The Importance of Matchmaking in League of Legends and its Effects on Users

WPI Interdisciplinary Qualifying Project

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2015

Abstract

Massively multiplayer online games have become a large industry with millions of users playing every day. Matchmaking is used to group players in a fair game for multiplayer online video games. In this paper, we examine how well matchmaking systems create matches that are enjoyable for players in the popular multiplayer online game League of Legends. We collected data about the matchmaking system of League of Legends by surveying players before and after a game and collecting statistics about their games. We analyzed this data and came to several conclusions: queue times rise with rank but are generally quite low, the main factor reported to affect the game outcome is player skill, and players generally enjoy games where their team is better or the game is even.

Table Of Contents Page Number

1. Introduction

1.1 Videogames and Society

The video game industry as a whole is expansive. Millions of people play video games each day, and the number of people playing keeps increasing.[3] According to the Entertainment Software Association, fifty-nine percent of Americans play video games.[1] Video games also cross age and gender lines, as according to the same report the average age of people playing video games is 31 years old and 48 percent of gamers are women. The NPD Group inc, a marketing information and statistics company, reports that in 2013, consumers spent 21.53 billion dollars on the games industry.[1] One growing genre of gaming is online gaming. A 2013 report by the NPD found that 72 percent of gamers played online, up from 67 percent the previous year.[9] The same survey reported a 6 percent increase in time spent online by players.[9] In these games, users play with and against one another over a network. Games are often hosted by region based servers, but played around the world.

1.2 Matchmaking

Matchmaking is the process used to match players of similar skill levels together in competitive online games. Halo 2 was one of the first games to use an automated system to match players together.[16] This system allowed players to create a playlist of maps they were interested in then tried to connect them to a game that best fit what they had chosen. If this did not work it tried again with a different map.[16] It was a simple system, but effective. Numerous other games today use similar systems to creating matches.

Players desire accurate matchmaking, because unbalanced matches can ruin the experience of all players. They also want fast matchmaking, as waiting a long time for a match is tedious and leads to player dissatisfaction.

Because matchmaking systems are fairly complex and the companies that use them are competitive, little data is known about the actual systems.[15] Players enter the matchmaking queue where they wait with other players who have also entered the queue. Since perfectly balanced matches are often not available the system will wait until properly ranked players enter the queue and are then placed into the group. Players are grouped together according to a rating given based on player performance in previous matches played. In games where players are part of a team, players are sorted on to teams with the goal of the matchmaking system to make them as mathematically even as possible. Much of the time perfectly even matched games are not possible so the system makes concessions in evenness for the sake of a shorter wait time. The amount of time this takes depends on the number of players that are waiting to join a match. When developing a matchmaking system the goal is a balance between finding the best match and starting the match within a reasonable amount of time.

Matchmaking is an integral part of multiplayer online games and has an important impact on overall player experience. Game companies have invested large amounts of money and time into improving their matchmaking systems in the hope of creating the most even game as possible in as little time as possible. Companies such as Valve, a large game company based in Seattle known for games such as Half-Life (1998) and Counter-Strike (1999), have used

surveying to attempt to improve their matchmaking systems for their game DOTA 2 (2013). Since these types of competitive games rely on even matches, accurate matchmaking systems encourage players to continue playing the game.

A relatively new genre of games are called MOBAs (Multiplayer Online Battle Arenas).[4] This genre began as a mod for Starcraft (Blizzard, 1998), but fully developed as the Warcraft 3 (Blizzard, 2002) map known as Defense of the Ancients or DOTA.[2] DOTA quickly rose in popularity and after a number of years new versions arose in the form of full fledged MOBA's. MOBAs are session based, competitive, team based, and objective driven games. Their appeal is playing different characters, known as champions, in the same game type with continuous skill progression. MOBAs usually consist of teams of players pitted against each in a closed arena. Teams are organized and put together using matchmaking systems. The balance of the teams is important in ensuring an enjoyable match between the two teams, which is one of the basic goals of a MOBA game.

1.3 League of Legends

We investigated matchmaking systems, their effects on players, and player perception of matchmaking using the game League of Legends or LoL (Riot Games, 2009) as our case study. LoL is the most popular current day MOBA.[4] LoL was made to be a competitive game with constantly evolving strategies. Games take place on a number of different maps, but for the purpose of this study we focus on the most played map, Summoner's Rift. This map is a 5 player versus 5 player (5v5) map with the goal being to destroy the enemy's base. Players can earn points to unlock new characters to play and character customization which changes their character's abilities in game, and can pay money to unlock cosmetic items called skins. Players begin at level 1 and play to level 30. This provides a time for the player to become adjusted to the mechanics and different champions in the game. After this adjustment period, players enter into the main pool of players and can play in ranked games to move up and down a ranked ladder of players. For many players trying to advance up the ladder is one of their main goals. Players track their status in the ladder through their rank which begins at Bronze and maxes out at Challenger. The competitive atmosphere developed by this ranking system drives League of Legends' ranked play. The competitive nature of the game has led to its success and has given it a strong E-Sports following.

Currently League of Legends is the most popular E-Sport with over 32 million people watching the Season 3 Championship by livestream.[5] LoL has professional leagues in the US, Europe, China, and Korea which compete year round. League of Legends' strong E-Sports community drives the competitive aspects of the game and forces it to evolve.

1.4 Matchmaking Systems and ELO

A session of LoL begins with players queuing to be matched with other players of similar skill. Players can enter the queue as an individual or with other players. This group of players is formed into a team, which is then matched against an opposing team of similar skill, and the game begins. A formula based on the Elo formula, created by chess grandmaster Arpad Elo to

rank chess players, is used to rank player skill and match players together.[18] The formula changes the player's rank each time he or she wins or loses a match. Players lose more Elo when losing to players with lower Elo than their own, and gain more when they beat higher Elo players. This Elo-based ranking system serves 67 million players each month for League of Legends alone.[3]

1.5 Our Goals

League of Legends players are matched with other players of similar skill so that matches are competitive and fun. While winning is enjoyable, it is less fun when games are too easy and there is less to be learned from playing against worse players. Losing is less fun and can be frustrating, however more can be learned from better players. This leads to a desire for balance between the two, making an even match preferable. We are trying to find out how well League of Legends matches players and how that relates to their enjoyment of the game.

