International Journal of Multimedia and Ubiquitous Engineering
Vol.11, No.3 (2016), pp.257-272
http://dx.doi.org/10.14257/ijmue.2016.11.3.25

Social Networks in "The Mana World" - an Analysis of Social Ties in an Open Source MMORPG

Markus Schatten[1] and Bogdan Okreša Đurić[2]

Artificial Intelligence Laboratory
Faculty of Organization and Informatics
University of Zagreb
Pavlinska 2, 42000 Varaždin, Croatia
[1]markus.schatten@foi.hr, [2]dokresa@foi.hr

Abstract

A social network analysis is conducted in an instance in the Mana World, an open source massively on-line role playing game (MMORPG), during a controlled experiment in which data from 181 player characters was gathered during a period of 2 months. The presented results are part of the first phase of the Model MMORPG (Large-Scale Multi-Agent Modeling of Massively On-Line Role-Playing Games) project in which players played a specially designed quest to find patterns of organizational behaviour between players. Results give an insight into the various networks that formed during the experiment based on numerous criteria including in game friendships, parties, and various types of communication.

Keywords*: MMORPG, social network analysis, visualization*

1. Introduction

In this study we continue our research on the ModelMMORPG (Large-Scale Multi-Agent Modeling of Massively On-Line Role-Playing Games) project1 which employs a combined theoretical and empirical approach to study MMORPGs. Our objective is to find organizational patterns in gaming behaviour of both human and artificial agents (players, bots, mobs, non-playing characters – NPCs *etc.*). From the theoretical side, a multitude of organizational patterns from organization theory literature is tested in MMORPG settings, and compared with patterns found in empirical research. From the empirical side, the project studies human organizational gaming behavior on a number of venues across various gaming servers in order to find most suitable organizational forms employed by most successful player communities. ModelMMORPG is aimed towards understanding the underlying principles of self-organizing and adaptable networks of large-scale multi-agent systems (LSMAS) as well as enriching the organizational design methods for the development of MMORPGs.

When following Wikipedia a massively multi-player on-line game (MMOG) is a (computer/video) game that supports a great number of players playing simultaneously on-line causing (often even fostering) interaction among them. Role-playing games (RPGs) are a video game genre in which the player controls the actions of a protagonist or potentially several party members in a well defined world setting. MMORPGs are thus a combination of these two game types allowing players to control the actions of their protagonist (or avatar) by mutually interacting with a potentially large user community on-line.

[1] See http://ai.foi.hr/modelmmorpg for details.

ISSN: 1975-0080 IJMUE

There are a number of different subgenres in MMORPGs, nevertheless a usual setting includes a protagonist which is placed into a world where he has to interact with NPCs (Non-Playing Characters) and mobs (enemies, monsters) which have to be beaten or give him tasks (quests) that it has to solve to be able to buy better equipment, learn new skills like magic and similar, or proceed to higher player levels. We have chosen The Mana World (TMW)2 MMORPG to conduct our research i ModelMMORPG. The reasons for selection were: (a) it is open source (GPL licensed) allowing us to modify code and add additional functionality, (b) it has a supportive community, (c) it supports a number of interaction techniques which can be studied (*e.g.* trade among players, IRC based chat, organizing teams called parties, social network functions *e.g.* friends, enemies, parties *etc.*), (d) it is a (more or less) finished game featuring lots of quests that can be analyzed [8].

To be able to study the organizational behaviour of players, we have designed a special quest in which players ought to organize their activities in order to solve it. The quest3 has been designed during a 3-day brainstorming session and later on developed by project members [4, 8]. Afterwards, during a data collection phase players (mostly students from three different countries) have played the game during a period of one month. All participating players have been informed about the data gathering process, and due to potential privacy issues, all the collected data has been rendered anonymous [3]. After data collection, the data was analyzed using social network analysis (SNA) techniques in order to find patterns of organizational behavior among successful players. Some of these results are presented herein.

The rest of this paper is organized as follows: firstly in Section 2 we give an overview of relevant literature. Then in Section 3 and 4 we provide a social network analysis of the various social networks that have formed during the data collextion phase, firstly analyzing relation based social networks and afterwards communication based social networks. In Section 5 we discuss our findings and in Section 6 we draw conclusions and give an outline of future research.

2. Social Networks in MMORPGs

MMORPGs provide us with a great opportunity to study human social behaviour due to their numerous users, large market share and various opportunities for individual, group and global activities [8]. Not only do they provide a data source of unprecedented quantity, they are also a source with enhanced ease of access to collected data similarly to other social applications, which is a crucial point in modern social sciences [10]. Whilst social sciences research demanded several weeks of working time only to gather data relevant for a research in the past, by using methods that might introduce biases; the data gathering using automated methods on virtual societies, such as MMORPGs or social media, provide fast delivery of relevant data with subjects behaving as when they are not watched [6-7].

MMORPGs are a source of data unimaginable in the past – gathered comprehensive data can include all the data on every single action each of the participating players ever takes, with much less effort. MMORPGs represent a tool for gaining insight into collective human phenomena and large-scale social dynamics [1-2]. Instead of being exclusively socially oriented, MMORPGs can be used as sources of economic data as well, offering a natural environment that supports conducting of behavioural economics experiments [10]. Similarly, in ModelMMORPG we try to study organizational behaviour which is closely related to economic thinking.

---

[2] See http://themanaworld.org for details.

[3] See http://dragon.foi.hr for details.

