

Visual Analysis of Players' Activities in World of Warcraft Game

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Abstract— In order to see a whole picture of players' interaction with game world in terms of their decision making, progress, and how the overall game level design and game mechanics are reasonably organized, we conducted a visual data mining on the data that includes quantitative data of players over a period of time from several months to several years, and contains valuable information on players' behavior, game design, game planning, game content, and services etc. Our analytical analysis on the data leads a way for game designers to improve existing games as well as to design better games in the future.

Index Terms—Visual mining, big data, game analytics.

I. INTRODUCTION

In recent years, there has been a rise in interest in collecting and analyzing game metrics, and how they can be used to inform the game development process. Game designers rely on game metrical data to revise game design, adjust levels, difficulty, game core mechanics and contents in order to increase gamers loyalty and keep players in the game for a long time. Williams et. al.[1] suggested four game data collection approaches: survey-based studies, online testing, participant observation and online interviews. All these methods require some form of participant recruitment in game, and makes it difficult to collect, analyze game data since these approaches depend on sampling of population. The Massively Multiplayer Online Games (MMOGs) offer another opportunity for researchers who want to study player behaviors in game because game services of MMOGs offer data for individual characters, allowing players to visit the site to learn about their achievements and compare with other as well. However, the data is not available directly, some researchers[2][3][4] have developed scripts, add-ins on MMOGs game services to query level, class, items equipped, and some statistics of players' performance on World of Warcraft(WOW) game, and explored some interesting work as well.

This queried data includes quantitative data of players over a period of time from several months to several years, and contains valuable information on players' behavior, game design and planning, game content and services etc. With the rising of big-data, it's possible for researchers to explore the data directly to see a whole picture of players' interaction with game world in terms of their decision making, progress, and how the overall

game level design, game mechanics are reasonably organized or not. Especially, the visual data mining provides insights and gains a fundamental understanding of the game design based on whole pictures of players' behaviors.

The paper is based on data collected by Lee et. al[3], where three years of WOW game data is queried with LUA scripts. We mainly focused on data of year 2008, where a new release of WOW: Wrath of the Lich King on November, with extended new game contents, levels, regions, and skills for gamers to explore.

The paper is organized as follows. In Section 2, we discuss the related work. In Section 3 we conducted visual data mining to study how player's behavior in regarding new release, region, avatar, level design of game. Section 4 summarize preliminary findings in our case studies.

II. RELATED WORK

From the perspective of game designers, players' behavior is one of the most important factor they must consider when they design game to justify their game decisions on level, items and equipment, difficulties of game, game world rendering etc. Although player centric design strategy provides game designer a logic way to pretend what is going to happen in the shoes of players, direct evidence and proof from whole game data is still a best feedback on game design. To gain a fundamental understanding of the game play behavior of online gamers, exploring user's game play time provides a good starting point when WOW game services allow players to query and compare achievements on game server. Game designer will observe data to see how to increase game loyalty by providing rich favored avatar, game world, equipment, adjust game level and difficulty, new release with new attractive features.

Collean Mackline etc [5] have built game prototypes to illustrate how different game data to be represented in game. The Kimomo Color prototype uses cross-reference table to show game core mechanics on color material and the manufacture of dye. Directed graph that represents living and non-living elements is used in the Mannahatta Game prototype. Two directed graphs, one for the life that depends on the trees and another for the commodities that represent rain-forest ecosystem in the third Trees of Trade prototype while player are asked to analyze and rebuild the directed graphs that depend on biological and commercial relationships.

David Kennerly[6] explained how game designer can apply data mining techniques to analyze how players acquire experience in an MMORPG. Ducheneaut etc. [4] studied more than 220,000 World of Warcraft characters over 8 months, the players behaviors such as play time, time to move up a level, in which avatar is studied statistically. Weber et al. [7] investigated learning strategies in StarCraft based on over 5000 replays of expert matches data to train machine learning algorithm in order to predict strategy. Lewis et. al[2] performed quantitative research on WOW game with 166047 characters from the US and Europe. They constructed a Naive Bayes classifier that predicts the class of players based on the items they are wearing, the players' behaviors such as days to level 80, class death on way to 80, popular items are also studied quantitatively.

