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SOCIAL NETWORK ANALYSIS OF VIRTUAL COMMUNITIES IN ONLINE GAMES

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ABSTRACT

Online games have had a noticeable increase in the market. Today, many people interact for hours in a virtual gaming world called the Massive Multiplayer Online Role-Playing Game (MMORPG). Players maintain relationships and build large communities, which are formed by diverse people who establish links in very different ways. The research analyzed the development of these communities through the application of the graph theory and the elements that pertain to social network analysis. For this matter, a study was made with the players of the Ragnarök Online, brought to Brazil in 2004, where the profile of the player, the game's workings and its communication elements were all taken into consideration.

KEYWORDS

Virtual Communities, Social Networks, MMORPG, Graphs.

1. INTRODUCTION

In 2005, the growth in electronic games development became notorious, boasting an income of US$ 32.6 billion worldwide (including console sales), and exceeding that of the movies market (Gamasutra, 2006). The success of those games lies in their unpredictability and inexact occurrences, since those depend heavily upon the people who are interacting.

In the multiplayer game style (online games where different people participate simultaneously), the Massive Multiplayer Online Role Playing Games (MMORPGs) genre arose, around 1997. Those would have servers that were capable of supporting thousands of

players, who would assume the identities of their characters and interact in that game's particular "reality".

The degree of importance that the player designates to his activity in MMORPGs can be inferred from the results of a research conducted by the Website MMORPG.COM (MMORPG.COM, 2002): 8% of the users claim to play less than 1 hour a day, while 8.7% claim to play over 16 hours daily. However, the average period of utilization of games by the majority of players is from two to eight hours a day, leading to the conclusion that there is indeed some sort of immersion in the interactive environment.

This interactivity allows the formation of virtual communities by the users, which in turn permits the establishment of significant personal ties with the passing of time. Today, according to a study made by MMORPGCHART.COM, the number of players around the world surpasses nine million (MMORPGCHART.COM, 2005).

This phenomenon establishes new fields of research for the comprehension of the behavior present in virtual communities formed by players. A theoretical-practical approach which permits the visualization of those communities' structures is the analysis of social networks. Such an approach allows, through the utilization of graph theory and relational data studies, the explanation for a given reality; i.e. the description of the kinds of relationships established in a virtual community of MMORPG players.

Based on this proposition, the paper is organized in the following way: section 2 presents the concept of virtual communities and describes how those communities behave in the game environment; following on section 3, the explanation pertaining to social network analysis theory; section 4 is a case study for the verification of the concepts and properties presented, and lastly, section 5 presents the conclusion of the investigation and future works.

2. ONLINE GAMES AND VIRTUAL COMMUNITIES

Online communities are the focus of numerous academic studies that take into consideration: chat rooms (Wellman, 1997), discussion forums (Rheingold, 1988), newsgroups, among others. Because they are virtual, those communities are formed without presential contact, since the growth of Internet access has enabled a bigger number of people to make use of this communication vehicle to interact with third parties.

In that same line of thought, since 1974 Role Playing Games (RPGs) have been in existence, characterized by the interpretation of characters and based on books that contain rules and data for presential entertainment with a group of people. However, with the technological advance, allied to computational tools made available for Internet interaction, the appearance and development of online RPGs was made possible around 1977. Those, denominated Massive Multiplayer Online Role Playing Games (MMORPGs), present infinite possibilities for adventures, complemented by various customization options for the characters. Among the characteristics of MMORPGs, one can highlight the scalability, enabling the support of hundreds or thousands of players simultaneously, who, through immersive interaction, explore the detailed worlds by interpreting their characters. MMORPGS also present infinite possibilities of adventures, which contrasts to traditional games (based on an objective and a final stage). A third element that differentiates these online game types is the concept of divulging and commercialization, which allows the formation of a great virtual community of players.

As told before, online games, especially massive online games, support a great number of players at the same time. Because many people are interacting simultaneously, many ties are built in this virtual universe. Therefore, one can conclude that electronic online games generate large communities, created inside the game itself, discussion forums or presential events, such as live RPGs, or *manga* (Japanese comic books) and anime (Japanese cartoons) meetings. In most of those games, each player depends on other players to complete tasks and missions, create guilds and other group activities.