We researched players' opinions regarding their League of Legends game experiences and how this relates to matchmaking. We asked players how even their matches were and how much they enjoyed them. Based of this information we analyzed if players would have a noticeably improved experience if matchmaking put together more even matches. We also examined the time players spent waiting for matches to see if there were issues with that aspect of matchmaking. Based on our data the intent is to see if improving the matchmaking system would significantly improve player experience.

1.6 Methodology

We held a series of studies in a campus computer lab where we invited players to come in and play League of Legends matches. Before and after each match, players took a survey asking for their thoughts on the matches including how balanced they believe the games were, what factors led to the game outcome, and how much fun the games were. We collected game statistics such as gold, kills, and deaths for each player from the League of Legends online match history after each match as well. We took this mix of quantitative and qualitative data and analyzed it for trends related to our problem statements.

1.7 Findings

We gathered valid data from 52 games to analyze for our studies. We found that queue times are generally short, with the median times under 60 seconds across all ranks. Player enjoyment is related to both the game outcome and how well their team works together. Players reported about 70% of games are somewhat even, while 30% are uneven.

Chapter 2 includes related work and background on matchmaking, League of Legends, and survey methodology. Chapter 3 introduces our plan for data collection and analysis. Chapter 4 lists our study results and demographics. Chapter 5 describes our analysis and Chapter 6 is conclusions made based off our data. Chapter 7 has ideas for future related studies.

Chapter 2: Background and Related Works

League of Legends came out in 2009 but has much history behind it. The game itself has come a long way from its original version, as has the genre it spawned from. When trying to understand the aspects of the game we realized we had to understand and know the history of the game and genre. We also did research into surveys and surveying methods. Finally we looked at a number of papers related to our own study to see what other researchers attempted in related subjects.

2.1 Background: MOBAs

The Multiplayer Online Battle Arena genre began as a custom map for the original Starcraft created by a modder named Aeon64. This mod, Aeon of Strife or AoS for short, created the general format for MOBAs, but was far different from today's versions. The first successful replica of AoS was the original Defense Of The Ancients (DOTA) which was an early unpolished version of the extremely popular DOTA Allstars.[2]

It was after DOTA Allstars' success that game companies saw a market and decided to make stand-alone MOBA games. In 2008 and 2009 the first round of MOBA games were released starting with Demigod (Gas Powered Games, 2009), Heroes of Newerth (S2, 2010), and League of Legends (Riot, 2009). These games revolutionised the MOBA genre and showed its potential. Not long after this first wave of MOBAs, more were created, the biggest being DOTA 2, a sequel developed by Valve and lead by Icefrog, the main creator of DOTA Allstars. Since then numerous other MOBAs have been developed, each trying to do something different. More recent games such as Smite (Hi-Rez, 2014) and Heroes of the Storm (Blizzard, 2015) are trying to leave their own unique impression on the genre by adapting and changing, Smite by giving a different perspective (over the shoulder as opposed to isometric), and Heroes of the Storm by utilizing Blizzard's large and well known roster of characters.

2.2 League of Legends

The MOBA genre has become more crowded, but a number of games stand out as the most successful. League of Legends is the most popular since, according to statistics produced by Riot Games, the developer, it has the most players.[4] League was one of the first MOBAs developed and was notable for being free to play, which was uncommon at the time. League of Legends quickly grew into the massive following it has today attracting many players playing numerous hours each day.

Players in League of Legends start at level 1 and must play to level 30 before they are eligible to play in ranked games. Once players reach level 30 they are able to play a series of 10 "promotional" matches. Once these are completed the player is placed into a league based on their performance. The ranked ladder of LoL is split into 7 leagues. They are, from lowest to highest,: Bronze, Silver, Gold, Platinum, Diamond, Master and Challenger. Each league is split into 5 tiers, 1 being the highest and 5 the lowest. Players can earn points by winning games and lose points by losing games. Once they reach 100 points in their division, they enter a best of 3 series, or best of 5 series if they are currently in tier 1 of their league. If they win, they are

promoted to the next tier. For example, a player in Gold 4 who wins their series would move to Gold 3 and a player in Platinum 1 would move to Diamond 5. Players can advance on the ladder as a solo player or and as a team of five, with a separate rank for each. Ranked play is mainly played on Summoner's Rift, the five versus five map. The map itself is broken up into sections. There are three lanes (top,middle, bottom) and jungles filled with creatures separating them.

There are several player roles that most often appear in each game: Top Lane, Mid Lane, Jungler, Marksman, and Support (Markman and Support start in the Bottom Lane), and each role has specific responsibilities and different play styles. Players' roles often influences what part of the map they play on. Each team has a base comprised of different buildings. From each base spawn groups of monsters often referred to as "creeps". Groups spawn periodically and proceed down their lane to meet and fight with the opposing teams creeps. In each game players earn gold by killing creeps, neutral monsters, and other champions. Gold is used to buy items which increase their champion's power and give them new abilities.

The game map is covered by fog of war which obscures anything out of the sight range of a team's minions, towers, champions and wards. Teams typically try to gain control of the map by placing sight wards and destroying enemy wards to give their team more information, and by killing towers to allow their friendly minions to push further into enemy territory. Map control benefits a team by making it easier to take neutral objectives and catch and kill enemy champions.

