CSCE 475/875 Multiagent Systems

Handout 24: Game Day 3 Auction Day Analysis

April 8, 2020

Auction Rounds

Table 1 shows some of the basic information for each of the 10 rounds of auction. GZ and Matrix each won twice, and Null Pointer and Optimal Alligators each won three times.

Rd.	Auction	Winner (#)	Winning Bid	Payment
1	English	Matrix (1)	$120	$120
2	Japanese	GZ (1)	$110	$110
3	Dutch	Null Pointer (1)	$200	$200
4	Sealed, First Price	Null Pointer (2)	$160	$160
5	Vickrey	Optimal Alligators (1)	$220	$140
6	English	Optimal Alligators (2)	$80	$80
7	Japanese	Matrix (2)	$190	$190
8	Dutch	GZ (2)	$150	$150
9	Sealed, First Price	Null Pointer (3)	$150	$150
10	Vickrey	Optimal Alligator (3)	$132	$130
			TOTAL	**$1,430**

Table 1. Winning bidders, winning bids, and payments for all rounds.

Tables 2 shows the bids for the two rounds of English auctions.

Round 1 (3 teams)		Round 6 (3 teams)	
Team	**Bid**	**Team**	**Bid**
Monitor didn't track the first few bids		GZ	$20
GZ	$65	Optimal Alligators	$40
Matrix	$70	Matrix	$50
Null Pointer	$80	GZ	$70
GZ	$90	**Optimal Alligators**	**$80**
Matrix	$100		
GZ	$115		
Matrix	**$120**		

Table 2: English auction bids (winning bid in bold).

Table 3 shows the bids for the two rounds of Japanese auctions.

Round 2 (4 teams)		Round 7 (3 teams)	
Team	**Amount Out**	**Team**	**Amount Out**
Optimal Alligators	$60	GZ	$60
Matrix	$100	Optimal Alligators	$190
Null Pointer	$110		
Win:		**Win:**	
GZ	$110	Matrix	$190

Table 3. Teams participating and exiting, for the two rounds of Japanese auctions. There were 10 bid announcements in Round 2; there were 18 bid announcements in Round 7.

Team Statistics

Table 4 shows the private valuations of each team for 10 rounds of auctioned items. All teams followed the rules correctly. Figure 1 visualizes the average valuation of each item. There were no particular patterns observed. In the past, I have observed higher valuation of items in English rounds and lower valuation of items of the later rounds.

Rd	GZ	Matrix	Null Pointer	Optimal Alligator	Avg.
1*	$120	$180 # ^	$80	$40	$105.00
2	$100 ^	$140 #	$100	$60	$100.00
3*	$40	$60	**$200** # ^	$20	$80.00
4*	**$200**	$120	$160 # ^	$160 #	$160.00
5	$180	$40	$140	**$200** # ^	$140.00
6*	$80	$80	$20	$140 # ^	$80.00
7	$60	**$200** # ^	$60	$180	$125.00
8	$160 # ^	$160 #	$40	$80	$110.00
9*	$20	$20	$180 # ^	$100	$80.00
10	$140 #	$100	$120	$120 ^	$120.00
TOT	**$1,100**	**$1,100**	**$1,100**	**$1,100**	

Table 4. Private valuations of each team for 10 rounds of auctioned items. * indicates a round where there was only one team with a much higher valuation than the rest. E.g., Round 1 where Matrix has $180, $60 higher than the 2nd highest valuation. # indicates the team with the highest valuation. ^ indicates the winning team.