Those online games are not more innovative than other "solo" (disconnected) games. The difference is that when online games are concerned, the factors that unite the players towards the achievement of a common goal are always the communities and characteristics of the game. Because of that, presential events are made, where participants meet each other personally, or even in-game events, in which players meet in social situations in a totally virtual environment.

The online world then becomes in a real alternative reality, with its own rules. In this virtual universe the player's success depends on his/her dedication and orientation. Most players join an online game not only to play the game and have fun with it, but to belong to a community. Inside the game, it is easier to make friendships or get company, because the player does not need to leave home to meet others or wait for an exact time (Turkle, 1995).

In an online player virtual community, the relationships between people are formed independently from their social standings, age, or other characteristics that are common to a presential relationship. This happens due to the impersonation of the character by the player behind it.

The nature of online games drives players to develop their own identities. This identity will define to whom he/she will relate to, what will be his/her position in the community and what will be his/her destiny and goal in the game's virtual world. That is emphasized by the avatar, which is the graphical representation of the player in the cyber space, as well as the choices made by the player like profession or class, depending on the game.

This character role play can or not reflect the real personality of the player, but it is believed that most people create their characters according to their own personalities. This aspect is essential to the construction of relationships in the community. The idea of a virtual community (Rheingold, 1988) inside the game works just like a community outside the game. The members of this community - in this case, the players -, need each other, and there are many types of relationships. In this community, the members act not only in the game, but also in each of their individual lives, becoming important in the player's social circle.

Following this line of thought, playing becomes a social practice. Then, it is almost natural, a routine, to log into the game to maintain the community, and most importantly, to belong to it (Rheingold, 1988). Many times the community is even more important than the game, as pointed by the survey realized by the Website MMORPG.COM (MMORPG.COM, 2002), informing that most players think that the community and the possibility to role play are the most important aspects of a game – and not the game itself.

Another practice that those games incentive are competitive cooperation processes (Lévy, 2000). Each player competes against all other players, because they want to be the best or higher level player,or because of any other reason. Often, completing missions and adventures or defeating enemies is not possible or very difficult to be done alone. That way, players must form strategic groups (since usually each profession or class complements the others) to conclude those tasks. Therefore, to become a better player (and thus compete more), this

player must cooperate with other players. This is also a collective intelligence process (Lévy, 2000), because each player contributes with his/her best feature to the group.

As for the communication between players, there are many types of tools that may vary depending on the game. They might be synchronous (real time), asynchronous (only the user that sends the message needs to be connected) and hybrid (allows synchronous and asynchronous communication).

Most online games, especially MMORPGs, have real time chat rooms (synchronous system) for people sharing the same location (in the game world). Many times it also allows private messages and private chat rooms, and sometimes, asynchronous messaging system (such as the e-mail system from the games Everquest II and Star Wars Galaxies). There are also messages called broadcast or system messages, which are sent by the game administrators and are received by all players in the game, or all players in a determined area.

The communicational tool most used outside the game is the forum. Often, an official forum is made available , where players can discuss servers, clans, item selling, show game pictures, events, classes, etc. There are often topics not related to the game where players can discuss other subjects, which is important to strengthen their ties.

The study of those tools offered complementary information for the construction of the taxonomy of ties that can be established between MMORPG players from a given social network.

3. SOCIAL NETWORK ANALYSIS APPLIED TO ONLINE GAMES

Any community can be studied by social network analysis. The analysis of those networks intends to find patterns and key elements, and even behavior models in the studied community. For that reason, social networks analysis constitutes an interdisciplinary area used to study phenomena in the real world, such as the behavior of groups of people and communities, the different ways of interaction between civilizations, and other elements (Wellman, 1996, 1997; Molina, 2001).