Encouraging teamwork and coordination also increases fun. Riot has taken a number of steps to encourage teamwork. Riot introduced several ways for teams to communicate, such as an informational ping system, and encourages players to "honor" one another for good teamwork as well as report players who are toxic. Players who do not leave games and are communicative and respectful also receive in game rewards. This type of reward system encourages players to work together.

2.3 Background: Surveys

When designing surveys, a few important guidelines should be followed to ensure that the resulting data will be useful and accurate, and that the subjects of the survey are not confused. The wording of questions is important to reduce bias in answers; strong words like "should" or "must" may elicit a different response than other words. The order of questions is important to make sure the survey taker understands the question's context.[19] For example, grouping all of the questions concerning one game type together makes the survey more clear. The survey should start general, with questions about demographics and overall views, then gradually get more detailed. Questions should be specific and unambiguous. Acronyms and technical terms should not be used without proper explanation first. Multiple choice questions should cover all possible responses as thoroughly as possible.[20]

2.4 Related Works

Maxime Véron, Olivier Marin, and Sébastien Monnet, looked into how effective matchmaking is and how factors such as latency, wait times, and player behaviors affect matchmaking. The paper uses League of Legends as a case study, collecting public data from the servers and analyzing it to see patterns in the factors they are looking for. The researchers look into the technical side of matchmaking and latency and begin to formulate a new system to improve it. This paper looks into matchmaking and what is wrong with it, very similar to our paper. However, it mainly looks at latency and matchmaking, where our results are more based on player perceptions.

Olivier Delalleau et al. studied matchmaking in general and compared it to a new system implemented in the online multiplayer game Ghost Recon Online. It delves into what the real goals of matchmaking are and whether equal skill levels actually translates into more fun for the player. It studies a way to match players with more factors than just skill level, like different player behaviors in game relative to what kind of players they are matched with. It also uses a system of asking players to answer an in game survey about the quality and balance of their matches. This paper relates to ours because it looks into the matchmaking system and what factors make a balanced match. It uses the idea of a survey to gauge player satisfaction like we do. It uses one game as a model and looks for more than just skill as a factor in making a balanced and fun match.

Matthias Dick et al. investigated matchmaking with a focus on lag and latency than on other matchmaking factors. It researches four different games, performing a survey of players to collect data then reinforcing this data with an experiment on the same factors. This paper introduces a part of ours in more depth. It examines latency and lag effects on match fairness. The authors also used a survey to test their hypothesis.

Chapter 3: Research Methodology

Given how important balanced matchmaking is, and player perceptions of matchmaking, we conducted a survey of players to gather data on. To do this, we needed the opinions of players based on their experience in actual games. We designed a survey to collect player perceptions of their games. Because we wanted to compare this against statistical data, such as gold differences, player KDA ratios, and player rankings, we also used several resources to collect statistics from League of Legends. We used third party Websites to collect player rankings and number of wins, as well as the online match history Website run by Riot Games for post game statistics including game time and gold difference.

3.1 Survey Design

As a first step, we created a list of questions that provided data related to our problem statements. We applied what we had learned from several survey writing sources such as Qualtrics to further revise these questions and made sure that the data collected was useful and unbiased.[19] These questions made up our survey, which we then split into 4 parts. The survey was designed to be filled out by both us (the researchers) and the players we were surveying. The sections filled out by the researchers contained factual questions about the match data, and the player sections included questions about their opinions on the game they just played. These were put together in one survey to make the data about each game easy to analyze as a whole. The first section contained basic player information such as “summoner name”, the player’s LoL username, and how often they played different game modes. This was filled out by the player before they began queuing for a game. The next section contained questions about the rankings of the players in the subject’s game. We used a third party (op.gg) Website to help us fill out this section. The third section contained questions about the player’s perceptions of the game just played, including enjoyability, teamwork, and game evenness. The last section allowed us to record game information such as kills by each team and player KDA (kill-death-assist) ratios. We used Qualtrics, a surveying system that WPI licenses, to design and administer the survey. We found it to be simple to work with for survey design and the data it returned was in an easy to analyze form.

3.2 Study Design

We solicited players to participate in our studies. We held live sessions where players came to a campus computer lab and play games. To get people to come and play we emailed a number of students through the IMGD major and Game Development Club email aliases. We wanted to send campus wide emails to attract as many people as possible, but were unable to do so as the undergraduate email alias had recently become more strictly moderated. However, the aliases we emailed were likely to result in more
responses per number of emails because the people on those mailing lists were known to have an interest in video games. We also specifically invited our friends to come play, as many of them play League of Legends and were happy to help our study. We found that we did not need

to provide incentives because most of our participants enjoyed playing League of Legends with friends.

We then held a series of studies in a campus computer lab. Students were able to join the study at any point during our study periods, which usually lasted around five hours. Our three studies all took place at various times over several weekends as we believed that would be when most people would be free to participate. We reserved two rooms with about 20 computers total spread out across several tables. Each computer used the newest version of Windows 7, Intel Core i7-3770 3.4GHz (8 core) processors, 12 gigabytes of DDR3 ram, and an AMD Radeon Graphics cards.[21] All computers had 24 inch Dell monitors and did not have speakers. At the busiest times during our study about a dozen players were playing games simultaneously. We also used our own laptops as well as lab computers to collect data and administer the surveys. LoL runs on a patch system where balance changes and new game items and champions are periodically added. At the time the study was held (December 2014-January 2015), LoL was on patch 4.21.

3.3 Study Procedure

Players arrived in groups and as individuals and were first asked to fill out a consent form, informing them of the study procedures. Although this study had minimal risk, we made sure participants knew how the collected data would be used. Users were then asked to log into the LoL client and were allowed to start a custom game to adjust any settings such as keybindings. In addition, to ensure that the gameplay in the lab would reflect a normal game as closely as possible players were allowed to bring whatever equipment (mice, headphones, keyboards) they wanted. Players were asked to play Ranked games if possible so that more accurate data concerning player rankings could be collected; however if players were unranked or strongly desired to play normals instead they were allowed to do so. All players queued solo as queuing with another player would have skewed results since duo matchmaking is different from solo matchmaking.