MMORPGs provide not one, but various types of social structure and interaction. Interaction types were discussed by Son *et al.* in [9], based on six distinct interactivity networks (shop, mail, trade, party, whisper, friend). The Mana World provides us with many networks that can be studies. As for once, each character can form six different social networks by using in game labels/relations including:

- Be Friend,
- Disregard,
- Ignore,
- Blacklist,
- Set as Enemy,
- Erase.

Such networks form directional graphs since they do not have to be mutual. Besides such networks, players can organize into parties to pool resources and be able to solve harder quests together. These parties form strongly and weakly connected components in the underlying social network, and are an additional relational network that can be analyzed.

Another network of interest is the trade network, in which players can trade various items and money. Additionally, players can communicate using a number of chat types including whispering to each other, party chats, trade chats or general chats. Each of these chats constitute a social activity network that can be analyzed.

There are of course other networks which might be of interest, including temporal location based networks (*e.g.* two players are connected if they are at the same place at the same time – examples of such networks include mutual fights, fights against a common enemy, soving quests together *etc.*).

Herein we will constrain our analysis on relation based social networks (especially friendship networks and party membership networks) as well as communication based networks (especially whispering, party and trade chats).

3. Relation based Social Networks

In the following we will present an analysis of the data collected during a 1 month period on the developed ModelMMORPG test-bed. During this period a virtual community of 181 players has emerged and herein we have chosen to analyze the social networks that have emerged between them while playing the so called quest for the dragon egg which we have developed. The quest for the dragon egg was specially designed to foster organizational behaviour: in order for a party of players to hatch a dragon egg to get access to a dragon companion during battles, the have to find a dragon nest which occurs randomly on a number of locations during a defined period. Thus, parties have to organize into teams with tasks to find on which location the egg has been layed. When they find the nest, they have to battle dragons, which are quite strong opponents and cannot be easily slayed alone. The egg cannot be transported by only one player, but three players have to be in line-of-sight so the egg doesn’t brake. The egg to be hatched a special hatching potion has to be prepared needing various ingredients. Additionally, to make things harder, there is a time limit in which the hatching has to be completed since the egg goes bad after a while, and there are of course competing player parties with the same objective.

The data analysis is mostly performed using Pajek4 and R5. Data analysis performed after the testing period was over, generated a network of characters which had developed various relations. 96% of these character relations were friendly, leading us to conclude that users used character relations as a mechanism

[4] http://mrvar.fdv.uni-lj.si/pajek/
[5] https://www.r-project.org/

for keeping in contact with their in-game friends and monitoring their on-line presence. A visualization of this network is shown in Figure 1.

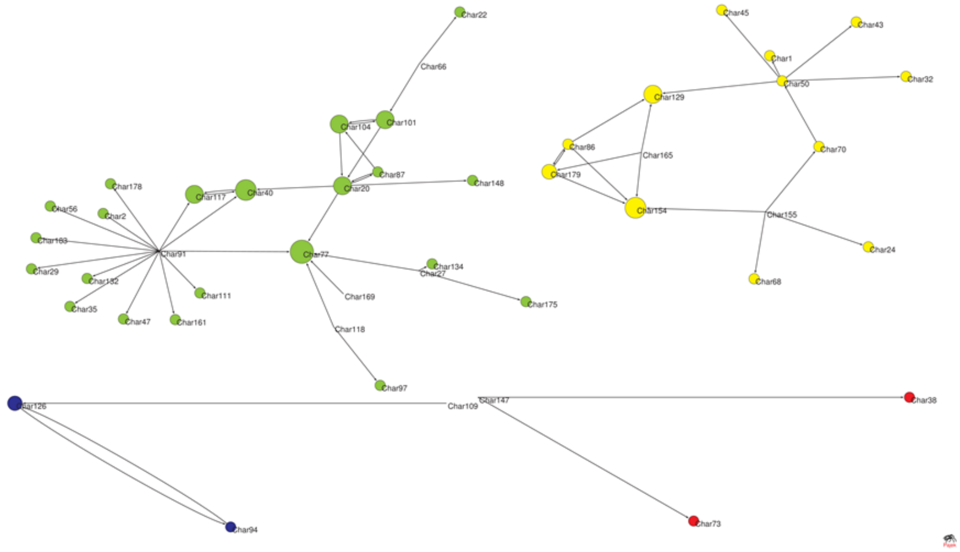

Figure 1. Network Visualization of Character Relations with Coloured Components and Nodes Sized According to their in-Degrees

The network visualized in Figure 1 shows only characters who were engaged in some kind of relation with another in-game character. Four weak components are clearly recognizable, and are shown using differently coloured nodes. The size of a node depends on the in-degree of the node. Some characters have no other characters which would initiate a relation with them, therefore they have in-degree equal to zero, and are presented by only a label without a circle. In-degree is chosen to be represented here because of its meaning in forming relations – a character can tie to another character, but this tie does not have to be returned. Therefore, it is interesting to observe how often characters received affection and friendly relations, even if they did not give anything in return. Moreover, as mentioned earlier, the in-degree of a node in this case can be observed as a number of other characters who find it useful to monitor whereabouts of the related character, *e.g.* when they are online and where (in-game) they are positioned. Nodes are labeled using their in-degree () and a random number.

Four strong components consisting of at least two nodes are identifiable. These strong components of two or more nodes are shown in Figure 2 below. Node size here depends on the sum of in- and out-degrees of each node.