A social network consists of elements or actors – which can be people, communities, groups, organizations, etc. Between two actors a relationship can be established, and called a tie (Wasserman & Faust, 1994). Those relationships can be affective, of kinship, affiliation, or any other sort of bond. The theory of social networks is based on graph theory. Consequently, it can be visualized graphically by a graph, where its vertices are the actors and the edges represent the ties.

According to graph theory, the edges can be directed or not, depending on the ties shared by the actors being reciprocal or not. Since not every relationship between the actors is reciprocal, directed graphs are used more often to represent social networks. There are two types of social networks, egocentric and sociocentric.

The sociocentric networks are the ones that study the relationships between all the actors in the network (Figure 1). If they are complete sociocentric networks, they contain all the relationships from all actors in the network; hence they are more difficult to be collected. However, those networks have a larger quantity of information and allow a more detailed analysis. It must be noticed that not every network is always totally connected. Sometimes

there may be elements or subnetworks that are disconnected, dividing the networks into groups (Hanneman, 2001).

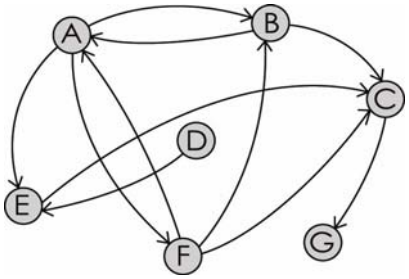

Figure 1. Directed Sociocentric Network

There is a very popular gathering method for sociocentric networks, which is the snowball method. In this method, the researcher interrogates a set of actors to collect their relationships, and each one of those actors submits a number of their own relationships. The process is then repeated until the objective is met. The inconvenience of the snowball method is that it tends to collect only the most popular actors on the network, allowing the exclusion of the most isolated or less connected elements, since it depends on indications. On the other hand, it can be a fast gathering method if the survey is initiated from the most popular elements in the network.

The egocentric networks study the relationships between actors starting from only one actor in the network. The egocentric networks can be classified in: pure and interconnected. In the pure egocentric networks, only the relationships between the main actors and the others are taken into consideration. In the interconnected egocentric network, apart from the relationships between the main actor and the secondary ones, the relationships between secondary actors are also considered.

It is easier to collect egocentric networks, since they only need information from one element. Nevertheless, in contrast to complete networks, they present a weak point: not having enough details available for the analysis of the properties of the network. This happens because they are focused on the individual and not the network as a whole. Even so, some properties relating to the subnetworks can be estimated with egocentric interconnected networks.

However, if the two types are combined it is possible to obtain a broader panorama of a specific community. In the same manner, the theoretical basis of graphs allows the calculation of some elements and significant properties for the social network analysis.

One of those is the degree of a vertex, defined by the numbers of edges that arrive in the vertex. From this concept, in a directed graph, two degrees can be defined: the *indegree* and the *outdegree*. The calculation of a degree from a vertex makes it possible to investigate the behavior of an actor. The average degree of a graph is calculated by the sum of all the in or out degrees divided by the number of vertices. It can be useful to categorize the actors. For instance, if the outdegree of an actor is above the average, one can conclude that the actor is *communicative* in the community. And if its indegree is above the average, one can establish that the actor is *popular*. In many networks, it is usual to categorize actors by their degrees.

For a more specific examination, the variance of in and outdegrees of a vertex can also be estimated. This calculation is relevant as it can help establish if an actor is more “chosen” than another. Complementary, one can also calculate the density of the graph (Diestel, 2000). The

density is obtained through the proportion of arcs in relation to its universal set. The result is the percentage of edges existing in the network in relation to the arcs that could exist. To calculate density, it is necessary to calculate the number of edges of the complete graph (graph with all the possible edges), that is, the maximum possible number of relationships in the network.

The way actors are placed in the network can also be studied to analyze that actor's behavior and social characteristics. To exemplify that, as previously explained, the more bonds an actor has, the more popular he can be. But it is still possible to conclude that this actor can have more influence upon the network, and also be more influenced by the others. In addition to that, it is possible to affirm that the more networks are connected, the better they are for distributing information, news, resources or even diseases.