Before they entered a game each player filled out the first part of the survey which collected general, basic information such as their “summoner name” (which allowed us to look up their game using third party website), how often players played certain modes which ranged from never to frequently which we considered at least twice a day, and what type of role they like to play. This part of the survey had four questions and took about a minute for players to complete.

Following the initial questions, we took control of the survey and recorded the time the player spent in queue. Once the game was loading, we used online resources to find statistics about the player and the game that was about to take place. To find player statistics we used the website lolking.com. providing the player rank and wins in ranked and unranked. We used the websites lolnexus.com and op.gg to collect data on the ranks of all the players in the match. Once this data was collected the second part of the survey was finished and we waited for the players to finish their match.

After the match was completed, participants were asked to fill out the third section of the survey which asked a number of qualitative questions about the match they just played. These questions covered a number of topics including, how even they thought the match was, why

they won or lost, how fun the match was, and a number of other questions. One of first questions after players finished the game was How enjoyable was the game you just played? This was the main question that we compared to our other questions that followed, How well did your team work together? and how even did you feel the game was? This part of the survey had 10 questions of different types and players took about 5 minutes on average to complete it. Players filled out this section and once again we took control to fill out the fourth and final section.

For the last section, we used League of Legends' match history website to collect statistical data on the match just played. We looked at gold and experience graphs and recorded the difference in gold at the twenty minute mark and at the end of the game. Unfortunately, we required unranked players to log into their accounts to look at their match history as normal games are not publicly available, but this was only a minor inconvenience. After the survey was completely filled out players were allowed to begin another game if they wished.

When playing additional games, participants were asked to fill out the survey in the same way, but were able to ignore some questions in the first part concerning frequency of play and roles played, as these would not change from game to game. Their summoner names were still collected so that the game data could be easily found. This process continued for as many games as a player wanted to play until the end of our study period. In an attempt to get more individuals to play games we held the study three times. All three studies had around ten individuals participate with some playing numerous games. All data collected from the survey was saved on Qualtrics and downloaded in the form of excel sheets for us to analyze.

During the study a number of players hung out, as if they were playing as a group and not participating in a user study. Some players kept to themselves more, in most cases it was an open environment with people talking about how their game was going, or other activities such as browsing the internet or watching other players games. We did not prevent them from hanging out, but also did not keep track of whether players were isolated or part of a group.

Chapter 4: Results

4.1 Demographics: Ranking

We collected 65 total responses to our survey. Of these, 52 were valid. A valid response means that all the necessary data was collected. We had some issues with the match history website not updating right after some of the games completed on one of our study days and some of the surveys were unable to be completed for this reason. However, most of the surveys ran smoothly and the majority of the data was usable. We had 23 unique participants, all WPI students. The most games played by a single participant was 7, and several just played one game.

The distribution of player rankings is shown below in Figure 1. At any point on the graph, the corresponding percentage shows how many players are below the given ranking. In our study, 13% of players were Unranked. Excluding these players, 5% were Bronze, 37% were Silver, 16% were Gold, 26% were Platinum, and 16% were Diamond.

On the North American server, where all our participants played, the League distribution is 20% Bronze, 45% Silver, 23% Gold, 8% Platinum, and 2% Diamond.[22] This is represented by the green triangles on the graph. Our distribution is more even across all leagues, while the actual distribution has more players in the 3 lowest leagues.

Note: Master and Challenger are very small in comparison to the other leagues, and none of the players in our study were in these leagues, so they are not included in the graph.

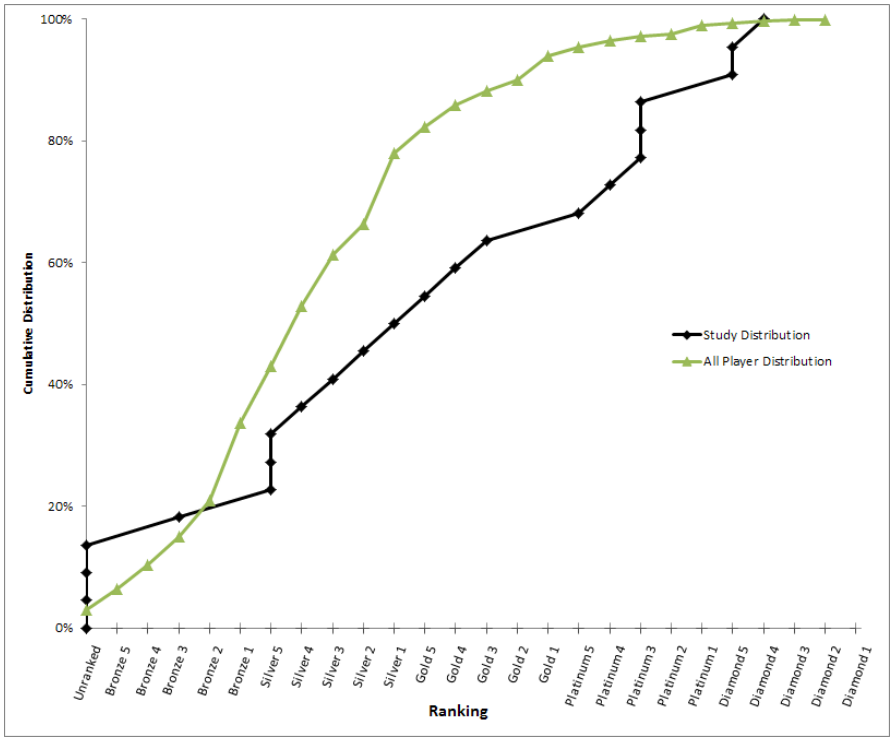

Figure 1: CDF of Player Rankings

4.2 Demographics: Frequency of Play

The responses to the question “How often do you play the following game modes?” are shown below in Figure 2. Each player was told to answer this question just once, regardless of how many games they played during the study. We obtained 25 responses total (a few players answered this again if they attended more than one study time).

