Exercise 5
Implementing a decentralized agent

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November 26, 2017

1 Bidding strategy

In this assignment, we are running a company with multiple vehicles, and we need to compete against opponents in auction in order to win some tasks. To do so, we first need a planning strategy and then a bidding strategy, which are explained below.

1.1 Planner

Before working on the bidding strategy, we first needed a planning algorithm to be able to find the marginal cost of a new task in an auction, and being able to derive a bid from it. We realized the algorithm from the assignment on the centralized agent suited our needs, so we reused it in our solution.
This planner is used to find the marginal cost of a new task with respect to an existing possible plan. From here, it was already possible to have a simple bid, being the marginal cost of the auctioned task. Of course, this strategy didn't lead to good results because it didn't take into account that we are competing against other agents.
We then created a bidding strategy to have a more competitive bid.

1.2 Bidding

First of all, we decided not to use the probability distribution of the task because in the auction we need to decide about specific tasks. We could have use the probability distribution to force the obtaining of a task leading to a city with high probability of a task popping there, but we taught it was negligible.
In order to bid better and be more competitive, we needed to adapt our bid

to the opponent, so the idea was to make an estimation of the opponent strategy. The first information we use to refine our strategy was the result of an auction. In there, we keep track of the tasks won by our adversary to be able to have a better idea of his strategy.
In order to estimate the opponent strategy, we decided to use our own planner to be able to have an idea of our opponent marginal cost.
When the logist system ask us for a price, we first compute our marginal cost but we also make an estimation of our opponent marginal cost. From there, we enter in our strategy as follows:
The idea was first to discount our services for the first auctioned tasks, but then adapt our bid to the opponent.

1. If we are at the beginning, bidding for the first tasks, we play it safe and ask a really small amount to deliver this task:
   (a) If we won zero task, we discount our service to 101% of our marginal cost
   (b) If we won 1 task, we discount our service 102% of our marginal cost
   (c) If we won 2 tasks, we discount our service 105% of our marginal cost
2. If we already won some tasks, we make a bid according to our opponent estimation
   (a) If the estimation of our opponent bid is bigger than our bid, we can safely increase our bid. We decided to set our bid to be the mean of our bid and the opponent bid.
   (b) On the other hand, if our bid is bigger, we can't do much because we don't want to propose a lower bid otherwise we will lose money.
   (c) If we won 2 tasks, we discount our service 105% of our marginal cost
3. Finally, if our opponent didn't won any tasks, we safely increase our bid by 120%

2 Results

2.1 Experiment 1: Comparisons with a dummy agent

2.1.1 Setting

First, we created a dummy agent who will always bid his marginal cost. The dummy agent uses the same planner as use, but has no strategy to adapt his bid to the opponent.
We run a 19 tasks auction.

2.1.2 Observations

At the end, we won 15 tasks win a reward of 3799 and our opponent won 4 tasks with a reward of zero. We clearly see that the only tasks our opponent won was the one where he add a zero marginal cost (the task was maybe on his path to another pickup or delivery).

2.2 Experiment 2: Comparisons with a random agent

2.2.1 Setting

Then, we created an agent who will bid a random amount between his marginal cost and twice his marginal cost.
We also run a 19 tasks auction.

2.2.2 Observations

At the end, we won every tasks with a reward of 9892. We see that, because the dummy agent ask randomly a bit more than his marginal cost, our strategy behave well by bidding always a lower amount and still winning money. In fact, we observe that our reward is bigger, this is because we use our opponent bid to refine our, and bigger opponent bid leads to bigger bid for us.