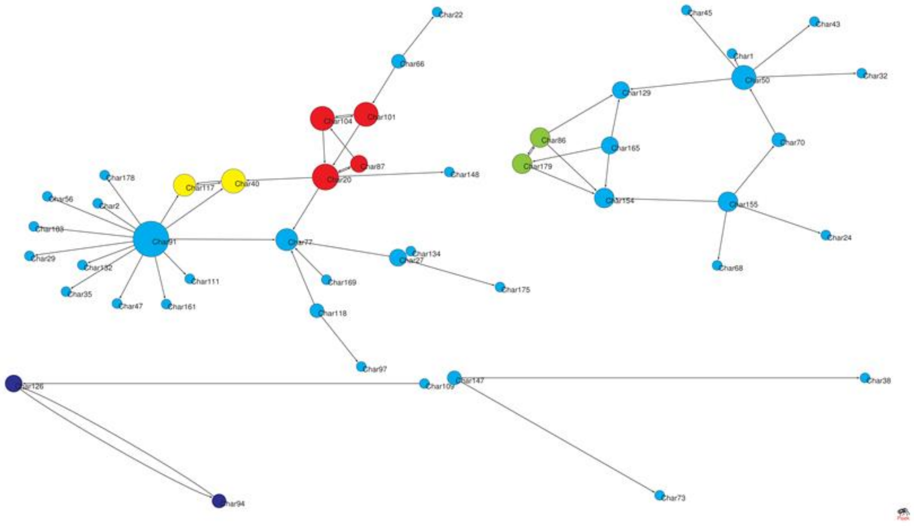

Figure 2. Network Visualization of Character Relations with Coloured Strong Components

The average closeness centrality in the network is 0,1562 which indicated a relatively weakly connected network with low information spread.

In order to succeed in the game, players must engage in cooperation with other players. The most obvious result of such behaviour is the creation of parties, *i.e*. groups of player characters. Such groups allow for easier cooperation and teamwork including group chat, experience sharing, *etc.*

Several parties were formed during the testing period. Since the game mechanics designed for this project demanded cooperation implemented using parties of at least three members, only such parties were of interest to our analysis. All parties are shown in Figure 3, with parties containing £2 members coloured light blue, and parties of interest (nodes numbered 49, 48, 75, 14, 43, and 62) coloured distinctively. Node sizes are related to out-degrees of particular nodes, therefore party-node size is defined by number of party members.

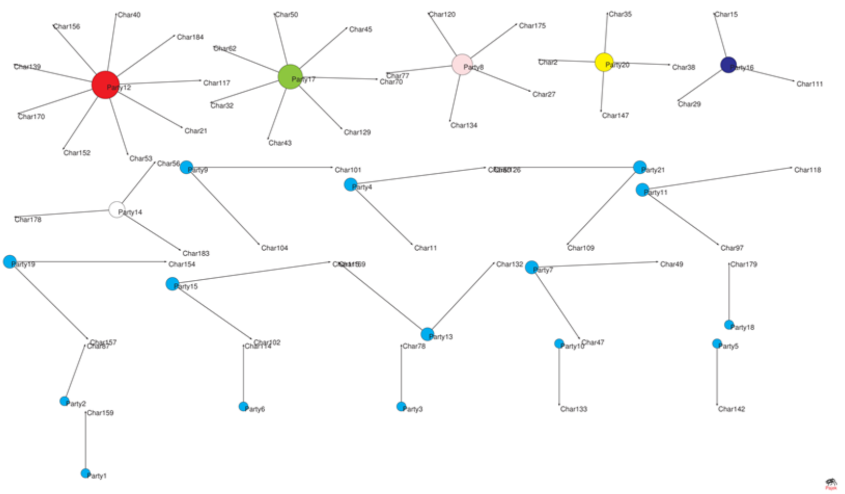

Figure 3. Character Parties with their Members; Parties of Interest (Nodes Numbered 49, 48, 75, 14, 43, and 62) is Coloured Distinctively: White, Dark Blue, Pink, Yellow, Green, and Red, Respectively

Adding character social relations to the network of party members allows for analysis of social relations between party and non-party members. Naturally, some grouping occurs. Arcs representing social relations have 1< weight< 6 with weight of 1 for friendly relation, and arcs representing party membership have weight 7. Pajek detected 14 islands by line weight with three to ten members each, as visible in Figure 4. Party membership is shown using purple arrows and social relations are shown using red arrows.

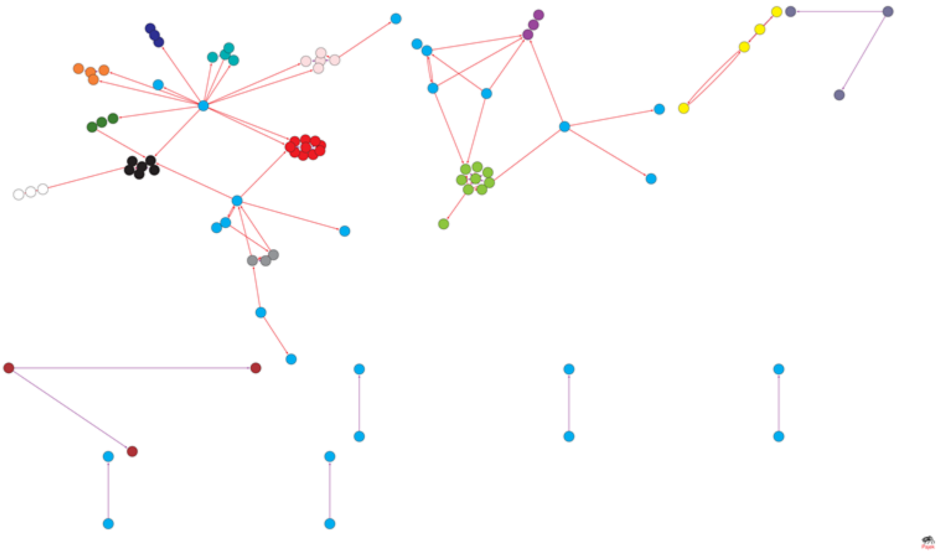

Figure 4. Character Social Relations (Red) and Party Membership (Purple) Formed Islands of Characters, which are Grouped Mostly According to their Party Allegiance

Communities formed by Louvian clustering method using default parameter values are depicted in Figure 5.