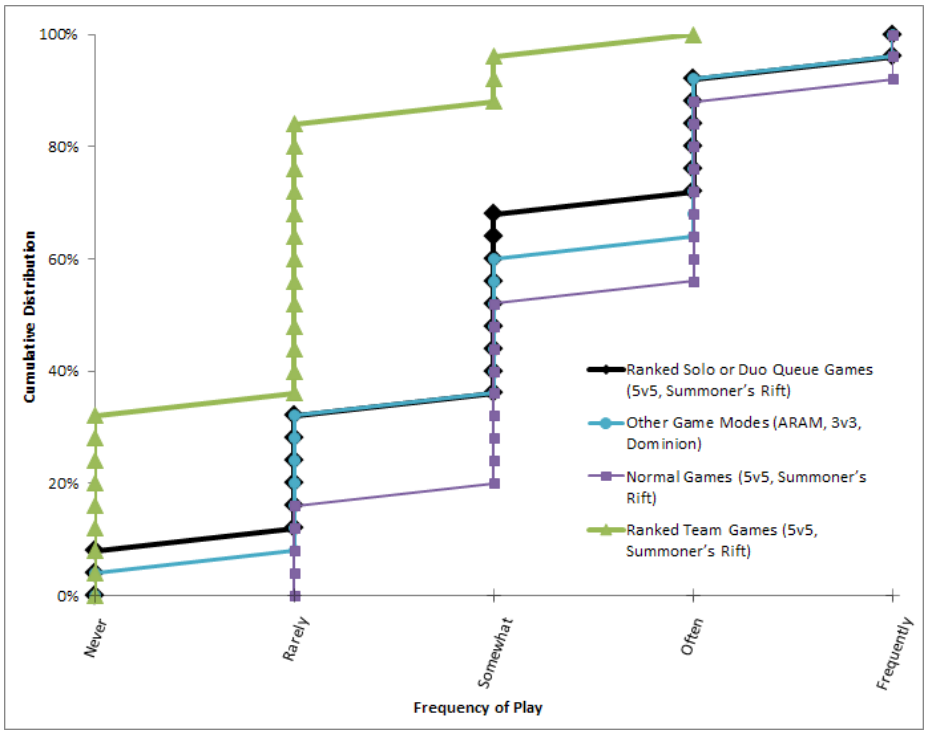

Figure 2: CDF of Play Frequency

The possible frequencies that players could respond with were: “Never”, “Rarely (a few times per month)”, “Somewhat (once or twice a week)”, “Often (every or nearly every day)”, and “Frequently (2+ hours per day)”. The game types given were “Ranked Solo or Duo Queue Games (5v5, Summoner’s Rift)” (Black Diamonds), “Ranked Team Games (5v5, Summoner’s Rift)” (Green Triangles), “Normal Games (5v5, Summoner’s Rift)” (Purple Squares), and “Other Game Modes (ARAM, 3v3, Dominion)” (Blue Circles).

The most popular game mode was Normal games, with 80% of players reporting that they played this mode at least once or twice per week, and half of all players reporting that they played it every day. The least popular was Ranked Team games, possibly because of the difficulty of getting 5 friends online at the same time. Eighty percent of players reported that they played this mode only a few times per month or less. In between the two extremes, about 60% of all players reported playing Ranked Solo or Duo Queue and other game modes at least a few times per week, and 40% reported rarely or never playing these modes. No players reported never playing any mode, so our study subjects were all active players.

Chapter 5: Analysis

5.1 Enjoyability vs Outcome

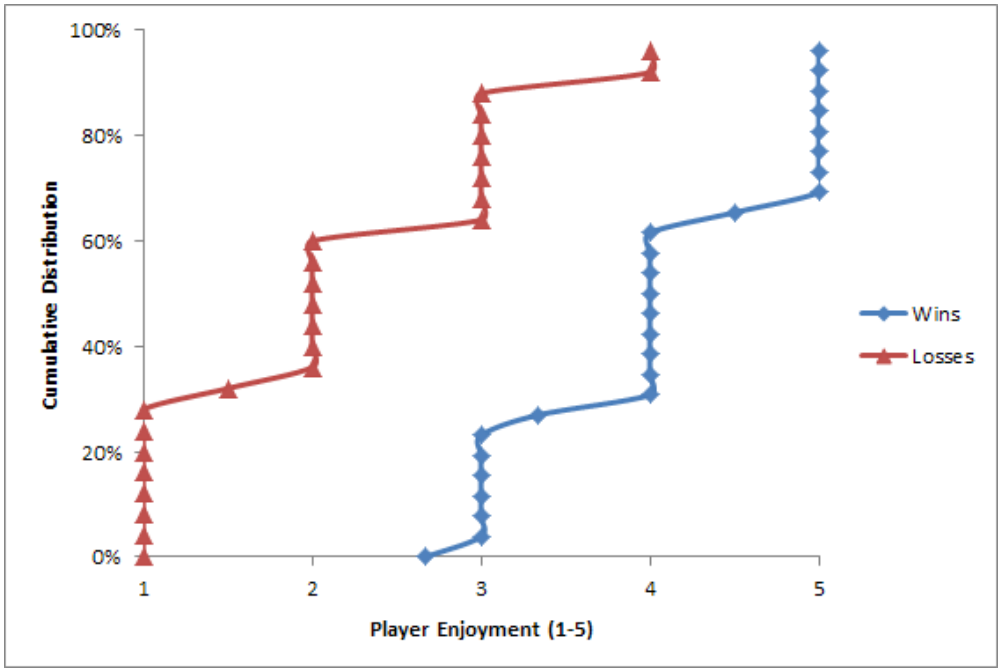

Figure 3: CDF of Player Enjoyment in Wins and Losses

Figure 3 shows the distribution of player enjoyment in wins and losses. The x-axis represents the players' responses to the question "How enjoyable was the game you just played?" Players could answer on a scale of 1-5. The y-axis is the cumulative percentage of player answers with each response. The blue diamonds represent player answers after winning, while the red triangles represent player answers after losing.

