

CSCE475/875 Multiagent Systems

Handout 19: Game Day 2 Voting Day Analysis

March 12, 2020

List of Movies

M1	1917	M9	Little Women
M2	A Beautiful Day in the Neighborhood	M10	Marriage Story
M3	Bombshell	M11	Once Upon a Time in Hollywood
M4	Ford v Ferrari	M12	Pain and Glory
M5	Harriet	M13	Parasite
M6	Jojo Rabbit	M14	The Irishman
M7	Joker	M15	The Lighthouse
M8	Judy	M16	The Two Popes

Table 1. List of 16 movies used.

Voting Results

Tables 2, 3, 4, and 5 show the votes for Rounds 1 (Plurality Voting), 2 (Cumulative Voting), 3 (Approval Voting), and 4 (Borda Voting), respectively.

Team	Movie
GZ-1	1917 (M1)
GZ-2	1917 (M1)
Null Pointer-1	1917 (M1)
Null Pointer-2	Joker (M7)
Optimal Alligator-1	Jojo Rabbit (M6)
Optimal Alligator-2	Ford v Ferrari (M4)
Matrix-1	Bombshell (M3)
Matrix-2	Bombshell (M3)
WINNER	1917 (3 Votes)

Table 2. Voting results of Round 1 (Plurality Voting). 1917 won with 3 votes.

Movie	GZ-1	GZ-2	Null Pointer-1	Null Pointer-2	Optimal Alligator-1	Optimal Alligator-2	Matrix-1	Matrix-2	Sum
M1	16	16	15	3	1	1	2	2	56
M2							2	2	4
M3							8	8	16
M4						8	2	2	12
M5							2	2	4
M6					8				8
M7			1	7	4	7			19
M8									0
M9									0
M10									0
M11				3	1				4
M12									0
M13					2				2
M14				3					3
M15									0
M16									0
TOTAL	16	16	16	16	16	16	16	16	

Table 3. Voting results of Round 2 (Cumulative Voting). 1917 (M1) won with 56 votes.

Comparing Tables 2 and 3, the votes were consistent for all voters. The top plurality team voted by each voter was also the team with the largest number of cumulative votes by the same voter.

Movie	GZ-1	GZ-2	Null Pointer-1	Null Pointer-2	Optimal Alligator-1	Optimal Alligator-2	Matrix-1	Matrix-2	Sum
M1	1	1	1	1			1	1	6
M2							1	1	2
M3			1				1	1	3
M4						1	1	1	3
M5							1	1	2
M6					1				1
M7			1	1	1	1			4
M8									0
M9									0
M10									0
M11				1	1				2
M12									0
M13					1				1
M14				1					1
M15									0
M16									0
TOTAL	1	1	3	4	4	2	5	5	

Table 4. Voting results of Round 3 (Approval Voting). 1917 (M1) won with 6 votes.

Not all teams were consistent when comparing Tables 4 and 5. Each movie that received at least one cumulative vote should also receive an approval vote. *Voters Optimal Alligator-1 and Optimal Alligator-2 did not approve M1 in Round 3 even though each of them voted for them in Round 2.*

Movie	GZ-1	GZ-2	Null Pointer-1*	Null Pointer-2	Optimal Alligator-1*	Optimal Alligator-2*	Matrix-1*	Matrix-2*	Sum
M1	16	16	1	15	5	3	2	2	60
M2	15	15	10	1	6	16	3	3	69
M3	14	14	11	2	13	13	1	1	69
M4	13	13	12	12	12	1	4	4	71
M5	12	12	13	3	8	15	5	5	73
M6	11	11	9	4	1	5	6	6	53
M7	10	10	2	16	2	2	7	7	56
M8	9	9	3	5	10	8	8	8	60
M9	8	8	4	6	14	7	9	9	65
M10	7	7	5	7	7	12	10	10	65
M11	6	6	14	13	4	10	11	11	75
M12	5	5	6	8	16	9	12	12	73
M13	4	4	15	9	3	14	13	13	75
M14	3	3	16	14	9	4	14	14	77
M15	2	2	7	10	15	11	15	15	77
M16	1	1	8	11	11	6	16	16	70
TOTAL	136	136	136	136	136	136	136	136	