Now, we look for "opportunities" for teams to make large gains. That is, if there was only one team whose valuation for an item was much higher than the rest, then that would be an opportunity for that team to make a significant utility gain, especially if the closest valuation was much smaller. Out of 10 rounds, there were four (4) rounds where such an opportunity existed—those highlighted with an * in Table 5. Matrix (1 opportunity), Null Pointer (two opportunities), Optimal Alligator (1 opportunity), and GZ (1 opportunity) had such opportunities. All teams except GZ with such opportunities won their respective rounds. Note that for Round 4, GZ had the highest valuation (=$200). However, they submitted their bid at $100. Though they had a non-trivial advantage (~$40), their low bid allowed Null Pointer to win the item instead. Had they gone with, say, a higher bid to ensure winning, they could have made a positive gain.
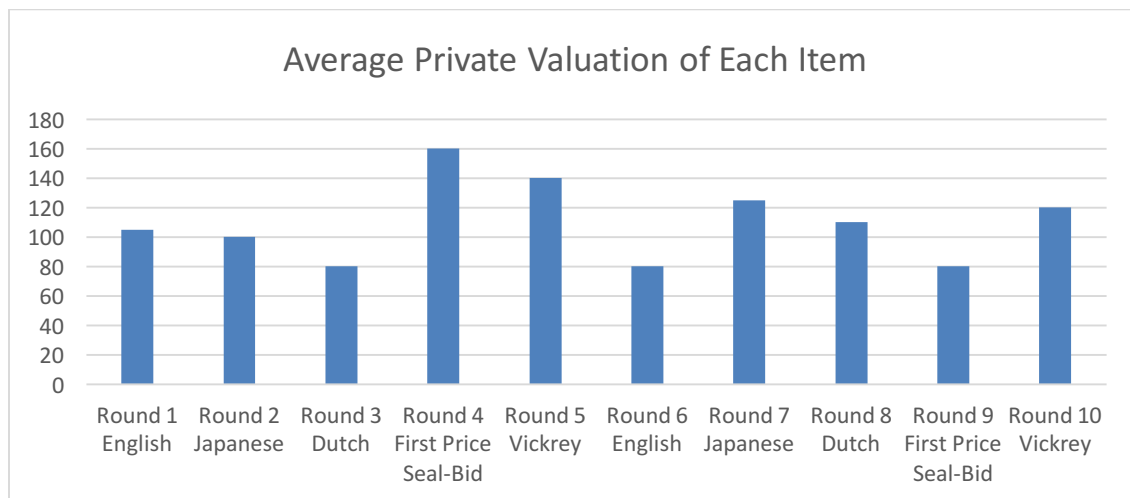
Figure 1. Average private valuation of each item per round.

Table 5 showed the auction rounds that each team participated. Further, the table shows that all teams participated in the rounds where they knew they at least shared the maximum valuation—i.e., $200—of the auctioned item. There were also teams that participated in rounds that they knew they were unlikely to win the auction because of their low valuation of the item being auctioned (as low as $20) such as GZ who participated in all rounds. That means, these teams were willing to lose $2 for each such round for nothing.

Team	1	2	3	4	5	6	7	8	9	10	TOT
GZ	√	√	√	√	√	√	√	√	√	√	10
Matrix	√	√	√	√		√	√	√		√	8
Null Pointer	√	√	√	√	√				√	√	7
Optimal Alligator		√		√	√	√	√		√	√	7
TOT	3	4	3	4	3	3	3	2	1	4	32

Table 5. The number of teams "in" (√) for each round of auctions. Shaded cells indicate winning teams.

Table 6 shows the final utility tally for each team. Per this table, **Optimal Alligator won the Game Day**. They were one of three teams that made a positive gain. GZ was the only team that had a negative gain. GZ also was the only team that did not leverage their advantage (in Round 4). The final rankings are provided in the table at the end of this handout.

Team	Original Money	Utility Gained from Items Won (#)	Payment	Participation Fee	TOTAL
GZ	$2,000	$260 (2)	$260	$20	$1,980
Matrix		$380 (2)	$310	$16	$2,054
Null Pointer		$540 (3)	$510	$14	$2,016
Optimal Alligator		$460 (3)	$350	$14	$2,096

Table 6. Total utility for each team. Total Utility = Original Money + Utility Gained from Items Won – Payment – Participation Fee.

Individual Team Analysis

Table 7 documents my comments on each team's worksheet and reports. Almost all teams adapted their strategies after observing the auction rounds, showing good agent behavior: observe, reason, and act. Different teams also had different "feels" for different auction protocols. Some teams were more comfortable with English auctions, some were more comfortable with sealed bids, and so forth. Some teams did not feel confident with First-price Sealed-bid auctions.