After winning a game, about 70% of players report that they are a 4 or 5 on a 1-5 scale, and were therefore enjoying the game. After a loss, this percentage falls to about 10%. After a win, no players reported a 2 or 1, indicating no unhappiness with the game. In games where they lost, 60% of players reported being unhappy. The final outcome of the game has a large impact on how much the players enjoyed the game.

Note that all except 5 of the games above were played in Ranked, so this may impact the results because players may care more about winning or losing the game than they would when playing Normal games.

5.2 Queue Time and Player Ranking

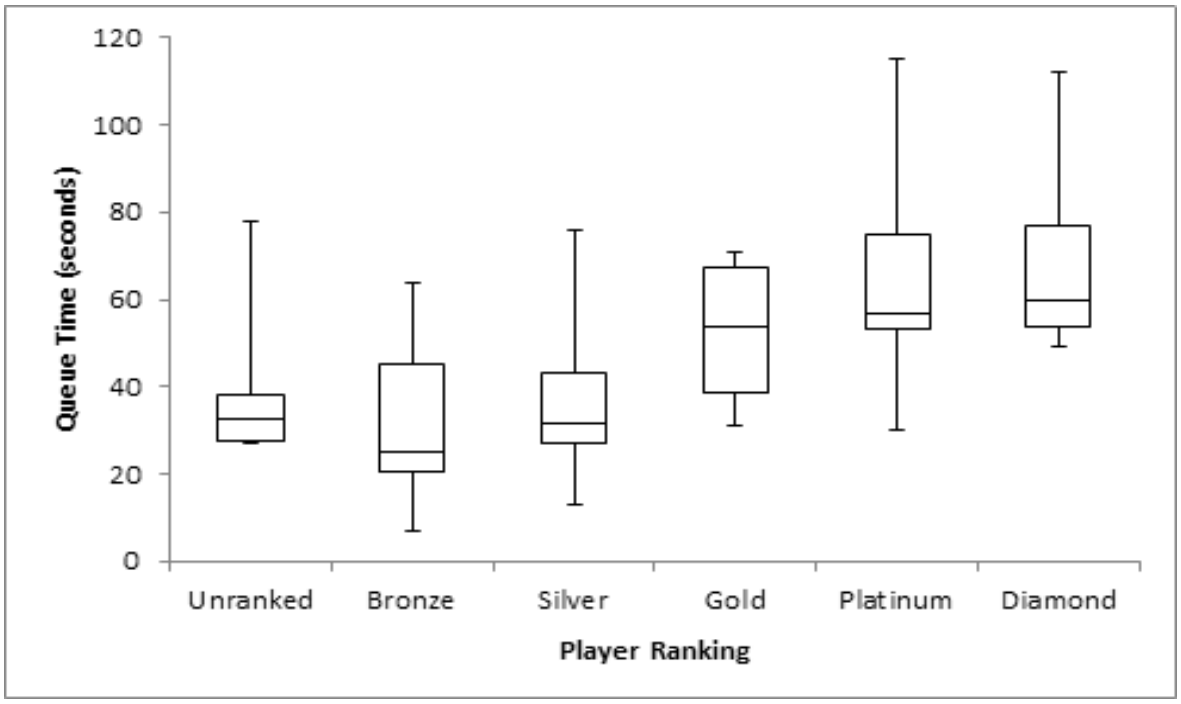

Figure 4: Queue Time and Player Ranking

Figure 4 shows the time spent in the queue by the player and the player ranking. The x-axis is the player ranking, with all unranked games played listed under "Unranked". The y-axis is the queue time in seconds, the time that the player waited before being matched into a game. Each box shows the first and third quartile and the median of all of the queue time data points for each ranking. The minimum and maximum values are shown with error bars.

The queue time medians increase with rank, with the exception of Unranked games which are about the same as Silver games. The variance is quite high, with queue times varying up to about 90 seconds within the same ranking. However, there is a definite upward trend, with Diamond players waiting around 40 seconds longer than Bronze according to the medians.

The matchmaking system looks for players that are close in Elo, which can be approximated using a player's rank, to match players into a game. The system will not match players outside of a certain range to avoid very uneven games. Because there are fewer players in the higher ranks than the lower ones, this leads to higher wait times for higher ranked players as the system searches for 10 evenly matched players.

Note that the queue time was manually recorded by watching the players' clients as they waited in queue. Due to administration error, 4 games did not have recorded queue times and were excluded from this graph.