Another property that can be analyzed is the distance between actors. This corresponds to the number of individuals (actors) connected existing between two elements. This is also a relevant factor to be considered when dissemination of information in a network is concerned. People that are less connected to the network may face difficulties receiving information.

Some important graph theory concepts can be relevant to determine which algorithm can be used for the analysis. The first one is the *walk*, which is a sequence of vertices. If there are no repeated vertices, it is called a *path*. In the same fashion, if no edges are repeated, they are called a *trail*. However, one of the most used notions in graph theory for the distance between actors is the geodesic path. This path is the shortest path between two elements, but it may not be the only one available. The longest geodesic path existent in a network is called the *diameter*, and it can tell how compact that network is (Diestel, 2000).

Next, the cutting edges and cutting vertices are the ones that, if removed, will disconnect the graph. This study can tell who are the essential actors and ties for the network. In social networks, those relationships and elements are called key-ties and key-actors.

Another part of the analysis is the structural analysis of the network, which studies more precisely the roles and positions of the actors in the network and also its relationship models and patterns. The depth applied to graph theory allows more specific approaches for the analysis of data. Therefore, it is possible to study several properties and characteristics of a social network. Nevertheless, each social network analysis must be specific for the population concerned, where the area of research in question should take more depth.

The table below shows the formulae and nomenclature used throughout this article.

Table 1. Social Network Properties and Formulae

Property Name	Notation	Formula
Number of edges	A	$\sum_{i=1}^{n} A_i$
Number of vertices	n	$\sum_{i=1}^{n} v_i$
Indegree of vertice v_i *(A^n = number of incoming edges*)	$g_e(v_i)$	$\sum_{i=1}^{n} A_i^e(v)$

Outdegree of vertice v_i (A^o = *number of outgoing edges*)	$g_o(v_i)$	$\sum_{i=1}^{n} A_i^o(v)$
Average in/outdegree (*indegree* = *outdegree*)	$\bar{g}_e = \bar{g}_o$	$\frac{A}{n}$
Indegree variance	S_{g_e}	$S_{g_e} = \frac{\sum_{i=1}^{n}(g_e(v_i) - \bar{g}_e)^2}{n}$
Outdegree variance	S_{g_o}	$S_{g_o} = \frac{\sum_{i=1}^{n}(g_o(v_i) - \bar{g}_o)^2}{n}$
Density	Δ	$\frac{A}{n(n-1)}$

The network analysis can gain more depth through the use of graph theory. However, it is up to the researcher to determine the necessary approach to the study. Graph theory supplies the mathematical basis for the determination of patterns and visualization of the networks. Nevertheless, each social network analysis must be specific for the population in the study, where the area of analysis pertaining to the research should take more depth.

4. A CASE STUDY OF MMORPG SOCIAL NETWORK ANALYSIS

Following this line of thought, a case study of a social network analysis of an MMORPG community is presented. This study is based on a previous research developed by Rodrigues and Mustaro (2006). As explained in the preceding section, the study of social networks analyzes communities and relationships between people, gathering its data from the structures formed by graphs. This allows, with basis on the theoretical structure and mathematical precision, the comprehension of social phenomena.

With Internet progress as a tool of communication, models of social networks were developed for the study of online communities. The universe chosen for the research involved the Ragnarök players from the Brazilian Chaos server.

Ragnarök (Figure 2) is a MMORPG created by Gravity and distributed in Brazil by Level Up! Games. The game is based in a Korean *manga* (oriental cartoon), and its history is established on Norse mythology. In Brazil, the game has three servers and the game expansions are called episodes, released sporadically. Like other MMORPGs, it is necessary to create a character and develop its personality and profession in the game.