Mirko Sužnjević et. al[8] studied players' behavior in World of Warcraft based on wJournal add-on structure. The players' behavior is categorized into six group: Questing, Trading, Dungeons, Raiding, Player versus Player (PvP) combat, and Uncategorized. The study shows that 43% of players' time is exploring or idle, 36% of players' time is in PvP combat, which mostly takes place in instanced zones. Players tend to gather at certain hotspots, and some instanced areas for Dungeons and for Raiding are rarely used.

Kang et. al[9] analyzed players' four types of behaviors, social, combat, movement and idling in WOW using trajectory clustering method. The insights on players' experience from simple trajectory data can be automatically generated by the model to save cost on level design.

Zhuang et. al[10] collected and analyzed a 5-month long measurement study of World of Warcraft. They found that the players' dynamic distribution of player session lengths is similar to that of peer-to-peer file sharing sessions, in-game character level or age is a good predictor for session length, and changes to a game's virtual world can cause dramatic shifts in the population densities of in-game locations, which are otherwise relatively stable.

Lee et. al[3] collected three-year of World of Warcraft players' data. A list of online avatars status is collected every 10 minutes. If an avatar logs in and logs out within 10 minutes, the program may not be able to observe his re-login activity in consecutive snapshots. During the monitored period, 91065 avatars and 667032 sessions associated with the avatars were observed in regarding players' id, level, zone, charclass, guild and timestamp of the snapshot was made.

In this paper we focused on player's interaction and social behavior in guild, avatar design and player's expressive play in WOW game, player's leveling path by zone and race as well as play time patterns and level difficulty design and progression control.

III. OBSERVATIONS

Gamer interaction and social function are always considered in the game design as ways to attract different gamers with enhanced gameplay experience. WOW guild is typically an in-game association of player characters. The formation of guild social atmosphere makes gamers easily to raid and rewarding.

Banking guilds also provides convenience to individual players as a way to increase the limited bank storage space available in the game. A guild greatly enhances your gameplay experience. You can meet friends, share adventures, and find people to protect you if you fight in faction versus faction combat. Typically, players in good guilds can go places and do things that players in poor guilds or no guild can't, because guilds offer many benefits including free items, opportunities for groups, access to trade skill masters, quest items, and readily available trade skill ingredients through gathering guild members.

We studied top ten guilds in WOW game by players' race and class as shown in following figure 1.

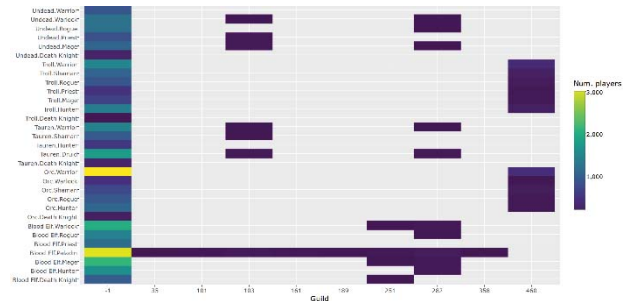


Figure 1: Guild composition by race and class

Majority of the players belongs to no guild when they join wow community, we can see that race combination of Orc and class Warrior and Blood Elf of Paladin are top avatar chosen by gamers. When gamers join guild, the number of Blood Elf of paladin drops greatly although this avatar still exists with low number of players on top 10 guild that has most players by race and class. We further studied successful rate of players who do not belong to any guild i.e. guild value of -1, and completed level 80, and listed top 10 and bottom 10 success rate shown in table 1 and 2.