Table 5. Voting results of Round 4 (Borda Voting). The Lighthouse (M14) and The Irishman (M15) are the winners of Round 4 with the most Borda count (77). Note that per the Game Day rules, Round 4 did *not* have a tie breaking policy and thus both movies won. **inconsistent preference ordering with Round 2 and/or Round 3*

Comparing Table 5 with Tables 2, we once again observed inconsistencies. *GZ-1 and GZ-2's votes were consistent. Null Pointer-1's votes were not. Null Pointer-1 rated M1 and M7 the top*

and second movies in Round 2, but rated them the bottom 2 in Round 4. This is likely due to a mistake in assigning the Borda counts: The top movie should receive 16 votes, not 1. Null Pointer-2 was consistent. Optimal Alligator-1, Optimal Alligator-2, Matrix-1, and Matrix-2 were also not consistent, having made likely the same inconsistency mistake as Null Pointer-1.

Also, for Round 4, there was not a tie-breaking policy per the Game Day rules. And thus, both M1 and M7 won the voting in this round. *GZ was the only team that provided the correct answer.* Both Null Pointer and Matrix used a tiebreaker (i.e., alphabetical order) and chose M15. Optimal Alligators did not get this correctly.

Round 5 is Plurality with Elimination voting, and again the tie-breaker is the alphabetical order. Table 6 shows the results. The definition for this mechanism is: *Each voter casts a single vote for their most-preferred candidate. The candidate with the fewest votes is eliminated. Each voter who cast a vote for the eliminated candidate casts a **new** vote for the candidate he or she most prefers among the candidates that have not been eliminated. This process is repeated until only one candidate remains.*

Because of the inconsistencies reported earlier in Tables 2, 3, and 4, here we will base our analysis only on Round 4's votes. Based on that, we have six movies that were the "most-preferred candidates" of the eight voters, respectively. That left the other 10 Movies out of the "most-preferred candidates" "circle". Since no teams voted for any of those 10 movies, the re-voting step did not yield any updates to the votes. Then one movie was eliminated in the successive five rounds. Table 5 shows the elimination rounds and the winner The Two Popes.

Elimination Round	Eliminated Movie(s)	Voters that had to revote	Movies that received the re-votes	Updated votes
1-10	All the movies that received 0 vote: Ford v Ferrari, Harriet, Jojo Rabbit, Judy, Little Women, Marriage Story, Once Upon a Time in Hollywood, Parasite, The Lighthouse, The Two Popes (Note: 10 rounds of elimination: one movie at a time using the alphabetical order to break ties.)	None	None	1917 (2), A Beautiful Day in the Neighborhood (1), Joker (1), Pain and Glory (1), The Irishman (1), The Two Popes (2)
11	All the movies that received <i>only</i> 1 vote: A Beautiful Day in the Neighborhood, Joker, Pain and Glory, The Irishman. Using the alphabetical order to break ties: the movie that ranks last among this group was The Irishman .	Null Pointer-1	A Beautiful Day in the Neighborhood	1917 (2), A Beautiful Day in the Neighborhood (2), Joker (1), Pain and Glory (1), The Two Popes (2)
12	All the movies that received <i>only</i> 1 vote: Joker and Pain and Glory. After tie-breaking, the movie that ranks last: Pain and Glory	Optimal Alligator-1	The Two Popes	1917 (2), A Beautiful Day in the Neighborhood (2), Joker (1), The Two Popes (3)
13	Only one movie received <i>only</i> 1 vote: Joker is thus eliminated	Null Pointer-2	1917	1917 (3), A Beautiful Day in the Neighborhood (2), The Two Popes (3)
14	A Beautiful Day in the Neighborhood received the least number of votes and is thus eliminated	Optimal Alligator-2	The Two Popes	1917 (3), The Two Popes (4)
15	1917 received the least number of votes and is thus eliminated	NA	NA	The Two Popes won.

