Game Theory in World of Warcraft

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Introduction

The popular video game World of Warcraft is a Massively Multiplayer Online Role-Playing Game (MMORPG), originally published by Blizzard Entertainment in 2004. Since then it has received numerous expansions that have added new content to keep the game current. The game has many different modes of play, including both competitive and non-competitive formats. Competitive formats include both Player vs. Environment (PVE) and Player vs. Player (PVP) content. This analysis will focus exclusively on PVE content. A core feature of the game is that players must choose one *class* to play, and then further must select a *specialization* from within their chosen class. Both the class and specialization selection determine which role a player will perform when engaging in competitive group content. Specializations can be switched, but the time investment required for competitive content typically requires focus to be primarily on one specialization. Switching classes is not possible and requires the creation of a new character. PVE content has two competitive modes, Raids, which are completed in teams of 20 players, and Dungeons, which are completed in teams of 5 players. Each player must fulfill one of three roles within a group: Tanks, Healers, or Damage Dealers. Tanks, who are optimized for defensiveness, fight the boss face to face and attempt to take most of the incoming damage to shield the rest of the team. Healers heal both the tank and the rest of the team as some incoming damage is unavoidable and cannot be absorbed by the tank. Damage dealers, who are optimized for offense, are focused on using their abilities to deplete the boss health pool as quickly as possible. Each specialization for each class fulfills one role, and each class has three specializations from which to choose. Some classes have all three of their specializations perform the same role, while other classes are hybrids and have their different specializations perform different roles.

Class and specialization performance are measured using several factors. The first metric is often overall throughput. This simply means that if one damage dealing specialization is tuned so their abilities are doing more overall damage than another, that specialization is likely to be a better selection when making a competitive group. The same logic can be applied to healers and, in some cases, tanks as well. However, this is not the only relevant metric as all classes and specializations have unique utility abilities that can provide huge benefits to themselves or even the entire group when dealing with the unique requirements for each encounter. For example, if an encounter requires players to move a lot in a short period of time, specializations with temporary movement increasing abilities are likely to perform better in practice, even if they are not doing the highest damage in theory. There are many utility abilities other than movement as well, such as group-wide damage reduction, temporary damage immunity, of the ability to deal a large burst of damage in a very short time. Therefore, depending on the content in question, group compositions are optimized for their performance in that setting.

Competitive Raids consist of an open competition among teams from around the world to determine who can be the quickest to complete all the enemy boss encounters within a given raid after its initial release, and thus achieve the ‘World First’ completion. This is primarily a community driven event, with no official hosting from Blizzard. However, given its widespread popularity and the rise of online streaming, it has become a live broadcasted event with expert casters, sponsors, and multiple professional teams and players competing. Raids are set up to have multiple Boss encounters (averaging 8-12 bosses per raid), each with their own unique design and tactical requirements. All team members must do various tasks within an encounter required by the specific fight mechanics, in addition to their primary role within the group. A typical group composition will include two tanks, 4-5 healers, and 13-14 damage dealers, but this can vary occasionally for unique fight strategies.

Competitive Dungeons are hosted by Blizzard and typically consist of an open-entry qualification round, with the top 8 teams advancing to compete in a live-broadcast head to head tournament. Each round of the tournament has teams paired up and they complete three dungeons against each other. For each dungeon, the team to finish the fastest wins that dungeon and the first team to win two dungeons wins the round. Dungeons are set up to have 3-4 bosses as well as other non-boss, but still challenging, enemies in between. The boss encounters in dungeons are significantly shorter than in raids, with the focus being on executing an effective strategy for completion of the whole dungeon at once, rather than one specific encounter at a time. In addition to tactics to deal with specific fight mechanics for each dungeon, strategies also include optimal class composition and planning an efficient route to travel through the dungeon. In dungeon tournaments, groups must have one tank, one healer, and three damage dealers, but there can often be variation among the classes and specializations chosen to fulfill those roles.

No previous game theory research has been found that models the competitive formats of World of Warcraft. Some previous research has been done regarding coordinated action within one raid team, but none that focuses on the strategy associated with competing against other teams.

Model & Game Design

PVE Raids

In a raid setting, teams have full control over deciding their composition. Since there are 12 classes, each with 3 specializations, and 20 spots in the team, this results in an enormous amount of potential compositions, even when restricting for role. Furthermore, finding the optimal composition is outside the scope of game theory. This analysis will assume the top teams know what their best compositions will be for each encounter in each raid and instead will focus on modelling the decisions associated with the competitive aspect of the World First race. For the best teams, the first few bosses are usually quite easy and do not require them to field a completely optimal set up, even if it would be slightly better. The true challenge for these teams will usually come from the final boss, and sometimes from the penultimate boss as well. Each boss in the raid will drop gear for 4/20 players once defeated. This gear will increase a character’s power level. Therefore, if the optimal composition for the final boss is different that for the earlier easy bosses (which is very often the case), there is an incentive for teams to bring a suboptimal composition for the early bosses, in order to acquire gear and maximize the power level of characters that will make up the composition for the final boss. However, if the composition is so suboptimal as to cause the team to struggle on the earlier bosses when they otherwise would not have, the lost time may not be worth the trade-off. In the real-life race, there are two professional teams, Limit and Echo, who are significantly above the level of anyone else and have achieved nearly all recent world first kills. While they are competing against all other teams, their strongest competition always comes from each other. The composition decisions can then be modelled as a two-player simultaneous game.