Team	Pre-Game	Tracking	Mid-Game/Post-Game
GZ	Game playing; strategic in bidding. "We want to bid more risk-neutral in the first three rounds because we do not want to spend more than is necessary right from the beginning and we don't want to bid too little to not have a chance at acquiring at least one item. If we are unable to acquire a single item from the first three rounds, we will	Tracked well; modeled other agents well.	**Mid-game:** "Since we still want to win items while increasing our utility and due to the observed high prices of the previous rounds, we will adjust our strategy by raising our bid prices from the 50% of our IPV to being just 10-20 less than our IPV.", "We believe the way Optimal Alligators calculated their bid was smarter than our own as it took into account what other teams would gain by not participating as well as the fee imposed on them." **Post-game:** "We learned that participating in every auction was not the best decision when there is a fee to pay

	adjust our strategy to become more risk-averse until we acquire an item. Otherwise, after we have acquired an item, we will begin bidding in a more risk-seeking manner in order to maximize our utility." No discussion on "valuation" strategy.		as well as the fact that many of our IPVs (by necessity) were very low. For instance, it wasn't worth participating in an auction in which our IPV was 20 for the item as we would not be competitive enough with the other bidders to win. We also learned that being more risk-neutral in the Vickrey auction is much better than trying to be risk-seeking as it is likely that the price that is needed to be payed is much less if it is won anyway. The big takeaway for us is to be more strict with the auctions we participate in in order to lessen the fees we have to pay when we aren't planning to be very competitive in the auction (when we have low IPVs).", "We believe that going for only 50% of our IPV was far too risk-seeking and wasted our money on fees when we could've been more competitive or at least tried sabotaging other teams' bids. **When designing and developing agents that learn in a multiagent system, we have learned to consider how agents may want to sabotage other agents in order to increase their utility with respect to them as well as to make sure the agents are competitive enough to compete with the other agents.**"
Matrix	Had both bidding and valuations strategies. "We set the valuation of $180 for the first round as we guess that other team may not set such a high value in the first round so that we will have a chance to increase utility in the first round." "We will probably not participate in a round when we have a valuation under $60." "For every item we bid, we need to pay $2 fee to participate. If we win an item with $2 lower than our valuation, we have net gain in that auction round. As a result, we will stop bidding if the item costs higher than our valuation minus participation fee."	Tracked well; modeled other teams fairly well.	**Mid-game**: Didn't make significant adjustments. "We find it hard to predict the behavior of other agents. For example, one team win the Dutch auction with the highest price ($ 200) fast and another team win an item in Vickrey with $220, which is higher than the highest possible valuation. They probably want to get rid of risk getting penalized for not winning an item." **Post-game**: "Although telling truth is the dominant strategy for Vickrey and Japanese auction, we observed that one team bid with a price higher than all the possible valuation. They probably don't want to be penalized for not winning an item and that's why they bid with such a price. This tells us that in practice there might be some other factors that make agents not use the telling truth strategy in Vickrey auction, which makes the it even harder to predict the behaviors of other agents. People need to be more discreet in designing and developing agents as there might be some factors that make agents behave differently from "theoretical" optimal strategy." "We left too early in Japanese auction in round

