first-price auction**.

Suppose the lowest winner’s bidding price is 0, and the second lowest bidding price is 30, then the winner has to pay (30%\* 56\* requested\_distance – 30) **at the second price auction**.

A taxi cannot bid negative price. The lower the price he bids, the more gain he can profit. However, he might loose a bid if too high price he bids.

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In order to be fair opportunity for all taxi drivers, the company has another restriction rule as that a taxi driver cannot participate to bid within a time period = requested\_distance d / 30 kilometer (hr) if he just wins an auction to serve a customer with the requested\_distance d.

The taxi company has 12 taxi drivers who are running a taxi at three shifts in V-city. 4 drivers are running from 3AM-1 PM, 4 are running from 9 AM – 7PM and 4 are running from 6 PM to 4AM. The initial positions of all taxi’s must start at the taxi company and return to the taxi company at the end of their shift in a day.

Please implement the multi-agent systems in Jade and simulate the scenarios of auction-based of customer request allocation to a taxi-driver agent by the call-center-agent (the auctioneer). Show visualization of the dynamic taxi movements for the scenarios of the transportation services in V-city and answer the following questions based on your simulation.

1. What is the best bidding strategy for a taxi-driver to maximize its own expected payoff in a week under different auctions? How does the taxi driver agent implement a look-ahead strategy to get more optimal payoff under the uncertainty in potential customer’s requests?
2. What will be the average payoff in a week for the driver agents at different shifts in V-city if the call-center using the Vickrey auction mechanism/first price auction?
3. What will be the company’s total expected payoff in a week under Vicrey auction mechanism and the first-price-auction?
4. What will be the average waiting time of traveling customer agents if V-city merely has this taxi-service company operating? What should company’s operation mechanisms (investments or auction rules) be minimally changed if the company wishes to impose a policy to ensure the expected waiting time to be limited (say 5 minutes) for customers.
5. Discuss what will you implement a fair profit-sharing auction rules under this scenario between the taxi-company and the taxi driver agents（20%; 30%;40% etc.）and why?
6. Any problems that you think can be improved for making the system more practical.