Table 6. Round 5 plurality with elimination. Here, a tie is broken alphabetically. The winner is The Two Popes.

Table 7 shows the results of Round 6 (Pairwise Elimination). Once again, here we use the alphabetical order as a tie-breaker. To do this, we used Table 4's preference ordering for each head-to-head contest. For example, 5 teams preferred A Beautiful Day in the Neighborhood (M2) to Bombshell (M3). And thus, M2 moved on to Round 2.

Candidate	Round 1	Round 2	Round 3	Round 4
M2 A Beautiful Day ...	M2 (5 vs. 3)	M4 (5 vs. 3)	M4 (5 vs. 3)	M14 (5 vs. 3)
M3 Bombshell				
M4 Ford v Ferrari	Tie → M4			
M5 Harriet				
M6 Jojo Rabbit	Tie → M6	M8 (5 vs. 3)		
M7 Joker				
M8 Judy	Tie → M8			
M9 Little Women				
M10 Marriage Story	Tie → M10	M13 (5 vs. 3)	M14 (5 vs. 3)	
M11 Once Upon a Time				
M12 Pain and Glory	M13 (5 vs. 3)			
M13 Parasite				
M14 The Irishman	Tie → M14	Tie → M14		
M15 The Lighthouse				
M16 The Two Popes	M16 (5 vs. 3)			
M1 1917				

Table 7. Round 6 Pairwise Elimination “tournament” results. The winner is The Irishman (M14).

Out of the four teams, three teams got it right. Optimal Alligators did not. However, of the three teams that got it right, GZ’s table was not entirely correct (3 mistakes in Round 1, 3 mistakes in Round 2, 1 mistakes in Round 3), Matrix’s table was not entirely correct (5 mistakes in Round 1, 3 in Round 2, 1 in Round 3), while Null Pointer’s table could not be examined because they did not submit the correct Game Day package.

Team Statistics

To compute the time spent on each, we found the smallest time stamp for each round, and subtracted each entry with that time stamp belonging to the same round. Table 8 shows the results and the total.

Team Name	R1	R2	R3	R4	R5	R6	TOTAL
1st Time Stamp	12:36:56	12:41:55	12:46:04	12:55:26	13:25:45	13:34:19	
GZ	0:00:00	0:00:00	0:00:05	0:02:13	0:03:58	0:03:20	0:09:36
Matrix	0:00:06	0:00:07	0:00:00	0:03:47	0:07:46	0:08:31	0:20:17
Null Pointer	0:00:05	0:00:19	0:00:00	0:03:08	0:09:59	0:03:40	0:17:11
Optimal Alligators	0:00:44	0:01:02	0:00:00	0:00:00	0:00:00	0:00:00	0:01:46

Table 8. Response time for each team for each e-mail on winner, “hours:minutes:seconds”. *These response time values have not been adjusted for incorrect winners and inconsistencies.*

As shown in Table 8, Optimal Alligators had the best response time, followed by GZ. In terms of response time, Null Pointer placed third and Matrix was last.

To calculate a winner, we first sorted teams based on the number of incorrect submissions and number of inconsistencies, and then based on timeliness.

In general, all teams were able to follow instructions of the voting mechanisms to a large extent and rules of the Game Day. Judging from the time-stamps of the *winner submissions*, some teams were not as well prepared as the others.

Rounds 1-3, and 5 are non-ranking voting mechanisms: plurality, cumulative, approval, and plurality with elimination. It is called non-ranking because we don’t necessarily need to order all

candidates. In fact, there is no strict preference ordering with these voting mechanisms. (Special Note: However, for Round 5, we were able to short-cut the elimination process by using the Borda voting from Round 4, allowing us to find the winner without having to carry out additional rounds of re-voting.) One team—i.e., Optimal Alligators—did not produce the correct answers in Rounds 4, 5, and 6.

