Exercise 5: An Auctioning Agent for the Pickup and Delivery Problem

Group №35: Smail Ait-Bouhsain, Maxime Gautier

November 25, 2018

1 Bidding strategy

Our bidding strategy is mainly based on the adversary's bidding. We know we must bid higher than our marginal cost and lower than the adversary's bid to be able to make a profit. We must therefore estimate as best as possible the adversary's plan in order to guess what he will bid next.

1.1 Estimating Adversary Plan

In order to estimate his plan we need to know his available vehicles, their initial positions, their capacity and the tasks of the adversary. However, we know nothing of the adversary except his bid at the end of each round. Therefore we assume that they have the same number of vehicles as us with the same capacity. We use an algorithm based on the adversary's bids to estimate as accurately as possible the initial city of its vehicles, knowing that two vehicles cannot start in the same city. We use random cities at the beginning but eliminate the wrong ones throughout the auction. Knowing this we can compute an estimate of the adversary's marginal cost which we will use to out-bid him.

1.2 Bidding

Our bidding strategy is to bid above our marginal cost and lower than the bid we estimate for the adversary. We estimate this bid to be a ratio times the adversary's marginal cost. We calculate the marginal cost thanks to the estimation of the opponent's vehicles, and we estimate the ratio by averaging the opponent's bids over the estimated marginal cost. This ratio updates at each round and should therefore be more accurate the longer the auction lasts. With this we have the lower and upper bounds for the range of our bid.

In the case where our marginal cost is lower than the estimated opponent's bid, we should win the task and we bid a number in the middle range of our bid. With each successive win, the bid range shrinks by half so that we bid closer to the upper bound. The logic being that, if we win, our estimation is accurate and we can bid higher whilst still underbidding the opponent.

In the case where our marginal cost is higher or equal to the estimated opponent's bid, we bid slightly lower than our marginal cost. This might cause a deficit, but it will be compensated by other tasks. We also keep track of the adversary's lowest bid so that we know what their minimum bid is, usually used in the case where their marginal cost is 0. If our bid is lower than our adversary's lowest bid, we bring it back up to lowest bid minus one.

Our long term bidding strategy is to bid low in the first few rounds in order to better our estimate of the adversary's plan whilst winning tasks and then bid close to our estimation in order to maximize profit and still win tasks.

We do not consider the task distribution while determining our bid because we found that tasks were usually too well distributed and it gave us no useful or reliable information.

Our bidding parameters are a set of ratios which allow us to vary our upper and lower bound, how much we bid under our marginal cost when needed, as well as the percentage by which we lower our first bids and the one which controls the size of our bid range. Another parameter is the number of rounds for which we bid low.

We've also added a maximum bid to avoid our agent by disrupted by an unreasonably high bid from the adversary.

2 Results

2.1 Experiment 1: Comparisons with dummy agents

2.1.1 Setting

We performed three tournaments between our agent and several dummy agents to see the impact of a different number of auctioned tasks. The dummy agents are the naive agent provided, an honest response agent that bids only according to its own cost and a best response agent that calculates its opponent's plan and bids to maximize the profit. This opponent plan is created using the same vehicles as the agents which makes it less accurate than our agent's estimate.

All tournaments are run in the England topology with seed of 123456 and a uniform task distribution. The number of tasks is 10, 20 and 50.

2.1.2 Observations

Agents	Win - Draw - Lose	myAgent	BestResponseAgent	HonestAgent	NaiveAgent
myAgent	6 - 0 - 0	-	WIN (5698 : 29)	WIN (6470 : 29)	WIN (10006 : 665)
BestResponseAgent	3 - 0 - 3	LOSE (40 : 1564)	-	WIN (9948 : 20)	WIN (10533 : 0)
HonestAgent	3 - 0 - 3	LOSE (50 : 428)	WIN (100 : 0)	-	WIN (100 : 0)
NaiveAgent	0 - 0 - 6	LOSE (668 : 5813)	LOSE (29 : 79)	LOSE (29 : 79)	-

Figure 1: Tournament with 10 tasks

Agents	Win - Draw - Lose	myAgent	BestResponseAgent	HonestAgent	NaiveAgent
myAgent	6 - 0 - 0	-	WIN (7174 : 78)	WIN (8433 : 69)	WIN (19531 : 1309)
BestResponseAgent	3 - 0 - 3	LOSE (60 : 2939)	-	WIN (26050 : 20)	WIN (22937 : 0)
HonestAgent	3 - 0 - 3	LOSE (120 : 2538)	WIN (200 : 0)	-	WIN (200 : 0)
NaiveAgent	0 - 0 - 6	LOSE (2448 : 11044)	LOSE (29 : 2012)	LOSE (29 : 179)	-