			2. We should communicate more during the auction process to prevent such mistake in the future." "We could probably win item 8 in Dutch auction. However, GZ win it fast with a price of $150. It taught us that we need to be more decisive in Dutch auction or we may lose the chance."
Null Pointer	Detailed bidding strategy for each round. General approach: "Our main strategy for the auction day is to follow the dominant strategy of truth telling for Japanese, 2nd-price sealed, and English auctions. We will also be risk averse for high priced items and risk neutral for anything under the price of 140. This was chosen because it is plausible that the other teams will prioritize the early bids more than the later bids because they would be risk averse due to a penalty for not winning any auctions. If they win one auction, that team can then relax a little since they have avoided the $2000 penalty of not winning any auctions. Conversely, our strategy is to be OK with losing an early auction and then go for the bids after the first two (Item 3 and beyond). The rationale here is that we can avoid the predicted rush mentioned earlier in this document and hopefully get a winning bid this way."	Tracked fairly well; Modeled other teams.	**Midgame**: "Other agents had a similar idea to ours in putting some weaker bids first, then going heavily after the initial auctions are concluded. This was revealed by the bids being only slightly higher than our own evaluation at the start, which means the winning teams are likely also truth telling." "We have chosen to undershoot our evaluation for the second round of 1st price sealed bids (round 9), since our total utility will likely be greater if we don't spend as much money. … We are going to undershoot our $180 evaluation and bid $160 with some room for adaptation; We won't go as high as we planned, but we won't go too low so as to keep our chances of winning high. If another team reveals their $200 evaluation in the rounds preceding 9, we will bid $150 instead. The reasoning for this is that the potential highest bid will have dropped enough that we believe that we could win with a lower price." **Post-game**: "As the game progressed it became increasingly important to pay attention to what other teams were doing as more and more information became available. … Due to this, we were able to tell when agents had gotten through their high value items, and this is what informed our decision to undershoot round 9 further." "**A big takeaway from this game was that the knowledge of what other players are going to do is extremely important in a competitive space and if an agent is able to capture or discern this knowledge, it will be able to make better decisions and derive greater utility over time**."
Optimal Alligators	Game playing; strategic in both bidding and also valuation of items. "Our valuations are based on the following theories: 1) English and Dutch, being more visible, are easier for agents to be competitive or confident on, so we value them low so losing those	Tracked well; Could have modeled other teams more.	**Mid-game**: "Some agents bid strangely, seem to be focusing on denying value to other agents rather than gaining value for themselves (especially Null Pointer). It's important to note that winning auctions is not always value-creating, but will deny value to other agents." **Post-game**: "English, Japanese, and First-Price there's no reason not to bid close to your true valuation (because we have IPVs in these

auctions costs less potential value; 2) Japanese, as the other open-outcry, is similar, but is easier to intimidate other agents with, so we value it more middling; 3) Vickrey lets us bid high and maybe not pay that much, so we value it highly; 4) First-price is valued above normal as a more costly version of Vickrey; 5) We distribute valuations across different auction types to diversify risk; 6) We focus high valuations in the middle since one team has been observed in the past to rank items in ascending or descending order – our middle four high-value auctions will reliably beat that team."		auctions). You want to bid slowly to minimize the final price, but the upper limit can be very close to the true valuation. Should skip on low-valued auctions, since the average sale price is a little higher than the average valuation (average valuation \$110, average sale price \$143). We also were glad to see that slightly bidding over the true valuation on Vickrey is a good strategy, since you either overpay slightly or get it much cheaper. This makes truth-telling a dominant strategy, and our risk-averse version only slightly increases the value.", **"Takeaway for designing multiagent systems: auctions are a very good method to incentivize truth-telling."**

Table 7. Our comments and observations of team strategies, worksheets, and reports.

Lessons Learned

Here are some overall lessons learned.

1. Rationally, a team, without knowing or speculating on what other teams might do, should value the Vickrey round items at \$200. Why? This would allow a team a chance to be aggressive and put a higher bid with the hope that it would win the item at a second price that is lower than \$200. Likewise, the opponent winning bidder would also likely to pay higher than what they valued the item.
2. Participating in every round indiscriminately was unwise as the loss of \$2 as fee for each round lowered the utility of a team. All-pay auctions are all-pay for a reason: to make sure that the only teams that have a chance to win an auction are the ones participating. Thus, if a team values an item lowly, then that means the team will have close to 0 chance in winning the item. Then the team should not participate.
3. On the other hand, being conservative and only participating a few rounds might not afford enough opportunities for a team to get high rewards.
4. On average, there were no patterns in how teams allocated valuations to the items. However, in the years past, where we had more teams (say, 8 to 15 teams), usually there were clear patterns. For example, more valuations to the items in earlier rounds than those in later rounds. The common reasons for such a pattern were were teams feeling not sure about whether there would be time to carry out the last few rounds of auctions on Game Day, and that teams would be desperate and didn't want to get into the "battle". The common reason for earlier rounds to have a bigger average was that teams were more concerned about not getting items first, and thus valued the items more earlier in order to win high-utility items.
5. From Table 4, we see that there would be two particular types of situations:

a.   Lucky: this is where one team had a relatively much higher valuation than the rest of the teams for that round (1, 3, 4, 6, and 9). All teams but one won their round correspondingly.

b.   Yucky: this is where more than two teams had the highest valuation for that round. This situation did not occur on our Game Day.

c.   Under the above typing, all four teams had a lucky situation, and Null Pointer had two such situations.