Borda voting, on the other hand, is a ranking mechanism where one is required to provide a strict preference ordering completely. How to use the results of this voting to do Round 6? Not every team was clear on how to do this.

Team Name	Time Response	R1	R2	R3	R4	R5	R6	# Mistakes
GZ	0:09:36				1*			1
Matrix	0:20:17				2* + 0.5^			2.5
Null Pointer	0:17:11				2* + 0.5^			2.5
Optimal Alligators	0:01:46			2*	2*+1^	1^	1^	7

Table 9. Final standings based on time response, the number of incorrect submissions (^), and the number of inconsistencies (*). Teams that made more mistakes are rated lower. The time response is used to break ties. Thus, GZ is declared as winner of the Game Day, Null Pointer is second, Matrix is third, and Optimal Alligators is last.

Finally, as discussed in class, our Voting Day as preference aggregation did not motivate teams to be strategic. However, in order to win the Game Day, each team must be organized, effective, and efficient. This would be where pre-game strategies played a role—preparation of computation, understanding of the voting mechanisms, and thoughtfulness in answering the four questions.

Question Analysis

There were four questions posed.

Question 1. Using the above aggregated preference ordering, revisit Round 4 results, is the Condorcet condition satisfied? (Justify your answer.)

This condition states that if there exists a candidate x such that for all other candidates y at least half the voters prefer x to y , then x must be chosen. From the textbook we know that:

Definition 9.2.3 (Condorcet winner) *An outcome $o \in O$ is a Condorcet winner if $\forall o' \in O, \#(o > o') \geq \#(o' > o)$.*

Most teams understand the concept of Condorcet winner. One team did not quite understand the difference between a Condorcet winner and the Condorcet condition. These two concepts are different. The condition says if the social choice function does NOT select the Condorcet winner as the social choice outcome, then the social choice function does NOT meet the Condorcet condition. This is important to remember.

There were two Condorcet winners: The Irishman and The Lighthouse. Each was preferred by at least four voters to any of the other 15 movies. Each also was preferred by five voters in some of those orderings.

The Borda voting results yield two winners: The Irishman and The Lighthouse. **Thus, the Condorcet condition was met.**

Question 2. Given the Borda voting results, is there a spoiler item such that its removal from the list would cause significant changes to the preference ordering? (Justify your answer.)

First of all, removing a candidate from the list does NOT mean that all the points that the candidate has go to the pool of remaining candidates.

From our textbook and lecture:

Sensitivity to a losing candidate

Consider the following preferences by 100 agents.

35 agents: $a > c > b$

33 agents: $b > a > c$

32 agents: $c > b > a$

Plurality would pick candidate a as the winner, as would Borda. (To confirm the latter claim, observe that Borda assigns a , b , and c the scores 103, 98, and 99 respectively.) However, if the candidate c did not exist, then plurality would pick b , as would Borda. (With only two candidates, Borda is equivalent to plurality.) **A third candidate who stands no chance of being selected can thus act as a “spoiler,” changing the selected outcome.**

So the question is looking for whether removing a “spoiler” would change the selected outcome.

How do we find one efficiently? If we look back at Table 5, the winners were M14 and M15. Is it possible to make M14 (The Lighthouse) the winner by removing another movie from the list? The key is to make the distance between M14 and M15 smaller whenever M15 is ranked higher than M14. So, we look at Optimal Alligator-1’s vote and Optimal Alligator-2’s vote. Note that we don’t look at the votes from the Matrix team because the distance was already the minimum (=1). By removing M8, for example, Optimal Alligator-1’s Borda counts for M14 and M15 would become 9 and 14; Optimal Alligator-2’s Borda counts for M14 and M15 would become 4 and 10, respectively, leading to a gain of two points for M14! Now, another key is to check Null Pointer’s Borda counts, to see whether removing M8 would cause the distance to reduce from another direction, to see whether there is a net gain for M14. Because M8 was rated very low by both Null Pointer voters, the removing it would not impact the distance between M14 and M15.