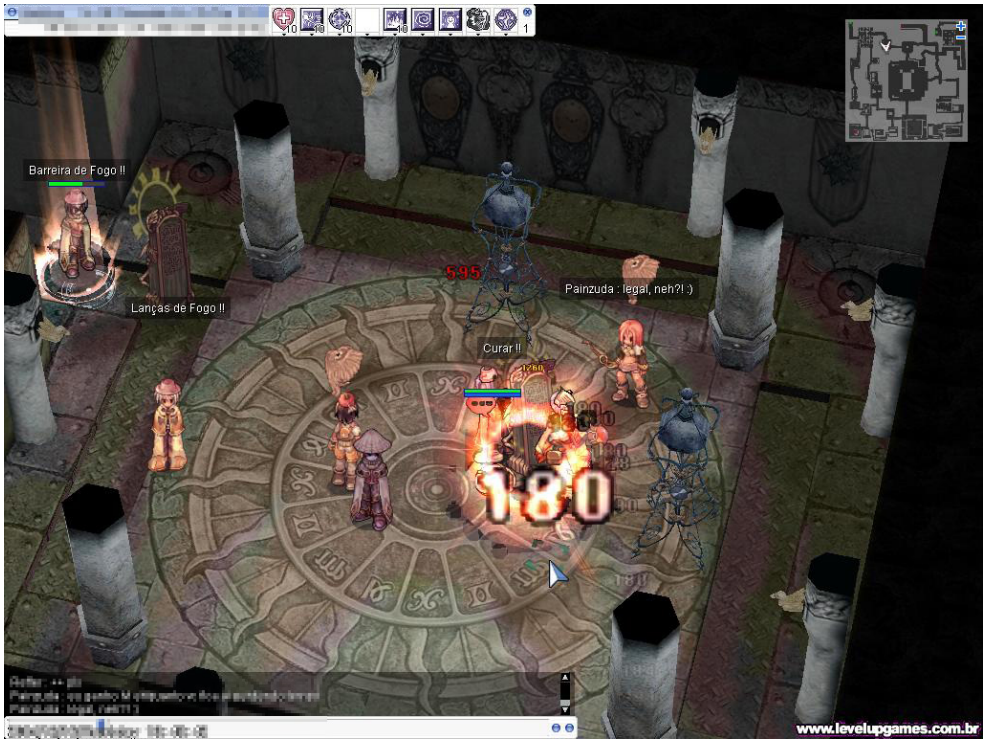

Figure 2. Ragnarök's Game Environment
Source: http://www.levelupgames.com.br

When a new character is created, the player can choose the name, hair style and color of the avatar (graphical customization of the character). Everyone starts with the same clothing - that changes according to the profession -, which is an identification element. The player can also choose the basic attributes of the character, such as strength, agility, vitality, intelligence, dexterity and luck, which will provide further influences on the development of that character's profession.

In the same fashion, the player starts out in Ragnarök as an Apprentice, which corresponds to level 1. Each level attained allows the player to pick new abilities. Aside from experience, the player may find items (weapons, armor, accessories, food and other rare items), to complement his/her character. When players reach level 10 they may choose their first profession (Acolyte, Archer, Magician, Merchant, Swordsman, or Thief). The profession determines, besides looks and items, the abilities available and the course of the player throughout the MMORPG. At level 40, it is possible to evolve to a second class of your chosen profession, which gives the player new abilities to choose from.

In Ragnarök, like in other MMORPGs, the players can challenge their friends in Player versus Player mode (PVP). PVP is a combat mode in which players fight among themselves and not against the computer. The objective of this mode is to best other players. There are several modes of PVP, such as level-limited rooms, duels, and team combats.

Ragnarök also presents events both internal and external to the game. Internal events occur in the MMORPG universe and may be exemplified by "novice picnics" – where GMs (Game

Masters – Level Up! Games' specialist employees who monitor the servers 24 hours a day) – help and orient the newcomers –, hunts, special missions and assignments, city raids, thematic events (such as Christmas, New Year, Woman's Day, etc.), PVP championships, marriages, parties and contests. Complementary, presential events, like the monthly Ragna Parties (events hosted at LAN Houses with activities, championships, gifts, etc.), game fairs, etc., have as their main objectives the ampliation of the MMORPG universe and the transcendence of computational virtuality.