6. ***Did the teams with more "opportunities" fare better than teams with fewer "opportunities"?*** Table 8 below shows something interesting. We computed the differences between the valuation of each team and the valuation of every other team for each round. We then counted the number of times a difference is lower, higher, and the same. And then we averaged these numbers across all rounds. From Table 8, we see that the teams with better opportunities to gain are those with a relatively high ">" average and a relatively low "=" average. Two teams had a better position: Matrix and Optimal Alligator, both with a smaller "=" average, and high ">". Null Pointer, on the other hand, was most disadvantaged in terms of opportunities (with the lowest ">" and tied with the highest "=" averages). Yet, Null Pointer finished third, outperforming GZ. In short, while luck played a role, valuation strategies, bidding strategies, and participation strategies all played a role as well.

	GZ			Matrix			Null Pointer			Optimal Alligator		
	>	<	=	>	<	=	>	<	=	>	<	=
1	2	1	0	3	0	0	1	2	0	0	3	0
2	1	1	1	3	0	0	1	1	1	0	3	0
3	0	3	0	2	1	0	3	0	0	0	3	0
4	3	0	0	0	3	0	1	1	1	1	1	1
5	2	1	0	0	3	0	1	2	0	3	0	0
6	1	1	1	1	1	1	0	3	0	3	0	0
7	0	2	1	3	0	0	0	2	1	2	1	0
8	2	0	1	2	0	1	0	3	0	1	2	0
9	0	3	0	0	3	0	3	0	0	2	1	0
10	3	0	0	0	3	0	1	1	1	1	1	1
	1.4	1.2	0.4	1.4	1.4	0.2	1.1	1.5	0.4	1.3	1.5	0.2

Table 8. Comparing each team's valuations to other teams' for each round. A large average #higher valuation per round (under the > columns) means a team's valuation for that round dominates quite a few other teams' and so on.

7. Due to the large potential penalty of not winning an item, the teams practiced different types of risk attitudes. When a team was still in need of an item, it was likely to be risk averse – afraid of not winning and thus offering a higher bid; and when a team had won an item, it was likely to be risk seeking – not offering a higher bid (see Round 4, GZ bidding $100 for the item that they valued at $200, having won an item already in Round 2).

8. From viewpoint of delivering the auctions, the sealed-bids were fast. Intuitively, one would think that English would be the next fastest as bids could jump. However, all our English rounds involved bidding "wars" of small increments between teams, making each round longer. Dutch descending and Japanese were thus faster.

9. In the past, teams that observed and modeled other teams would tend to do better than their individual situation afforded. But in our Game Day, due to the number of agents (only four) with 10 rounds of items, it was relatively easier for each team to win an item, and thus reducing the potential benefits for agents to model and leverage their knowledge to game

play against other agents. Nevertheless, it is still, in general, important for agents to consider their environment as well as other agents in the environment.

10. Note also that we had the game changer in this Game Day, and also our Independent Private Values (IPVs) were neither completely Independent nor Private. Further, we had all-pay auctions. So, our results here did not reflect exactly what theoretical works have found, as covered in our lectures. But these results showed a more real-world side of auctions and should give us a sense of how to "game" each auction round – how to strategically bid and gain information each auction.

Game Days League

Here are the final League Standings. GZ won the Game Days League, followed by Optimal Alligators, Matrix, and Null Pointer. GZ won Learning Day and Voting Day, Optimal Alligators won Auction Day.

Team Name	Learning Day	Voting Day	Auction Day	League Standings
GZ	1	1	4	6
Optimal Alligators	2	4	1	7
Matrix	3	3	2	8
Null Pointer	4	2	3	9