Movie	GZ-1	GZ-2	Null Pointer -1*	Null Pointer-2	Optimal Alligator r-1*	Optimal Alligator r-2*	Matri x-1*	Matrix-2*	Sum
M14	3	3	16	14	9	4	14	14	77
M15	2	2	7	10	15	11	15	15	77
Removing M8 would yield ...									
M14 new	3	3	15	13	9	4	13	13	73
M15 new	2	2	6	9	14	10	14	14	71

In general, are there other factors in this MAS environment that made the chance of having a spoiler very unlikely? Yes, there are two factors. First, the larger the candidate pool, the less likely it is to have a spoiler. This is because the voting points’ differentials become less significant when there are more candidates. For example, a candidate getting a 3 and another

getting a 1 in a pool of four candidates has a stronger advantage comparing to a candidate getting a 23 and another getting a 21 in a pool of 32 candidates. This means that removing one candidate from the pool would impact a pool of four candidates more significantly than it would a pool of 32 candidates. Second, the cluster of a few candidates as the top vote-getters could render the lower-ranked candidates non-consequential—they wouldn't be able to make it to the top no matter what. So that reduces the likelihood of having a spoiler.

Question 3. Did the above pairwise elimination order cause an item that Pareto-dominates another candidate to finish behind the dominated candidate? (Justify your answer.)

When an item *A* Pareto-dominates another item *B*, that means at least one agent strictly prefers *A* over *B* while *all* the other agents at least weakly prefers *A* over *B*.

In this case, as a result, *no one movie Pareto-dominated another movie*.

Several teams had a misconception. They misunderstood Pareto domination. They thought that *A* Pareto-dominates *B* as long as more teams preferred *A* to *B*. Due to that misconception, they had the following reasoning. For example, both M14 (The Irishman) and M15 (The Lighthouse) were Condorcet winners. But they were paired in the first round. As a result, The Lighthouse was eliminated in the first round, even though it Pareto-dominated M8 (Judy) (Judy made it into the second round).

However, the correct understanding regarding Pareto domination is that as soon as there is a voter that prefers *B* to *A*, that means *A* no longer Pareto dominates *B*. This is important.

Question 4. Provide another pairwise elimination order that would cause an item that Pareto-dominates another candidate to finish behind the dominated candidate?

Since no one movie Pareto-dominated another movie, it is *not* possible to provide a pairwise elimination order (agenda) that would achieve the above.

Individual Team Analysis

Table 10 documents my comments on each team's worksheet and reports.

Team Name	Pre-Game	Tracking	Mid-Game/Post-Game
GZ	OK. But strategies on how to compute and send results in a timely manner were not clear.	OK but did not quite track their Round 6's intermediate results accurately.	Answered all questions well. "We also learned how time consuming borda voting is in regards to determining the borda count for each candidate by hand, something that we will want to use a calculator for next time." "The big takeaways for this voting day is that there are many different ways of determining a winner for given preference orderings and that voter behaviour can lead to interesting situations in which, for instance, there is no candidate that Pareto-dominates another." "Additionally, we found it very interesting how teams 6 and 7 (note from Soh: Matrix-1 and Matrix-2) nearly reversed our strategy of voting which is largely responsible for there being no candidate that Pareto-dominates another."
Matrix	OK. But strategies on how to compute and send results in a timely manner were not clear for Rounds 4, 5, and 6.	OK but did not quite track their Rounds 5 and 6's intermediate results	Answered all questions well. "We learnt in the game that voting is not a straightforward matter." "As the result of voting could be manipulated by some agents' own preference, We think mechanism design is really important. Otherwise, the result of voting may not be efficient for the system." "The big take away is that