Figure 5. Clustering Using Louvian Community Clustering Method with Default Parameter Values Gives 19 Clusters

4. Communication based Social Networks

Time references mentioned further are based on minutes elapsed from the time testing period started, I.D. a short time before the first relevant record was saved (2015-6-1 13:00).

Whispering is an action of sending a textual message from one player to another. Whispering is private, *i.e*. only sender and receiver can see the message which was sent. The analysis of whisper data shows which players communicate the most. The following data are results of the gathered whisper data being analyzed in the whole, at the end of data gathering period.

Using Louvian clustering method, with default parameter values, seven communities were detected. These communities are shown in Figure 6.

Figure 6. Clustering Using Louvian Community Clustering Method with Default Parameter Values Shows 7 Communities that were formed

Many characters are strongly connected since they exchanged a lot of messages. Computed betweenness centrality detects three top nodes: Char77 (0,5687), Char175 (0,3230), Player (0,2281). Their somewhat high centrality signifies that they stand in information flow between many characters, yet obviously more flows exist, since their betweenness is not significantly high.

Using R with network and ndtv libraries, a heatmap was generated depicting whispering intensity of each pair of players, as shown in Figure 7. It is observable that characters with high betweenness centrality have a lot of tracked traffic.

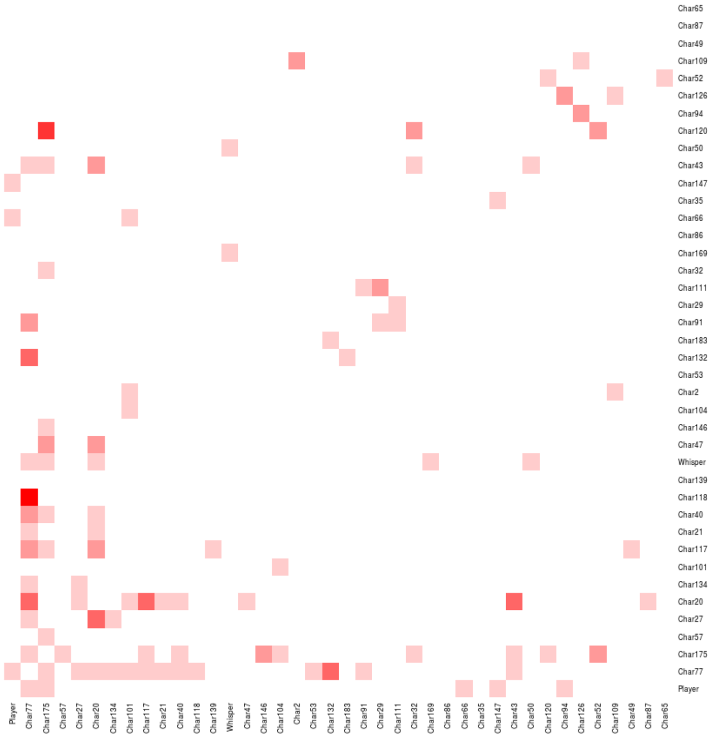

Figure 7. Heatmap Showing Whispering Intensity for Every Pair of Players

Figure 8 shows all exchanged whisper messages between users and gives an insight into the main information nodes of the formed community.

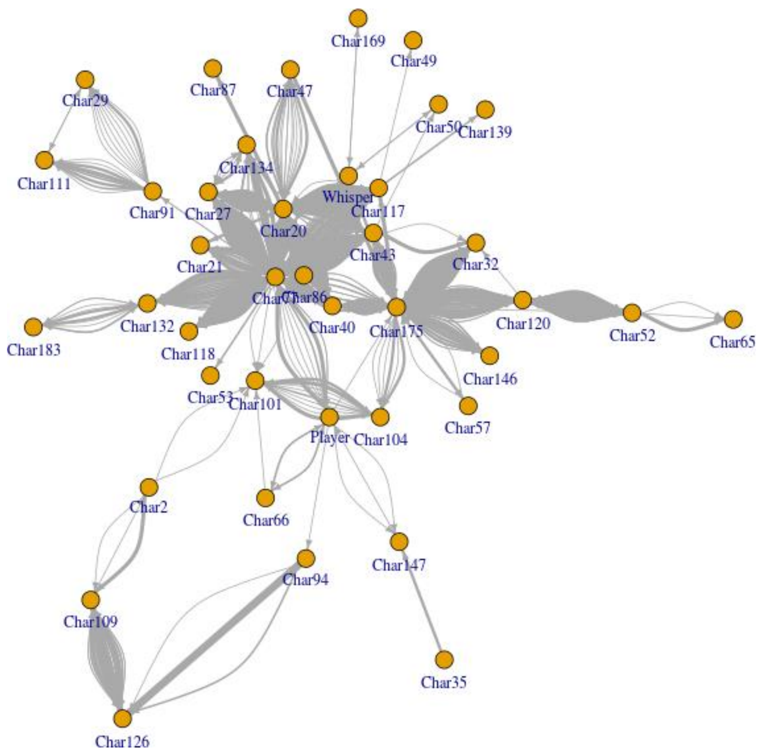

Figure 8. All Whisper Messages Exchanged between Users during the Testing Period may Indicate that Several Users were Main Sources of Information

Combining data about party membership, social relations and whispering activity provides one with additional information on who the players communicated with, regarding their party membership. Network was generated using the Union of Lines command in Pajek, combining network of social relations and party membership, and network of whispering activity. Nodes in Figure 9 are coloured according to Strong P-Cliques partition with proportion of linkage with members of group equal to 0,9. Arcs representing party membership, social relations and whispering activity are coloured purple, red and black respectively.