Normal form representation:

Players: Limit and Echo (Professional World of Warcraft Teams)

Strategies:

- Play the optimal composition for each boss
- Play the optimal composition for the final boss for the whole raid
- Play a non-optimal composition (perhaps to avoid others copying their method)

Payoffs: Likelihood to win the race

Matrix representation:

		Echo		
		Optimal Each Fight	Optimal for Final Boss	Non-Optimal
Limit	Optimal Each Fight	5,5	3,7	8,2
	Optimal for Final Boss	7,3	5,5	9,1
	Non-Optimal	2,8	1,9	3,3

Table 1: Matrix representation of raid competition game

The payoffs, which represent likelihood to win, were created with the assumption that if at least one of these teams plays an optimal composition for the final boss, they will win. However, if both play non-optimal, there is a chance for a different team to win. The payoffs were also chosen to reflect a greater discrepancy in win probability if the matchup was optimal for final boss vs. non-optimal, compared to optimal for final boss vs. optimal for each fight. This is because a team playing a non-optimal composition would have a disadvantage on every fight, rather than just a power level disadvantage for the final fight.

PVE Dungeons

In dungeons, teams are more restricted in their composition decision, with each team being required to have one tank, one healer, and three damage dealers. However, this still leaves many possible compositions to choose. Once again, this model will assume all top teams know their best composition and/or strategy for each dungeon they play and will instead focus on the decision made in the context of the competitive tournament. The tournament is structured as a bracket of, initially, eight teams. In each round, winners of the head to head matchups advance, and the winner of the final round wins the grand prize. A dungeon strategy consists of group composition, tactics for specific encounter requirements, and planned route through a dungeon. Unlike raids, dungeon competitors get practice time in advance to refine strategies as much as possible. Teams who find unique routes or compositions may be able to keep them secret before the competition but once they use them in the tournament, they will be known to everyone. This can create an incentive for teams to hold their optimal routes and compositions for future rounds, provided they are confident they can win the current round without them. However, if their opponent has also found the optimal route or composition and deploys it in this round, they are very likely to lose. Once the final round is reached, there is no longer any downside to using the best strategies, as giving away this information can no longer help other teams in the future. Therefore, the final round will not be included in the model as there are no interesting strategic decisions made. All previous rounds can be modelled as a two-player simultaneous game.

Normal form representation:

Players: Team 1, Team 2

Strategies:

- Play the optimal composition and the optimal route
- Play the optimal composition and a non-optimal route
- Play a non-optimal composition and an optimal route
- Play a non-optimal composition and a non-optimal route

Payoffs: Likelihood to win the round AND win the whole tournament

Matrix representation:

		Team 2			
		Opt Comp/Opt Route	Opt Comp/Non-Opt Route	Non-Opt Comp/Opt Route	Non-Opt Comp/Non-Opt Route
Team 1	Opt Comp/Opt Route	2,2	10,0	10,0	10,0
	Opt Comp/Non-Opt Route	0,10	4,4	4,4	10,0
	Non-Opt Comp/Opt Route	0,10	4,4	4,4	10,0
	Non-Opt Comp/Non-Opt Route	0,10	0,10	0,10	7,7

Table 2: Matrix representation of dungeon tournament game

The payoffs here are chosen such that either team is guaranteed to win if they are playing either an optimal composition or an optimal route and the other team is not. This is assuming that, at this level of competition, players are of equal skill level and so neither team would be capable of overcoming a non-optimal strategy when the other team was playing an optimal one. In cases where both teams play the same strategy, the payoffs were created to reflect that each team has an equal chance to win (on account of equal skill), but they are both better off if they play non-optimal routes and compositions. This is because it doesn't hurt them to do so in this round if their opponent is also playing it, and it is better moving forward that they did not reveal the optimal strategy to other groups they may face in subsequent rounds.

Game Solution & Results

PVE Raids

		Echo		
		Optimal Each Fight	**Optimal for Final Boss**	Non-Optimal
Limit	Optimal Each Fight	5,5	**3,7**	8,2
	Optimal for Final Boss	**7,3**	**5,5**	**9,1**
	Non-Optimal	2,8	**1,9**	3,3

Table 3: Raid competition game with best responses & dominant strategy

For the raid competition game, we see the best responses for both teams underlined in table 3. From this, we can see there is a pure strategy Nash Equilibrium where both teams play an optimal group composition for the final boss, and both receive a payoff of 5. Furthermore, we find that playing the optimal composition for the final boss is a dominant strategy for both teams. This means that regardless of what the other team plays, it is always better to play optimal for the final boss. This also results in an overall utility of 10 for both teams combined, which is equal to the highest attained amount in the game.