Table 1: Top 10 success race

Race	Class	Num. Players	Player in Level 80	Percentage
Orc	Death Knight	164	13	7.9%
Blood Elf	Death Knight	956	53	5.5%
Undead	Death Knight	223	11	4.9%
Tauren	Death Knight	246	10	4.1%
Undead	Priest	814	21	2.6%
Undead	Mage	1077	27	2.5%
Tauren	Shaman	927	20	2.2%
Tauren	Warrior	1447	31	2.1%
Undead	Warlock	1231	24	1.9%
Tauren	Druid	1760	33	1.9%

We find that popular race and class is not a good indicator to beat the game as indicated in bottom ten success rates, but race and class play an important role to be successful in game. Top ten successful rate shows that player who had chosen Dead Knight of all four races has a higher chance to finish game without being killed in game.

Table 2: Bottom 10 success race

Race	Class	Num. Players	Player in Level 80	Percentage
Blood Elf	Paladin	3038	38	1.3%
Blood Elf	Mage	2122	24	1.1%
Undead	Rogue	1204	12	1.0%
Troll	Hunter	1379	12	0.9%
Orc	Hunter	1064	9	0.8%
Blood Elf	Hunter	1595	12	0.8%
Blood Elf	Warlock	2002	15	0.7%
Troll	Rogue	881	6	0.7%
Blood Elf	Rogue	1410	6	0.4%
Orc	Warrior	3147	9	0.3%
Troll	Shaman	1058	3	0.3%

There are total 421 guilds in the whole year of WOW data. We further analyzed which guild has highest number of successful rate to see how guild helps player grows, the top ten are in the following table 3:

Table 3: Top percentage in guild completed 80 levels

Guild Num	Num. Players	Num. in Level 80	Rate
473	1	1	100.0%
447	1	1	100.0%
504	2	1	50.0%
364	13	5	38.5%
414	19	7	36.8%
485	6	2	33.3%
147	3	1	33.3%
424	136	43	31.6%
471	29	8	27.6%
207	11	3	27.3%
368	4	1	25.0%
459	46	11	23.9%
342	50	10	20.0%
481	10	2	20.0%
508	5	1	20.0%

There is no exception that all guild that has 20% or higher change to complete the WOW is in guild that the size is relatively small, further study also shows that if the size is too small, then player's success rate drops close to 0%.

Table 4: Bottom percentage in guild completed 80 levels

Guild Num	Num. Players	Num. in Level 80	Rate
-1	34258	454	1.3%
460	1796	0	0.0%
282	1141	12	1.1%
103	1073	202	18.8%
251	686	25	3.6%
101	620	50	8.1%
161	610	72	11.8%
189	532	93	17.5%
104	516	66	12.8%

The size of guild gives mixed signal on how guild helps players to move up because it ranges from 0% to 18.8% in success rate to reach level 80.

3.2 Hot avatars in combined race and class

The player needs to create an account, then chooses a race and corresponding class and moves up level by level to overcome challenges designed by game designer. In most MMO games, varieties of avatar pre-build type are provided for players to choose, and players also have opportunities to change and customized avatar in later game. We studied number of players of WOW game by race and class, where these races speak many different languages, have different homelands and racial traits, and can pursue different classes. Race has basic statistics on strength, agility, stamina, intellect, and sprite.

A class is the primary adventuring style of a player character which determines the type of weapons and armors to be used, as

well as what abilities, powers, skills, and spells to be gained throughout the adventures.

The player's choice of which class to play is constrained by the choice of race; each of which has a different group of available classes to choose from.

The popularity of race ranked from high to low is as follows Blood Elf, Orc, Troll, Undead, and Tauren, while the popularity of class ranked from high to low is as follows Warrior, Hunter, Rouge, Mage, Warlock, Paladin, Shaman, Priest, Druid and Death Knight.

We also studied what combined race and class are preferred by player by counting how many of players who have chosen it in WOW gameplay, and plotted data in heat map with distribution by number. We found the most popular combined race and class is Orc Warrior of Orc, then Blood Elf with Paladin, followed by Mage, then Warlock class as shown in Table 5 and Figure 2.