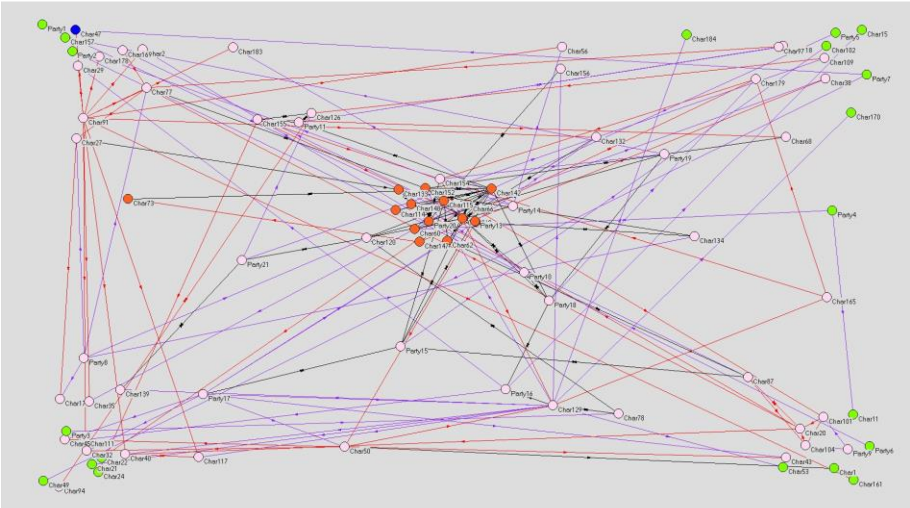

Figure 9. Strong P-Cliques Partition with Proportion of Linkage with Members of Group Equal to 0,9

Even a simple analysis yields interesting information. Graphing collected data using R, some insightful graphs were constructed, as shown below.

In Figure 10, where number of messages per character is shown, it is immediately visible that most of the whispering traffic was caused by only a couple of users. This information is consistent with structure of networks shown earlier.

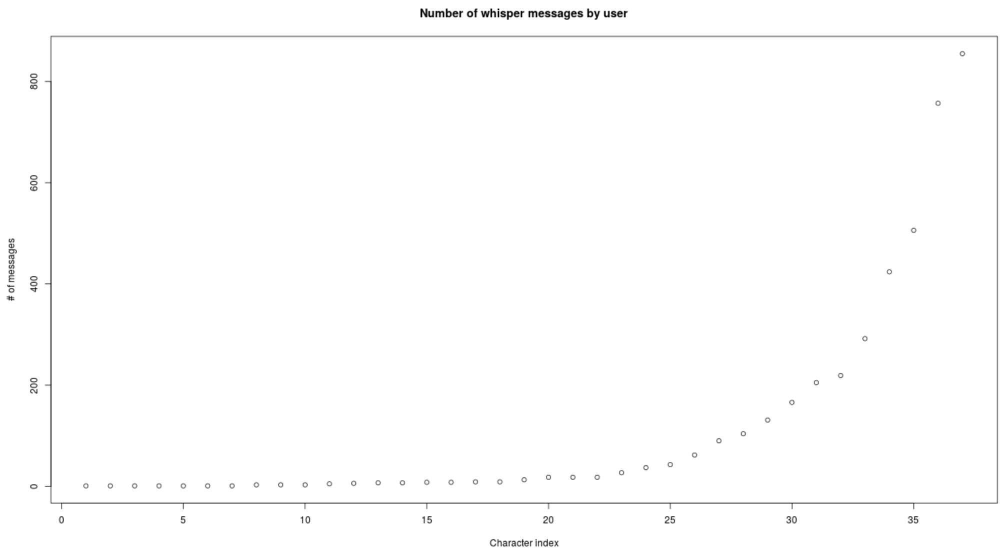

Figure 10. Number of Whisper Messages by Character Makes Dominance of Some Users over Whispering Data Evident

Five most active characters, which account for 69,80% of whisper message traffic are shown in Table. 1.

Table 1. Five Characters with the Greatest Number of Sent Whisper Messages

Character	# of messages
Char117	292
Char40	424
Char175	506
Char77	757
Char20	855

It is interesting to observe exchange of whisper messages through the whole time of testing period, and their fluctuations. Figure 11 shows the number of whisper messages through the whole data collection period.