PVE Dungeons

		Team 2			
		Opt Comp/Opt Route	Opt Comp/Non-Opt Route	Non-Opt Comp/Opt Route	Non-Opt Comp/Non-Opt Route
Team 1	**Opt Comp/Opt Route**	**2,2**	**10,0**	**10,0**	**10,0**
	Opt Comp/Non-Opt Route	**0,10**	4,4	4,4	10,0
	Non-Opt Comp/Opt Route	**0,10**	4,4	4,4	10,0
	Non-Opt Comp/Non-Opt Route	**0,10**	0,10	0,10	7,7

Table 4: Dungeon tournament game with best responses and dominant strategy

Table 4 shows the best responses for the dungeon competition game. We find a pure strategy Nash Equilibrium here where both teams play the optimal route and the optimal composition, and both get a payoff of two. Like the raid game, this is a dominant strategy for both teams. This is because if the opponent were to play something non-optimal, playing an optimal route or composition gives a guaranteed win which is always worth it. However, the overall utility gained here by both teams combined is only four in the Nash Equilibrium. If teams were able to coordinate, they could both play non-optimal strategies and get higher payoffs of either four or seven each, as this would increase their probability of winning future rounds by not giving information about optimal strategies. Since they cannot coordinate, we have the Nash Equilibrium where both are playing fully optimal strategies in each round.

Discussion

The results of this analysis show a surprisingly low amount of choice for teams in both games studied. Although it was not intentional when setting up the model that both would end up with dominant strategies for both players, it does make sense when compared with real-life results. In a recent interview on the Titanforge Podcast (2021), a main strategist from current world #1 ranked guild Limit discussed a previous raid in which their team played different, optimal compositions for each encounter to finish them quickly and get to the final boss as soon as possible. This contrasted with their main competitor at the time who used their planned composition for the final boss on many of the earlier encounters as well, to obtain gear. This illustrates a real-life example of the exact game scenario laid out in the raid model in this paper. In this case, while Limit did reach the final boss ahead of all competitors, they ended up losing the race by a significant margin due to the characters in their final boss composition having much less power level than those of their opponent. This result aligns with the findings in this analysis that playing an optimal composition for the final boss, and optimizing its power level in advance, is the best strategy. While the teams involved did not necessarily model their decision in game-theoretic terms, this example shows that this way of thinking about the competition is prevalent at the professional level.

Both the raid and dungeon models are moderately sensitive to certain parameters that impact the payoffs. In the raid game, the most relevant parameter is how much the time gain is for running optimal compositions for all bosses. Clearly, all teams would prefer to have the optimal final boss composition once they reach it, but it is conceivable that the time saved on the earlier bosses may outweigh the power level gain of sticking with optimal final boss composition through the whole raid. This also depends of the difficulty level of the earlier bosses. The more difficult the early bosses, the more time will likely be saved by playing the optimal compositions for each of them. The dungeon model is most sensitive to how negative the impact is on future rounds by revealing optimal compositions and routes in the current round. If revealing this information drastically hurt a team's chances in the next round, it may be worth taking a risk of playing a non-optimal strategy. Unintuitively, the dungeon model is not overly sensitive to the assumption that an optimal strategy vs. a non-optimal strategy results in a guaranteed win. This assumption is likely the most tenuous as it is possible that a team playing a non-optimal strategy has at least small chance to win. However, to change the best responses, this would have to be a greater than 20% chance (translating to a payoff of greater than two) for the non-optimal team to win. Assuming professional players of equal skill level, it is difficult to imagine the chance for a non-optimal strategy to win being this high. Both models are highly sensitive to this assumption of equal skill and, by extension, that playing the same strategy leads to an equal chance to win. If this proved to be false, it may be worth it for the more skilled team to play a non-optimal strategy if they are likely to be able to win anyway. However, given how close these competitions usually are, a skill disparity between teams, particularly one large enough to affect the strategies, is quite unlikely.

Conclusion

This game theory analysis of competitive PVE content in World of Warcraft has shown the best strategies for teams to employ at the cutting edge of competition. A model was created for both raids and dungeons. In the raid model, results showed that teams should play an optimal composition for the final boss throughout the entire raid, as the power level increase for the final boss outweighs the potential time gain of optimizing compositions for earlier bosses. In the dungeon model, results showed that despite the incentive of keeping their optimal route and compositions secret for use in later rounds, teams should play fully optimally in every round as the risk of losing outweighs other incentives. Overall, the results suggest that there is likely more complexity for teams determining the optimal compositions and encounter strategies in advance than there is in determining strategies for the competitions. Optimizing group compositions and dungeon routes likely falls under the umbrella of combinatorial optimization. However, there are still insights to be gained from the game theory analysis. There is often talk among the World of Warcraft community about the different options, as outlined in this analysis, that teams may take for approaching raids and dungeons and these discussions are far from reaching a consensus regarding a dominant strategy. Therefore, this analysis shows that when analyzing these competitions in game-theoretic terms, there clearly is a best option.

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