5.3 CDF of Perceived Evenness

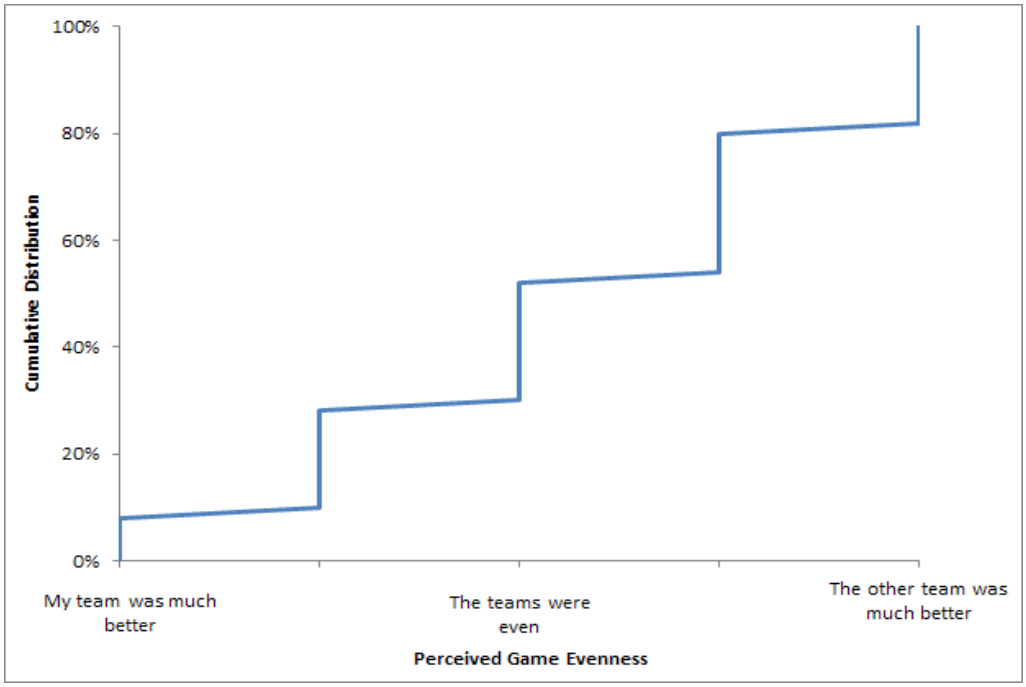

Figure 5: CDF of Perceived Game Evenness

Figure 5 shows the percentage of players that reported each option for the question "How even was the game you just played?". About 70% of players reported that the game was even, or one of the teams was a bit better. About 30% reported that their team or the other team was much better. Therefore, most games were perceived to be at least somewhat even, while fewer were completely uneven.

5.4 Enjoyability and Perceived Evenness

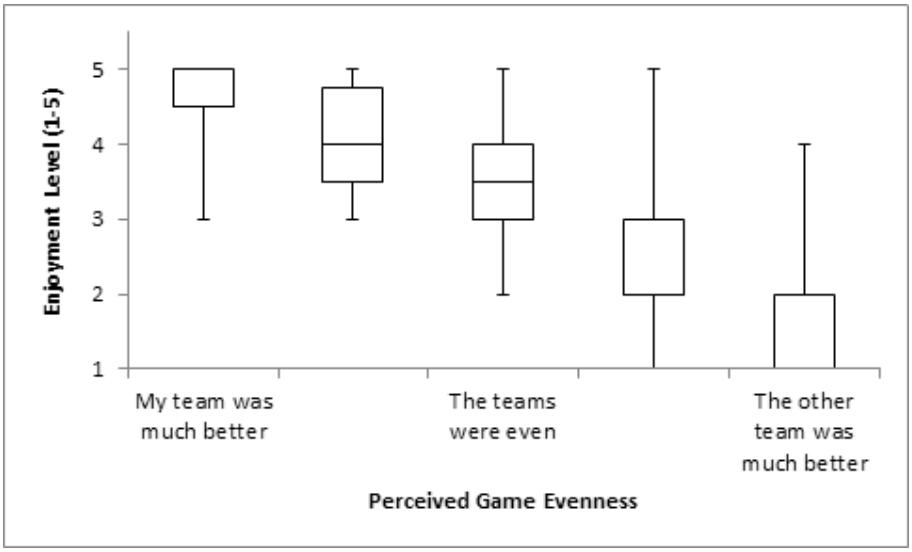

Figure 6: Player Enjoyment vs. Perceived Evenness

Figure 6 shows the relationship between player enjoyment and the perceived evenness of the game. The x-axis measures the perceived evenness of the game by the players, using the possible responses from the survey as labels. To measure enjoyment, players were asked "How enjoyable was the game you just played?" and could answer on a 1-5 point scale. This data is plotted on the y-axis. Each box shows the first and third quartile and the median of all of the enjoyment data points for each possible evenness response. The minimum and maximum values are shown with error bars.

Players generally enjoyed the game more when they felt their team was better, and less when their team was worse. Games where the teams were perceived as even could potentially be very enjoyable or not at all, as there was a large amount of variation between the enjoyment responses in this category. All but 5 of the games above were Ranked, so in games that were even players may have been stressed about the outcome of the game, rather than enjoying the challenge.

In games where their team was much better, high player enjoyment could be due to several factors. One potential factor is the fun of being able to win fights, obtain objectives, buy desired items, and generally feel like they are powerful and having an impact on the outcome of the game. Being ahead also gives players more breathing room for mistakes and reduces negative attitudes, as their teams are less likely to try and assign blame if they are winning. Finally, knowing that they are likely to get a win in Ranked likely motivates some players, especially if they are on a win streak or in their promotion series.