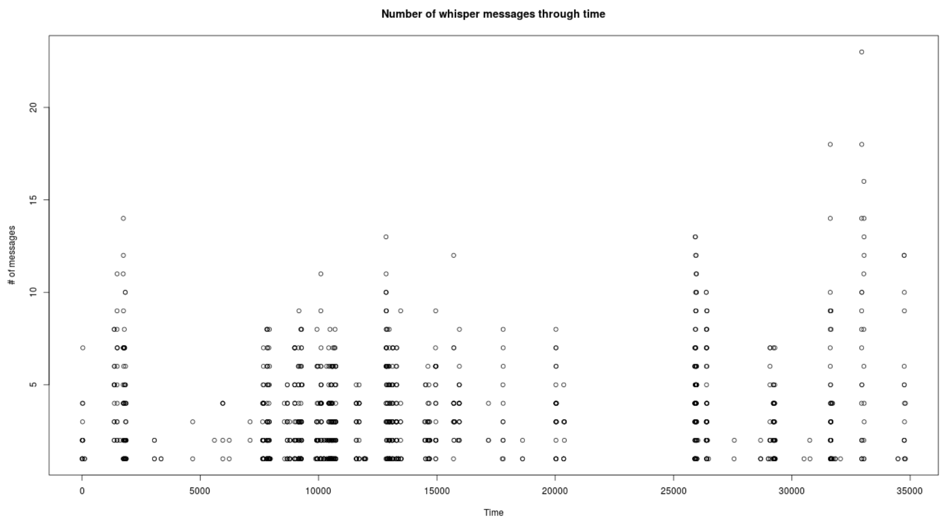

Figure 11. Number of Whisper Messages through Time Creates Visual Representation of when Users Have Been Most Active in the Game

The daily activity of users can be observed in Figure 12, where most intensive whisper message exchange happens in regular intervals. Data visualized in Figure 12 represents how long a user was active in the game, in total. Time of the first recorded whisper message of a user is shown on x-axis, and coupled with time of the last recorded whisper message of a user (shown on y-axis) indicates total time interval of a user's activity in the game. Three of the longest active users are shown in Table 2.

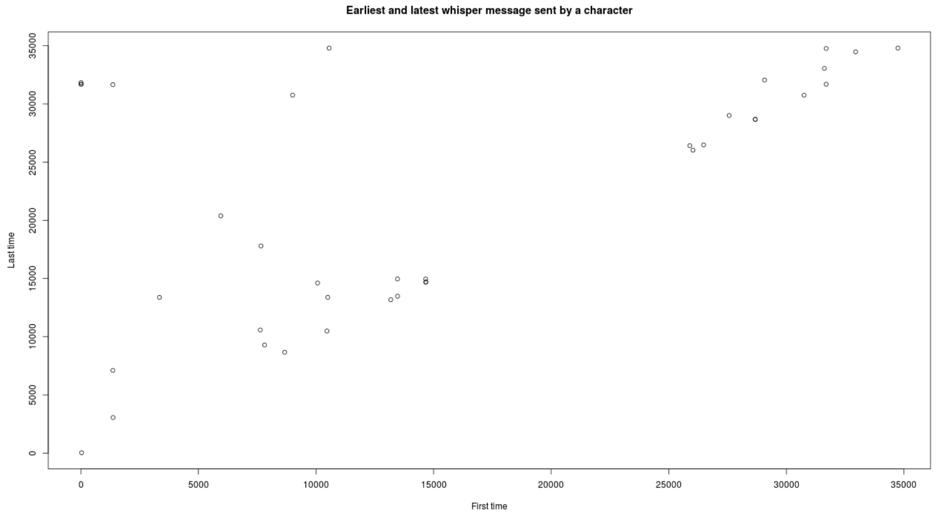

Figure 12. Time of the First and the Last Whisper Message of a User Indicates for how Long has the User Been Actively Involved with the Game

Table 2. Three of the Characters with Some of the Earliest and Some of the Latest Recorded Whisper Time

Character	First Time	Last Time
Char77	9	31839
Char175	16	31700
Char20	1362	31659

Party messages are visible to party members only, and are a perfect medium to discuss, organize and cooperate a party. Usually containing content more public then that of a whisper message, but not public enough for general chat. As is visible in Figure 13, only five users were significantly active in party message exchange. These five user's characters are named in Table 3.

Table 3. Most of the Five Characters which are Most Active in Party Chat are Members of the Same Party

Character	# of messages
Char49	3550
Char77	1521
Char175	1216
Char134	1035
Char27	663

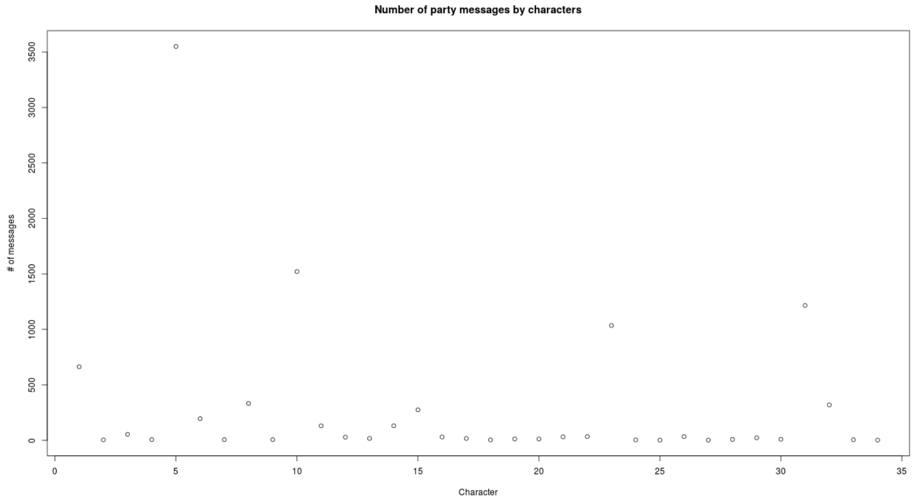

Figure 13. Significantly High Number of Party Messages May Indicate Strong Inter-Party Organization

Party message exchange diminished in time, as is shown in Figure 14. As the time passed by, parties got more passive and organization was not as crucial as before. It would seem players no longer needed information on where to find success in game, and time of interest passed, leaving in the game only those keen on adventuring.