Firstly, with the goal of gathering a database of players to be studied, an online research system was developed. The gathering of data was based on the elaboration and application of structured questionnaires to obtain information about the players' profiles. The online survey contained six modules, one related to the player's personal information, another related to the character's information, the third and fourth had questions about the player's preferences and the fifth was the most important for the social network construction. This part asked the interviewed, first, who they knew that had reached *level 99* (highest level) in the game and then, the player had to indicate 10 friends and categorize the relationship they shared. Finally, the last stage consisted of an open question, where the subject could express himself freely and permits to the player expose other elements that he/she considers relevant for the research scenario.

Through the observation and study of some online games (such as Ultima Online, Everquest 2, Star Wars Galaxies, etc.) four kinds of bonds were detected. The first one, the *Experience Level Tie*, is determined by the proximity of experience level among players who pursue success in a particular adventure. Since it is based on experience, it presents no social, racial, or age restrictions of any kind.

The second one, *Character Traits Tie*, is related to the choices (class or profession, race, visual characteristics belonging to the avatar, guild and/or psychological inclination of the character in the game universe) which can determine a sub-community for the player. Incidentally, there are adventures where professions or classes establish relationships of dependency due to the traits of characters or groups.

The third one, *Spatial Location* of the character in the game, is based on the fact that many times players frequent certain areas in the MMORPG – sometimes because it is the starting point – sometimes by necessity (relating to the conclusion of adventures/missions, or the improvement of character abilities, commerce areas, etc. Players that frequent the same areas tend to create ties because of the virtual proximity, or common necessities in the area.

Finally, the fourth, *Presential Tie*, is restrictive, since it depends on physical, cultural or social proximity (friends, relatives, neighbors, acquaintances, etc.).

This questionnaire was hosted in an Apache Tomcat 5.5 server, which makes use of Java Servlets (Figure 3) for the storing of the database. The database used was MySQL Server 5.0. All the tools utilized were free. This system was chosen due to its portability, security and mainly for its straightforwardness in data manipulation. A checking system was also elaborated to determine how many users took part in the research on a single day. This same system enabled the personalized e-mailing to each of the friends referred by the subject.

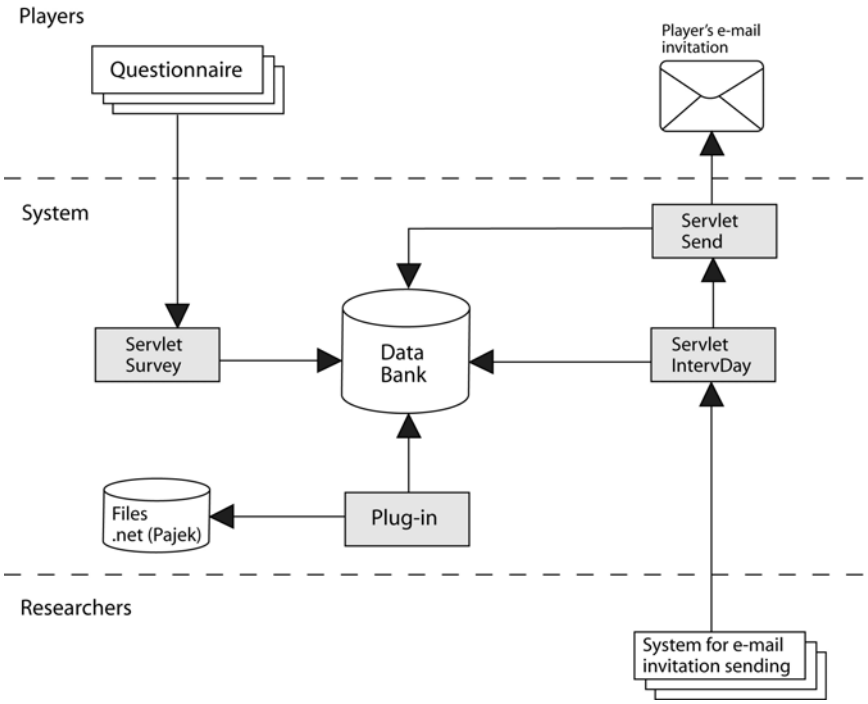

Figure 3. Representative Diagram of the system

The research collected, in a 30 day period (from the beginning of 2006), data from a 63 people. When the data gathering was complete, a plug-in was developed so that this data could be exported to the chosen manipulation software, integrating the system for the study of social networks. This software is the Pajek visualization and analysis program for social networks, used to graphically represent the networks obtained during the case study. This is a free program, which was developed for the study of complex networks and allows the advanced visualization of graphs formed by the interactions (rotation, vertex movements, 3D VRML exporting, etc.) between the participants of particular communities, which, in this work's particular case, are constituted by guilds (Huisman & Marijtie, 2004).