Table 5: Popular race and class combined

charclass	Blood Elf	Orc	Tauren	Troll	Undead
Death Knight	1006	175	271	64	233
Druid	0	0	1935	0	0
Hunter	1652	1184	597	1543	0
Mage	2218	0	0	748	1209
Paladin	3199	0	0	0	0
Priest	1244	0	0	582	926
Rogue	1479	994	0	1018	1303
Shaman	0	836	1018	1206	0
Warlock	2090	534	0	0	1381
Warrior	0	3506	1555	1697	928

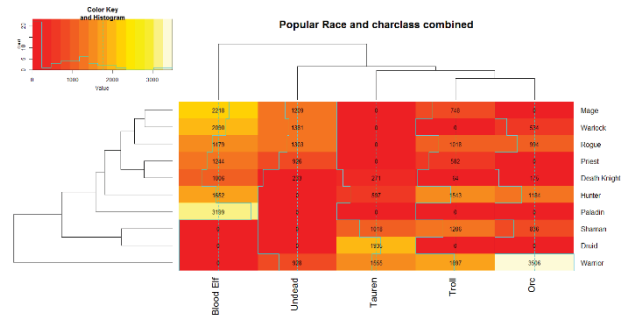


Figure 2: Heat map of combined race and class

The WOW player can change class and race during the play of game if the player is not satisfied with what had been chosen before. We studied all players who have changed either race or class during one-year data collection time. We found that change race or class is a rare event since 97.8% of players stick with what they started with, 1.92% of players change race or class only once, which means total of 99.72% of player are mostly satisfy with Avatar templates that have been offered by WOW game designer. Therefore, we can conclude that players are well satisfied with the rich race and avatar offered by game designers.

3.3 Players' game play time.

The design of difficulty in game in general follows the 'S' shape, where three stages of gameplay are slow beginning, steep acceleration and plateau. There are some variations that based upon the 'S' shape curve. The absolute difficulty of game is the skill needed plus the time pressure to solve challenges in a level.

The game designer in general expects game players to spend more time at higher level than lower level. Therefore, we use average time each player spends at each level as an indicator of the game difficulty. The plot of game time with log function is shown in figure 3. We can conclude that average time spend by player are gradually increasing up to level 70. The new release of Wrath of the Lich King, where the players spends abnormal amount of time to digest the challenges, skills, and game rules. After level 70, the difficulty moves smooth again up to level 80, which is the finale of the game, and players spends more time in order to win the game, however, the time is much more less than time spend on level 70. Overall, the level and difficulty design of WOW game is well considered and balanced based on data observed.

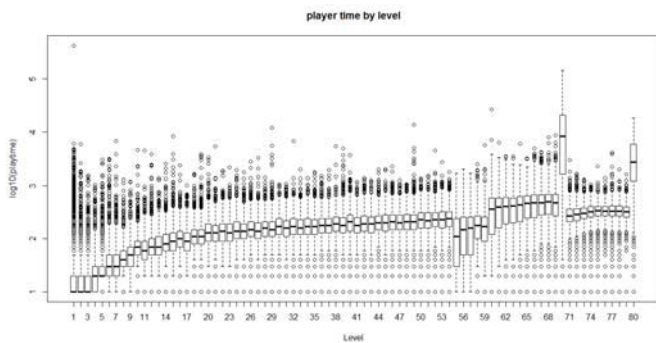


Figure 3: Time spent by level of all players

3.4 Player retention and recruiting

The number of active players per month is plotted in figure 4. The monthly average number of active player is 8303, only Jan, Feb, Mar., Oct and Nov. exceeds the average. Further statistics shows that 1107 out of 37354 active players who had played every month, which is about 3%, while the average monthly retention rate is 61%. It is interesting that the first half of a year from January to June remains above average retention rate, and second-half of year is below the average retention rate although the new Wrath of the Lich King was released.