Figure 2: Tournament with 20 tasks

Agents	Win - Draw - Lose	myAgent	BestResponseAgent	HonestAgent	NaiveAgent
myAgent	6 - 0 - 0	-	WIN (3312 : 612)	WIN (13606 : 227)	WIN (75088 : 8036)
BestResponseAgent	3 - 0 - 3	LOSE (149 : 8387)	-	WIN (73315 : 20)	WIN (73219 : 0)
HonestAgent	3 - 0 - 3	LOSE (329 : 2357)	WIN (497 : 0)	-	WIN (497 : 0)
NaiveAgent	0 - 0 - 6	LOSE (6172 : 39396)	LOSE (29 : 22365)	LOSE (29 : 478)	-

Figure 3: Tournament with 50 tasks

We can see that the winners do not change with the number of tasks. It seems those agents behave similarly against each other regardless of the number of tasks. The only notable difference between those tournaments is the total final profit which is much higher when there are many tasks which makes sense. Our agent should perform better when there are more tasks since the more data it collects, the better it should be able to predict the adversary's bid. However it already wins with a few number for tasks against dummy agents, so we do not see a difference when varying the number for tasks. Furthermore, the ratio we calculate, even if updated at each round, should stabilize rather quickly if the opponent bids with regularity.

2.2 Experiment 2 - Best results

2.2.1 Setting

We ran many tests to determine the best bidding parameters for our agents, as well as the best bidding strategy. For this we ran our agent against the best response agent from experiment 1, a risk seeking agent that always bids very low, often at a deficit and a classmate's agent.

2.2.2 Observations

```
### auction.xml ###
      Agents        | Win - Draw - Lose |  RiskSeekingAgent   |       MyAgent       | BestResponseAgent |    FriendsAgent
 RiskSeekingAgent   |      6 - 0 - 0    |          -          | WIN (3232 : -847)   |  WIN (6971 : 40)  | WIN (1587 : -1350)
      MyAgent       |      4 - 0 - 2    | LOSE (-789 : 1562)  |          -          |  WIN (7338 : 49)  | WIN (6028 : -1074)
 BestResponseAgent  |      1 - 0 - 5    |  LOSE (39 : 8710)   |  LOSE (69 : 5370)   |         -         |  LOSE (252 : 864)
   FriendsAgent     |      1 - 0 - 5    | LOSE (-1338 : 2291) | LOSE (-1362 : 4933) | LOSE (399 : 638)  |          -

First company results
  # wins   : 5
  # draws  : 0
  # losses : 7


### auction2.xml ###
      Agents        | Win - Draw - Lose |    FriendsAgent     |       MyAgent       | BestResponseAgent |  RiskSeekingAgent
   FriendsAgent     |      4 - 0 - 2    |          -          | WIN (-428 : -575)   |  WIN (161 : 39)   |  LOSE (-845 : 91)
     MyAgent        |      4 - 0 - 2    | LOSE (-994 : -877)  |          -          |  WIN (2528 : 19)  |  WIN (228 : -475)
BestResponseAgent   |      2 - 0 - 4    |  WIN (394 : 235)    |  LOSE (39 : 1423)   |         -         |  WIN (189 : -159)
 RiskSeekingAgent   |      2 - 0 - 4    | LOSE (-589 : 795)   | LOSE (-600 : 596)   |  WIN (894 : 29)   |          -

First company results
  # wins   : 7
  # draws  : 0
  # losses : 5
```

Figure 4: Tournament against smarter agents

```
double ratioA = 1;
double ratioB = 0.9;
double ratioC = 0.9;
double ratioD = 0.5;
double ratioE = 0.5;
int roundNumber = 4;
```

Figure 5: Bidding Parameters

After testing different solutions we found that the parameters shown above were best as they allow us to beat different types of agents. The ratios correspond to the one described earlier, in the same order. As we can see, ratio C must be close to 1 so we don't bid too much below our marginal cost. A is 1 so that our bidding range is accurate : the lower bound is simply our marginal cost. B is slightly under 1 since our estimation of the adversary's plan is fairly accurate. Ratio D is low since our first bids must be lower the opponent's in order to guarantee the win of the first tasks. Ratio E is the percentage of the range above which our bid will be. It is set at 0.5 so the first bid is at 75% of the range and that percentage rises with each successive won bid to maximize profit. The number of rounds for which we bid lower is 4 since that gives us enough of an edge at the beginning without creating a huge deficit.