The chosen algorithm for the visualization of networks on Pajek was Fruchterman Reingold's. This algorithm was developed by Thomas Fruchterman and Edward Reingold in 1991. The method has as its main objectives: to distribute the vertices equally along the available space, minimize the overlapping of edges, make the size of edges uniform and to provide symmetry to the graph (Fruchterman & Reingold 1991). To achieve that, the algorithm simulates a particle system where the vertices represent points of mass that repel each other mutually, while the edges behave like coils with attraction forces. Another unique point of that method, which was considered before adopting it in this work, is the possibility of visualization in two and three dimensions (Everton, 2004).

The research in question used a combination of networks. There is an egocentric network for each network of friends, starting from the friends pointed by each user, and from that point, a combination was made with the other ego-networks, forming a complete network. Next, during the data analysis phase, it was necessary to establish who the actors were and

what ties they shared. For this approach to be applied, the kinds of relationships that would be analyzed had to be established.

The demographic results indicated that Ragnarök is played predominantly by young (ten to twenty years old – 84%) people, with student being the principal occupation (87%). The majority of players' characters are from higher levels (who are more likely to build networks), belonging to second class and clans (79%). Most interviewees spend more than 25 hours a week playing, what emphasized the significance of the game in this person's life. The answers also showed that the presential interaction is not meaningful, because most players interact only from home and do not go to presential events. Nevertheless, human interaction is essential, justifying the popularity of the PVP mode. In addition, the importance of the community and the relationships in the MMORPG was confirmed, because its main feature is the possibility of playing with friends (58%). Also, 75% of the interviewees prefer mostly synchronous tools over asynchronous ones, and the majority condemns the lack of communicational tools available inside the game.

One of the networks constructed in the research is the players' friendships network. In this network, three main subnetworks were found, two of them being related to popular clans identified in the data gathering. It was also observed that the subnetworks represent higher connectivity, what elevates, as expected, the average indegree.

Now, a single subnetwork will be analyzed from this friendships network as an example. This network was visualized by the software Pajek (Figure 4) and exported from the databank by a personalized plug-in. With the intention of making the visualization and understanding better, edges of different colors were used for the construction of the networks (Table 2). Besides that, a second categorization was adopted: blue vertices represent the actors interviewed and red vertices the actors that were indicated in the survey.