The time line of Wrath of the Lich King is following:

1. July 3rd 2008, public beta released
2. October 10, 2008, announcement of new release was being manufactured for sale
3. November 13th, released to public

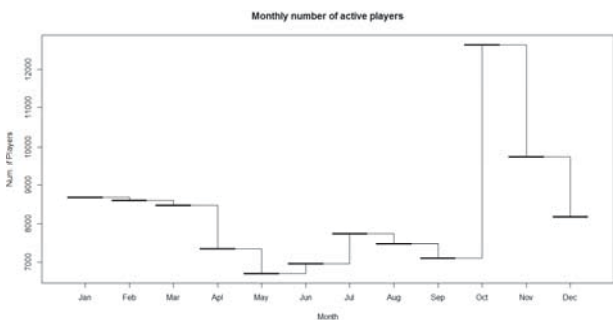


Figure 4: Number of players online by month

Content highlights of new WOW include the increase of the level cap from 70 to 80, the introduction of the death knight Hero class, and new PvP/World PvP content. No additional playable races have been added, though many new NPC races were featured.

After slightly drop of number of active players from January to March, a sudden drop of April, the number of active players in May is in deep valley, and then it is up a little bit in July, which fits the time of new beta of WOW, then it drops a little in August and September as well. There is a high peak of number of player in October, which affirms that new release of Wrath of the Lich King and advertising in game community does attract more players to join the game, however, November and December's number is not promising since it slides down again.

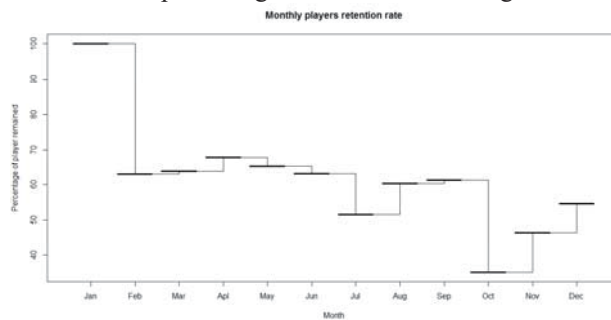


Figure 5: Monthly retention rate

If we use players of January as the base of retention, then each later month of retention is calculated by number of players who stay divided by total number of active players of the month as indicated figure 5. The retention rate is flat from February to September except the drop in July, when the new WOW is on public beta. The data shows that same heavy drop of retention on October as well when the new WOW was on market. After that, the retention rate steadily recovers in November and December.

We also studied how many months that players continuously play WOW after the first time login, the data is show in Figure 6. We can see that 60% of players quit playing after one month. 9% of players play two months before dropping out. 2% to 3% of players play 3 months to 11 months long, and 7% of players play for 12-month long.

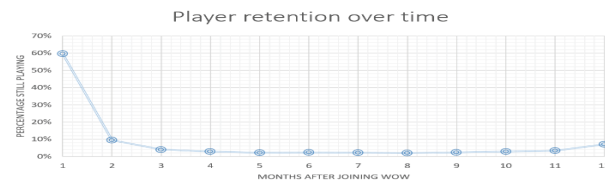


Figure 6: Retention over time by months

3.5 Successful Players' Moving Paths

We identify players by combined char, race and charclass, locate all players who have successfully complete the game from level 1 to level 80. The moving path by level is plotted with Race information in different color in figure 7. There are total 74 players are identified from the data of year 2008 that have played from level 1 to level 80. There are total of 37354 different char, if we combine char and race, there are 37875, if we use

char, race, and class to represent a player, then there are 38331 total different players, in which some player might play WOW game under different char, or some players own different race and class.