5.5 Gold Difference and Perceived Evenness

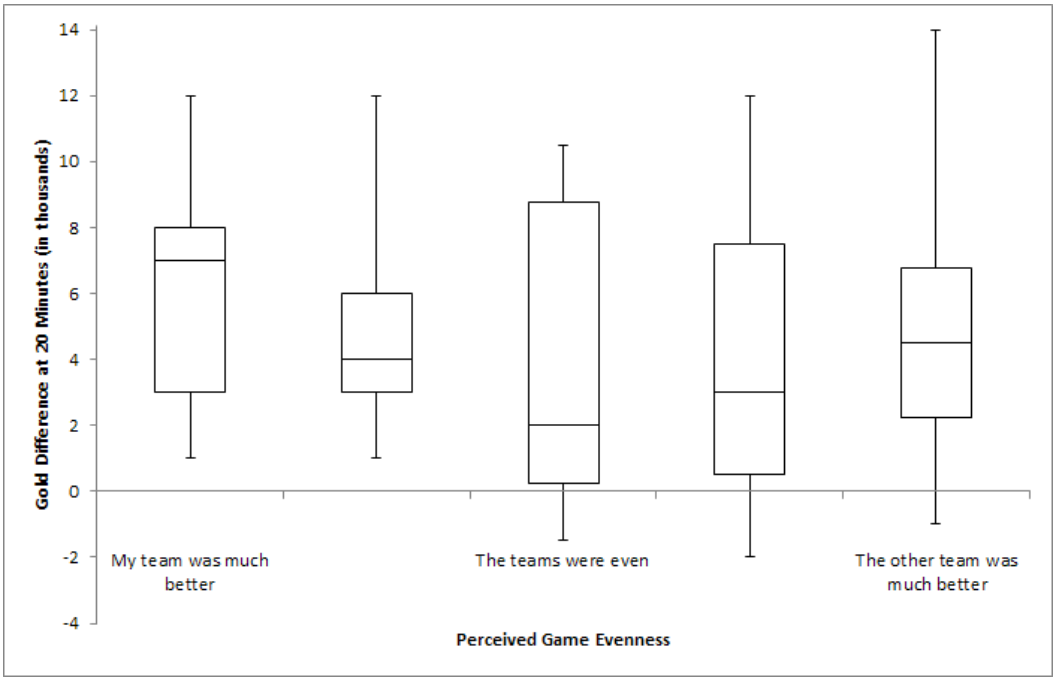

Figure 7: Gold Difference at 20 Minutes vs. Perceived Game Evenness

Figure 7 shows the relationship between how even the player thought the game was, and the gold difference between the teams at 20 minutes into the game. The average game time in our study was 34 minutes. Therefore, 20 minutes is well into the game and shows how even the game is around its midpoint. End game gold difference is inflated due to the winning team gaining gold for destroying the last few structures in the enemy base, so this graph shows the actual evenness of the game more accurately. The differences on the y-axis are in thousands of gold. The maximum difference is around 14 thousand, which would be a very uneven game. A gold difference of 0 is a very even game. Negative values indicate that the losing team was actually ahead in gold at the 20 minute mark, although this is rare.

When players reported an even game, the teams were generally between 0 and 8 thousand gold apart, with the median at 2 thousand. This median is quite close in comparison to games where the players felt the game was very uneven; however the range is still quite large. The median gold difference in these games was much higher at 7 and 4 thousand respectively. Interestingly, the players were not always perfect at predicting who was actually ahead; in some games, players said the enemy team was much better when their team was actually ahead. This might be due to the game being even at the 20 minute mark, but the other team pulling ahead later. Overall the players were quite accurate at predicting how even the game was.

5.6 Reasons for Game Outcomes

Reasons for Wins	
Map, Objective, and Vision Control	31%
Superior Player Skill/Mechanics	30%
My team's teamwork	30%
The other team's lack of teamwork	11%
Superior Picks/Bans	7%
Other team had player lag/DC	4%
Poor Itemization by other team	4%
Major late game mistake by member of other team ("Throw")	4%

Figure 8: Reported Reasons for Wins

Figure 8 shows that the most cited reason for wins was control of the map and objectives, with almost a third of all players stating this was a reason their team won. Other main reported factors were player skill and teamwork. Champion picks, itemization choices, and major late game mistakes were less common reasons.

Inferior Individual Player Skill/Mechanics	37%
My team lacked teamwork	35%
The other team worked together well	30%
Lack of Objective/Vision Control	19%
Someone on my team had lag or disconnected	11%
Champion Picks/Bans were inferior	9%
Someone on my team itemized poorly	4%
Someone on my team made a major late game mistake ("Throw")	4%

Figure 9: Reported Reasons for Losses

The most cited reason for losses was inferior player skill and lack of teamwork. Interestingly, the main reason cited in wins, map control, was less impactful in losses according to players. However, the top four reasons remain the same in both: player skill, good or bad teamwork, and map control. These results show that both individual skill and teamwork are very important to a team’s success.

Note that because players could choose multiple reasons if desired, the percentages do not add up to 100%.

Chapter 6: Conclusions

Finding evenly matched games in a reasonable amount of time is the ultimate goal of matchmaking. Losing can be frustrating and when a player sees no chance of victory they can easily become bored. To understand more about matchmaking and player feelings towards games we conducted a survey of players after taking part in games put together by Riot's matchmaking system.

League of Legends queue times are generally short, with the median times under 60 seconds across all ranks. Therefore, the matchmaking algorithm is delivering results quickly. Player enjoyment is correlated with: the game outcome and how well their team works together. All players cannot win all the time, and losing games teaches players and challenges them to improve their skills. However, uneven games cause unhappiness in the losing team that is disproportionate to the increase in happiness for the winning team. Even games are the best for both teams to enjoy the game. About 70% of games are somewhat even, while 30% are uneven. This percentage could be improved by improving matchmaking, but a game between two very evenly matched teams could still result in an uneven game. Our data even showed that players most enjoyed games that heavily weighted in their favor. It is likely that uneven games will always exist, and their existence is not necessarily bad as long as they do not occur regularly.

Chapter 7: Future Work

More work could be done on the topic of matchmaking in games and the study could move in a number of directions. The first and most obvious direction to take would be to hold a study with a larger group of people, and possibly more refined questions, hopefully providing more reliable and accurate results. Changing some questions based on an evaluation of what questions yielded the most interesting results would also be a desirable option for future studies.

Another direction the study could go would be a more accurate study if there was access to the hidden matchmaking ratings, algorithms, or other data Riot Games uses for matchmaking. Using this data, a group would be able to draw more accurate conclusions regarding match balance. Other statistics that Riot has access to may also reveal interesting data.

Doing a study where matchmaking was done by the researchers would also be an interesting direction for a future study. If a group could manually match players into custom matches they would be able to test their hypotheses using control groups. Having a controlled study would allow researchers to know player skills and create games for which they could predict the outcome given the way they match games.

A similar test could also be conducted in another game of the same nature. A future study could be conducted in DOTA 2, Smite, or other popular MOBA games. Results could then be compared across these studies to see if there is a relationship between them.

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