		accurately.	voting is not straightforward and could be complicated. As we choose different methods, the result of voting could be different. Some candidates, though have no chance to win, may still be able to impact the result of voting”
Null Pointer	It seems that Null Pointer would vote differently for each round and also introduce a “No-Win Candidate” and the notion of “priority” These strategies were puzzling to me. Strategies on how to compute and send results in a timely manner were not clear for Rounds 4, 5, and 6.	Could not tell the Game Day 2 package was not submitted.	Did not answer all questions well. There was lack of understanding on how to meet the Condorcet condition (vs. which movie is the Condorcet winner). “If the election is needed with speed in mind, plurality is the best bet but having a ordered list makes elections much more unclear in terms of who will win and definitely confuses the idea that somebody deserves to win above another.”
Optimal Alligators	Most prepared in terms of coming up with automation to perform the calculations for Rounds 4, 5, and 6.	Had trouble with Rounds 4, 5, and 6, due to faulty automation.	Did not answer all questions well. “In the future, we should try to solicit these requirements earlier so that we can have more development time and less crunch time.” “Voting methods, at first glance, seem like they should all agree, but many produce radically different votes, and small errors in calculation can produce large changes in the output.” “It should also be considered that voting methods like Plurality with Elimination add an additional level of complexity to the calculation of the winner and is more expensive to calculate than other voting methods.”

Table 10. My comments and observations of team strategies, worksheets, and reports.

Lessons Learned

Here are some overall lessons learned.

1. Only one tried to automate each round when in fact the first three rounds are fairly easy to find the winner just by manually inspecting the results online. Agents should be reactive, responding to events in a timely manner.
2. Cumulative voting’s results were uniquely different from all the other rounds. Why? It allows a voter to put all votes into one single Movie—allowing his or her level of preference for that single Movie to be appreciated in the social outcome. See Table 10.
3. Approval voting is more difficult for the Game Day Monitor to monitor. Plurality and Cumulative have a set total number of votes: N and $N*M$, respectively, where N is the number of voters, and M is the number of candidates. So, that allows the Monitor to know whether all votes have been collected.
4. Pairwise Elimination’s results depend on the elimination agenda.
5. Plurality with Elimination and Pairwise Elimination are time-consuming to compute, at least with the Borda counts.
6. Overall, Table 11 shows the winning Movie for each round. The social choice outcomes are the same for all rounds, and as a result does not show any of the paradoxes or issues that we discussed in class. However, the social welfare outcomes are different, as the ranking of movies as a result of the preference aggregation.

Round	Winning Movie	Second Ranked Movie
1. Plurality	1917	Bombshell
2. Cumulative	1917	Joker
3. Approval	1917	Joker
4. Borda	The Lighthouse, The Irishman**	The Lighthouse, The Irishman
5. Plurality w. Elimination	The Two Popes**	1917
6. Pairwise Elimination	The Irishman**	Ford v Ferrari

Table 11. Winning Movie and the second ranked Movie for each round. Due to inconsistent voting, no clear conclusions can be drawn across the six rounds. However, since Rounds 4, 5, and 6 used the same preference orderings, we observe that they yielded different social choice outcomes, and even also different social welfare (considering only top 2 choices).

7. Some teams understood the following concepts: the Condorcet condition, the Condorcet winner, Pareto domination, spoiler, and the various voting mechanisms. Some teams should understand the concepts more accurately.
8. Some teams were faster in response than some others. Think about real-time constraints in a competitive multiagent environment. Agents that are faster will enjoy an advantage. Remember this experience if and when you need to design a real time MAS.
9. Teams that were careful were ranked higher. As a MAS designer or as an agent, being careful is a good trait to have.
10. Automation is important. But since automation can also lead to un-checked mistakes, it is even *more* important to test the correctness of automation prior to deployment.
11. Teams that were prepared in general finished higher in the ranking for this Game Day. As an agent, each team should be observant, adaptive, reactive, and reflective.

Game Days League

Here are the League Standings. GZ has won Learning Day and Voting Day. Three teams are tied at second.

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