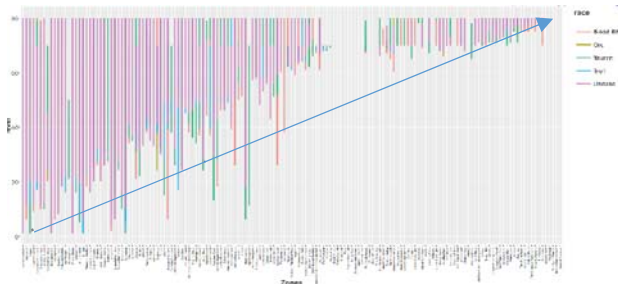


Figure 7: Success moving paths by zones to Level 80

We can see that some zones are never visited by players at all, such as *Black Temple*, *Blackwing Lair*, *Gruul's Lair*, *Hyal*, *The North Sea*, and *The Veiled Sea* etc. which suggests the designer needs to reconsider their designed game path to these zones. On the other hand, *Zones of Everson Woods*, *Mulgore*, *Tirisfal Glades*, *Durotar*, and *Orgrimmar* are special zones that there are players start with level 1 and finished at level 80. As indicated by the race name 'Undead', this race is the most common race that players complete all levels of the game, although *Blood Elf* is the most popular race in the game.

The 2nd group of levelling up path is from level 70 to 80, which are new levels added in new release of WOW. We can see that players of race 'Undead' continuously completed these levels on varieties of zones followed by *Blood Elf* race.

The diagonal path figure 7 also suggests possible transition of zones that game players would follow to levelling up and complete whole game successfully, and best race to choose in order to win the game is *Undead*.

3.6 Popular Zones and Transition Map of Players

If we represent each zone with a node, the size of the node indicates the number of players in the zone, we add a directed-edge to another zone if player moves to it, and we count how many players have taken such transition overall, which is represented by the thickness of the edge. The zone transition map in directed graph is shown in figure 8.

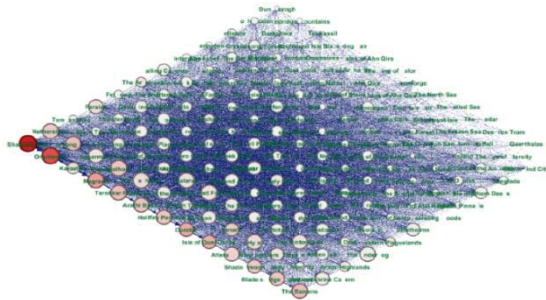


Figure 8. Zone Transition Map of all players

It is clear that most active zones and transitions are happened among *Netherstorm - Shattrath City - Orgrimmar - Karazhan - Nagrand - Terokkar Forest - Arathi Basin - Hellfire Peninsula -*

Durotar...-The Barrens. Although we have found that successful players did not visit some zones as indicated in figure 7, all zones is visited by players via some transitions.

We further divided game level into four groups, level 1 to level 19, level 20 to level 39, level 40 to level 59, and level 60 to level 80 to explore closely on how players move among zones to complete tasks and advance up.

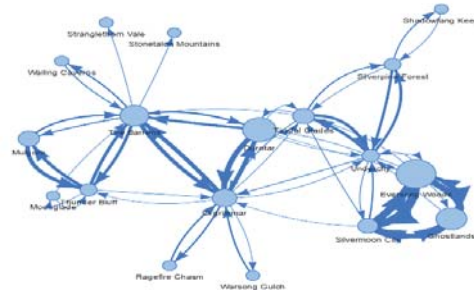


Figure 9: Zone transitions in Level 1 to 19

Figure 9 shows players' transition in level 1 to level 19. We can see that the majority of transitions to complete tasks are *Eversong Woods - Ghostlands - Silvermoon City*, the other one is among *The Barrens - Durotar - Orgrimmar*.

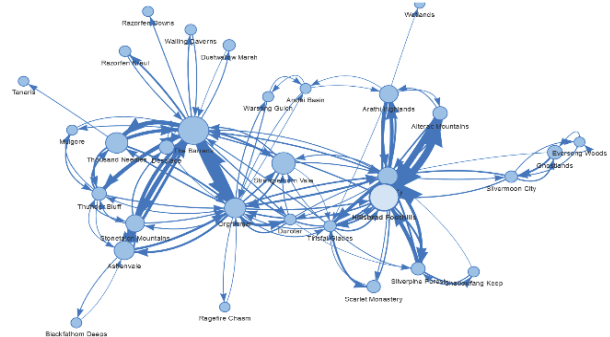


Figure 10. Zone Transitions in Level 20 to 39.