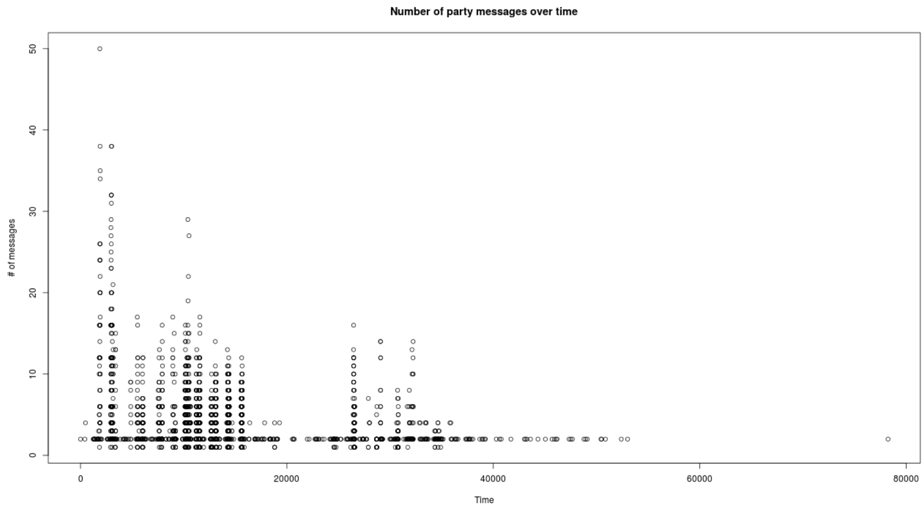

Figure 14. Where Whisper Chat Ceased (Figure 11), Party Chat Persisted, Although with Minimal Activity

Figure 15 confirms that most users used party chat for short periods of time only, and that most party chat activity stopped about time period 35000.

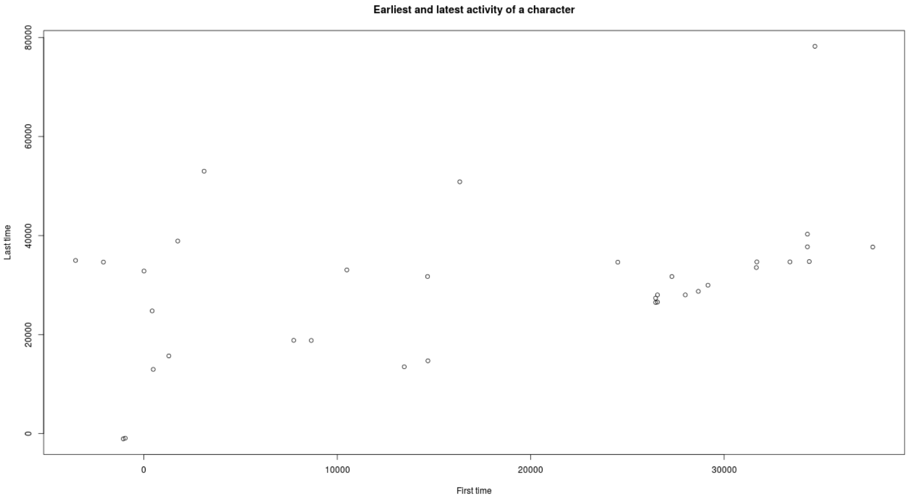

Figure 15. Only a Few Players Stopped Using Party Chat Rather Early in the Game, Indicating that Players Needed to Cooperate and Communicate in their Chosen Parties

When a user wants to trade some item for another item or in-game money, they must start a trade chat. Trading activity was sparse during the testing period, as visualized in Figure 16. It is evident that trading was attractive at some moments only.

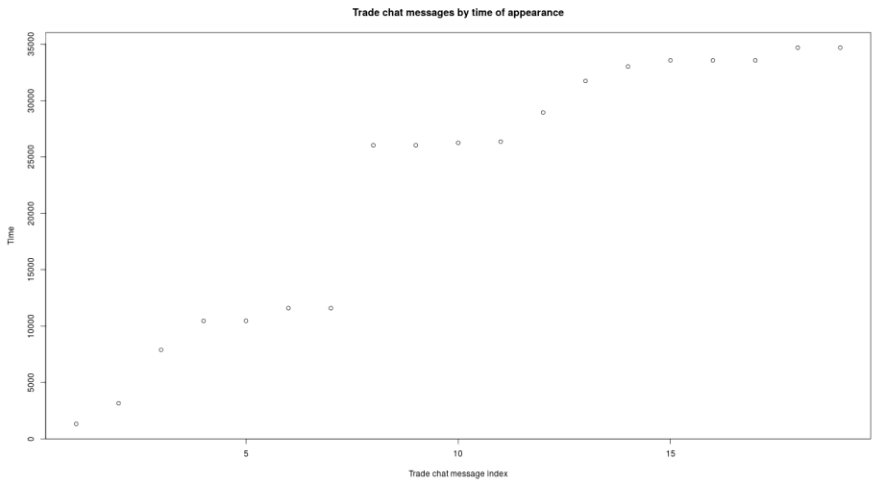

Figure 16. Visualized Trade Chat Message Time Data May Indicate that Players Used Trade Chat Only when Somebody Reminded them of the Possibility

5. Discussion

A virtual community of 181 players during the data gathering period of roughly 1 month provided us with a large amount of data and interesting analysis opportunities. The virtual community formed in TMW was not built without purpose. All the players had a shared goal – finishing a quest designed especially for this research. The assumption that most of the players played the game with sole goal of finishing the mentioned quest might affect the results and gathered data. The quest demanded cooperation, competition, and forming of alliances, therefore propagating such values.