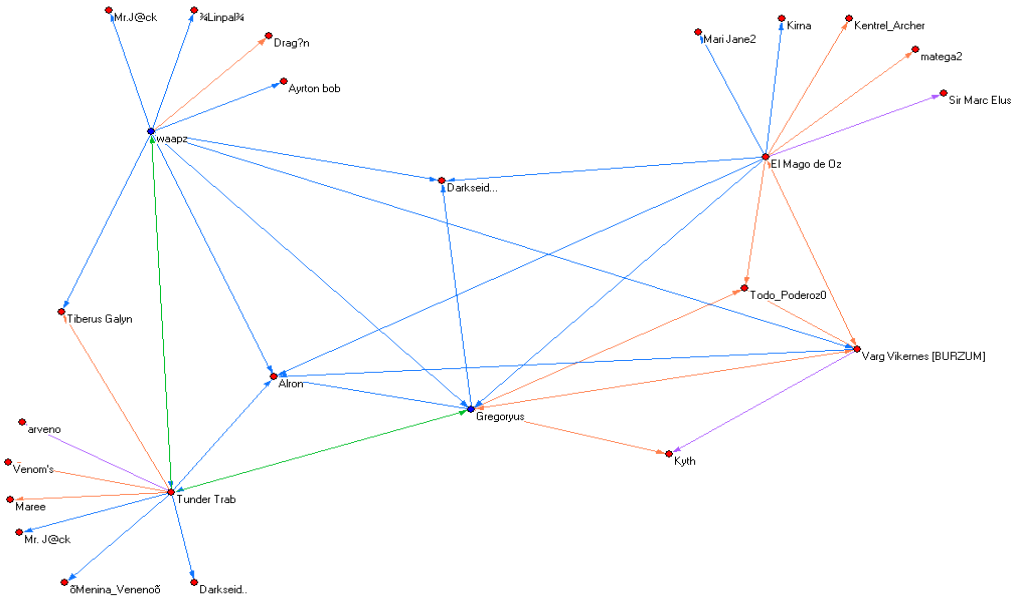

Figure 4. Subnetwork of Players' friendships

Table 2. Edge color names with respective ties

Tie	Color	Color Name
1 - Experience Level Tie		*Orchid*
2 - Character Traits Tie		*NavyBlue*
3 - Spatial Location Tie		*PineGreen*
4 - Presential Ties		*Peach*

The subnetwork shown above is related to the most popular clan indicated in the survey (most players in this subnetwork belong to this clan). That fact highlights the predominant type of tie found in the subnetwork, Character Traits Tie. For this subnetwork, the following properties can be calculated:

Table 3. Properties values of the Subnetwork's

Element		Value
Actors	=	23
Ties	=	41
Average Degree	≅	1,7826086957
Indegree Variance	≅	1,3875236295
Outdegree Variance	≅	12,5179584121
Density	≅	0,0810276679

This subnetwork is more connected than the main network. This can be verified by the average degree, that is higher than the average degree of the main network (0,9354838709). This subnetwork also has nine actors that may be considered popular, because their indegrees are above average. The most popular actor, with an indegree of five, can also be found in this subnetwork, *Alron*. There are not any key-actors or key-ties in this subnetwork.

If the variance is taken into consideration, one can observe that the indegree variance is higher than the outdegree variance. It indicates that the vertices tend to receive edges rather than giving edges. In this case, it shows that there are more indicated actors than interviewed in the research.

The density in this subnetwork is low, as expected, because some actors are just indicated, and thus do not contribute with any edges, just receive them. Consequently, it shortens the possibilities of ties in the network.

This subnetwork presents a predominant relationship of the type 2 (22 ties), what suggests that many relationships may be built inside the clan. In addition, many ties of type 4 (14 ties) were found what indicates a network of presential friends. Considering the database profile, one can see the three actors who pointed most of those ties live in the same city.

5. CONCLUSIONS AND FURTHER WORKS

Online games, moved by the technological advance, are making a revolution in communication and virtual community formation. One can conclude that online games nowadays have a significant value for many people and influence the culture and society.

With the study case it was possible to map an example model that produced many characteristics based on calculations towards an online survey. This is a simple representation of a greater use of the social network analysis.

The construction of those virtual communities can be studied by pertinent concepts applied to the social networks analysis, which allows the identification of relational patterns and actors' profiles. This sort of mapping permits a better comprehension of network behaviors towards the directing of marketing campaigns, development of communicational tools and even new MMORPGs. It is also possible to use social network analysis as a way of studying people's behaviors, because the player incorporates to his avatar's personality his own characteristics, representing them on the online world.

With the technological evolution, the virtual communities tend to grow even more and reach even more people. As a result, people are breaking geographical barriers to build their relationships, and in the same way, huge communities around the world.

As a future work, study of the evolution of a specific community of players is proposed, starting from more specific questionnaires and by following that community for a period of time. This would allow the mapping of the constantly changing characteristics of the community. Another pertinent study relates to the development of algorithms for the building of a simulation system for scenarios that would combine variables to form a better way of connecting the actors. This algorithm could be used to increment marketing strategies directed towards the player communities. Lastly, a deeper study about communicational tools available in the game is suggested for possible improvements and perfectioning.

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