As indicated in figure 10. *The Barrens - Orgrimmar* transitions still dominates, however, *Silvermoon City - Eversong Woods - Ghostlands* are not hot in these levels. Transitions among *Hillsbrad Foothills - Alterac Mountains - Arathi Highlands* etc. become new favored zones in level 20 to 39.



Figure 11. Zone Transitions in Level 40 to 59

From level 40 to 59, *The Barrens - Orgrimmar* transitions is not dominate any more as indicated in figure 11. *The Barrens - Thunder Bluff - Feralas - Un'Ooro Crater - Thousand*

Needles – Dustwallow Marsh – Tanaris – Orgrimmar – Stranglethorn Vale – Under City – The Hinterlands are new popular zones that players move around to complete missions and tasks.



Figure 12. Zone Transitions in Level 60 to 80

In levels 60 to 80, the transitions in levels before are settling down except *Orgrimmar* as indicated in figure 12. *Shattrath City* stands out in center and mostly transition happens from and to *Shattrath City* in these levels in order to complete tasks. It's clear that the game designer deployed hub-and-spoke level design techniques. In the game world, *Shattrath City* is a major hub in Outland situated in the Northwestern portion of Terokkar Forest, the first capital available to both sides that populated by ancient heroes and naaru.

IV. CONCLUSION

In the research, we use a whole year WOW big log data to investigate whole picture of players' interaction with game world in terms of their decision making, progress, and how the overall game level design and game core mechanics are reasonably organized via visual data mining. Our analytical work leads game designer a way to improve existing games as well as to design better games with real data that can be rely on directly in the future.

There is no players' profile in data, therefore, we cannot discover how players' personal information, such as age, gender, educational background would impact the progress and behavior in WOW game.

REFERENCES

- [1] D. Williams, N. Yee, and S. E. Caplan, "Who plays, how much, and why? Debunking the stereotypical gamer profile," *J. Comput. Commun.*, vol. 13, no. 4, pp. 993–1018, 2008.
- [2] C. Lewis and N. Wardrip-fruin, "Mining Game Statistics from Web Services : A World of Warcraft Armory case study When to Begin," *Search*, pp. 100–107, 2010.
- [3] Y.-T. Lee, K.-T. Chen, Y.-M. Cheng, and C.-L. Lei, "World of warcraft avatar history dataset," *Proc. Second Annu. ACM Conf. Multimed. Syst. - MMSys '11*, p. 123, 2011.
- [4] N. Ducheneaut, "Building an MMO With Mass Appeal: A Look at Gameplay in World of Warcraft," *Games Cult.*, vol. 1, no. 4, pp. 281–317, 2006.
- [5] C. Macklin, J. Wargaski, M. Edwards, and K. Y. Li, "DATAPLAY : Mapping Game Mechanics to Traditional Data Visualization," *DiGRA*, pp. 1–7, 2009.
- [6] D. Kennerly, "Better game design through data mining," *Gamasutra*, August. 2003.
- [7] B. G. Weber and M. Mateas, "A data mining approach to strategy prediction," *CIG2009 - 2009 IEEE Symp. Comput. Intell. Games*, pp. 140–147, 2009.
- [8] M. Sužnjević, M. Matijašević, and B. Brozović, "Monitoring and Analysis of Player Behavior in World of Warcraft," pp. 618–623, 2012.
- [9] S. J. Kang, Y. Bin Kim, T. Park, and C. H. Kim, "Automatic player behavior analysis system using trajectory data in a massive multiplayer online game," *Multimed. Tools Appl.*, vol. 66, no. 3, pp. 383–404, 2013.
- [10] X. Zhuang and A. Bharambe, "Player dynamics in massively multiplayer online games," Carnegie Mellon University, 2007.