Virtual communities, as long as being controlled by human users, *i.e*. representing human users in a virtual environment, are prone to be influenced by real-life stimuli. This assumption can be best observed in available data on party and whisper chat frequencies: time period between 20.000 and 25.000 time units is rather unpopulated, *i.e*. activity is almost non-existent. The mentioned time period corresponds to the real-life event of mid-term exams.

Analysis of whisper chat data, according to senders and receivers of a specific message, ignoring time constraints, provides one with seemingly the most influential individual in the community. Should a community member be evaluated by the amount of messages they send to their environment detects the most active members of the community, based on whisper message exchange, and all the included player characters.

6. Conclusion

With continuous growth, and increasingly large number of players, MMORPGs represent a vast playground for virtual society and virtual communities [8]. In a process similar to any computer-based activity, almost any activity in an MMORPG produces data, which is stored in order for the game to process smoothly. Such data can be used in various ways, from spying to social analyses.

Data analysis described in this paper uncovered several potentially interesting online community concepts: it is shown that real-life activities have heavy impact on the virtual community (although virtual environment can have a negative effect on players and their real-life performance [5]).

Formed virtual communities were observed through relation-based and communication-based social networks that formed during the data collection phase. The observed behaviour may be indicative of the way members of short lived virtual societies act in an environment, when mostly driven by a specific task.

Open questions that remain unanswered herein are related to the dynamics of social networks and likewise community formation during time. How did the various networks form? What were the basic activities that led towards network formations? How are these activities related to the communication that was conducted between the actors? Can we model these activities using agent based simulation? These and similar questions are subject to our future research.

Acknowledgment

This paper is an extension of the paper entitled “A Social Network Analysis of a Massively Multi-Player On-Line Role Playing Game” by the same authors, published at the 4th International Conference on Modeling and Simulation (CTSN). This work has been supported in full by the Croatian Science Foundation under the project number 8537.

References

[1] W. S. Bainbridge, “The scientific research potential of virtual worlds,” In: Science (New York, N.Y.) 317.5837, **(2007)**, pp. 472-476.

[2] E. Castronova, “On the Research Value of Large Games: Natural Experiments in Norrath and Camelot”, In: Games and Culture, vol. 1.2, **(2006)**, pp. 163-186.

[3] B. O. Đurić and M. Konecki, “Modeling MMORPG Players' Behaviour”, In: Central European Conference on Information and Intelligent Systems 26th International Conference. Edited by T. Hunjak, V. Kirinić, and M. Konecki, **(2015)**.

[4] M. Maliković and M. Schatten, “Artificial Intelligent Player's Planning in Massively Multi-Player On-Line Role-Playing Games”, In: 26th Central European Conference on Information and Intelligent Systems. 2015. Edited by T. Hunjak, V. Kirinić and M. Konecki, **(2015)**.

[5] C. S. Peters and L. A. Malesky, “Problematic usage among highly-engaged players of massively multiplayer online role playing games”, In: Cyber psychology & behavior: the impact of the Internet, multimedia and virtual reality on behavior and society, vol. 11.4, **(2008)**, pp. 481-484.

[6] M. Schatten, J.Ševa and B. O. Đurić, “Big Data Analytics and the Social Web-A Tutorial for the Social Scientist”, In: European Quarterly of Political Attitudes and Mentalities (EQPAM), vol. 4.3, **(2015)**, pp. 30-81.
[7] M. Schatten, J. Ševa and B. O. Đurić, “An Introduction to Social Semantic Web Mining & Big Data Analytics for Political Attitudes and Mentalities Research”, In: European Quarterly of Political Attitudes and Mentalities EQPAM, vol. 4.1, **(2015)**, pp. 40-62.
[8] M. Schatten, I. Tomičić and B. O. Đurić, “Multi-agent Modeling Methods for Massively Multi-Player On-Line Role-Playing Games”, In: MIPRO. Opatija, HR, **(2015)**.
[9] S. Son, A. R. Kang, H. C. Kim, T. T. Kwon, J. Park and H. K. Kim, “Multi-relational Social Networks in a Large-scale MMORPG”, In: ACM SIGCOMM Computer Communication Review, ACM, vol. 41. 4, **(2011)**, pp. 414-415.
[10] M. Szell and S. Thurner, “Measuring social dynamics in a massive multi-player online game”, In: Social Networks, vol. 32.4, **(2010)**, pp. 313-329.

Authors

Markus Schatten, is an assistant professor and the head of the Artificial Intelligence Laboratory at the Faculty of Organization and Informatics, University of Zagreb. He holds a PhD in information and communication sciences, MSc in information sciences and BSc in information systems. He authored and co-authored more than 60 scientific and professional papers and two books. He has lead or is leading 3 scientific nationally funded projects and was involved in more than 10 national and international scientific and professional others. His research interests include multi-agent systems, semantic Web, Internet of things, organization theory, autopoiesis, and social Web mining**.**

Bogdan Okreša Đurić, is a doctoral candidate at the Artificial Intelligence Laboratory at the Faculty of Organization and Informatics employed on the project ModelMMORPG - Large-Scale Multi-Agent Modeling of Massively Multi-Player On-Line Role-Playing Games. His former education at the mentioned faculty, enriched by the international activity he experienced while studying, motivated him to pursue academic and scientific career in diverse fields related to semantic modeling, multi-agent systems and social network analysis. Always ready for cooperation, teamwork and knowledge sharing, he is eager to make new acquaintances and reach for success with them.

