Analysis of Game Bot's Behavioral Characteristics in Social Interaction Networks of MMORPG

Seong Hoon Jeong
Korea University
Seoul, Korea
seonghoon@korea.ac.kr

Ah Reum Kang
Korea University
Seoul, Korea
armk@korea.ac.kr

Huy Kang Kim
Korea University
Seoul, Korea
cenda@korea.ac.kr

ABSTRACT

MMORPG (Massively Multiplayer Online Role-Playing Game) is one of the best platforms to observe human's behaviors. In collaboration with a leading online game company, NCSoft, we can observe all behaviors in a large-scale of commercialized MMORPG. Especially, we analyzed the behavioral differences between game bots and human users. We categorized the five groups, Bot-Bot, Bot-All, Human-Human, Human-All and All-All, and we observe the characteristics of six social interaction networks for each group. As a result, we found that there are significant differences in social behaviors between game bots and human.

CCS Concepts

•Information systems → Massively multiplayer online games;

Keywords

Social network analysis, Game bot, Massively multiplayer online game

1. INTRODUCTION

MMORPG is a huge social network with 15 million subscribers. The interactions in MMORPGs are not too different from how the real-world works. They can interact with other users by doing various actions such as party-play, player-to-player combat, item trading, and chatting in the game. These activities form multi-relational social interaction networks in the game.

However, not all of these activities are taken by human players. In popular MMORPGs, there exist game bots that are automated AI programs executing repetitive tasks. [1] The game bots interfere the gameplay of another human user. Game bots also make honest users feel deprived and annoying. Moreover, they continuously produce in-game items and money to gain illegal benefits, so they raise economic problems. We analyze the social network to present aspects of the game bots in Aion[1], which is the world's third most popular online game serviced by NCSoft. We analyzed the anonymized in-game log data that contained all of the interactions between users for 88 days (from April 9th of 2010 to July 5th of 2010). In order to distinguish the game bot group from the human user group, we use the banned account list provided by NCSoft as a ground-truth. During our observational period, about 96,806 characters played the game, and 14,378 characters were suspected of using game bots.

To find the characteristics of game bot and human user's behaviors, we categorize all in-game interactions as the six distinct interaction networks based on our previous work. [2] Each social interaction record contains a sender and a receiver: (1) Friend: S adds R to S's friend list. (2) Whisper: S sends a private message to R. (3) Party: S joins R's party. (4) Trade: S trades items or game money with R. (5) Mail: S sends a mail to R. (6) Shop: S buys an item from R's shop.

We define five groups to outline the differences between game bots and human users' interactions: (i) Bot-All: A game bot sends an event to anyone, (ii) Bot-Bot: A game bot sends an event to another game bot, (iii) Human-All: A human user sends an event to anyone, (iv) Human-Human: A human user sends an event to another human user, (v) All-All: Anyone sends an event to anyone.

2. RESULTS

Table 1 shows the basic network characteristics for each social interaction network and group. We observed the difference between human users and game bots. First, the Bot-Bot group only has social interactions in Party, Friendship, Trade and Whisper networks while the Human-Human group has social interactions in all networks. Second, the Bot-Bot group has more transactions for trading per party-play than the Human-Human group. The game bot group seems to exchange items frequently, but rarely buys an item via private shops. Third, the number of human users is 5.7 times higher than that of game bots. Nevertheless, the Bot-Bot group sent a mail more than the Human-Human group as shown in Table 1. Fig. 1 indicates the cumulative degree distribution of the in-degrees and the out-degrees in Mail network. The 90% of game bots send one mail and receive four mails, while the 90% of human users send one mail and receive seven mails. We identified that nine game bots respectively sent about 10,000 mails that have no attachment.

Fig. 2 shows the reciprocity of edges in each interaction network. The reciprocity is the fraction of reciprocal node

[1]AION Online, http://www.aiononline.com

SIGCOMM '15 August 17-21, 2015, London, United Kingdom

ACM ISBN 978-1-4503-3542-3/15/08.

DOI: http://dx.doi.org/10.1145/2785956.2790005

Table 1: Summary of the basic network characteristics.

	Party		Friendship		Trade		Whisper		Mail		Shop	
	#nodes	#edges	#nodes	#edges	#nodes	#edges	#nodes	#edges	#nodes	#edges	#nodes	#edges
Bot-All	21,511	108,575	12,889	22,906	19,710	42,094	11,970	36,362	42,553	103,442	2	1
Bot-Bot	4,063	14,223	1,717	3,803	7,120	19,137	1,919	5,328	0	0	2	1
H.-All	44,460	962,287	30,266	194,372	41,160	189,433	21,373	290,837	38,934	92,833	7,410	19,283
H.-H.	40,345	864,160	26,829	175,332	35,957	168,047	17,813	252,775	38,934	92,833	6,160	12,656
All-All	46,896	1,070,862	30,917	217,278	46,560	231,527	21,771	327,199	56,663	196,275	7,411	19,284

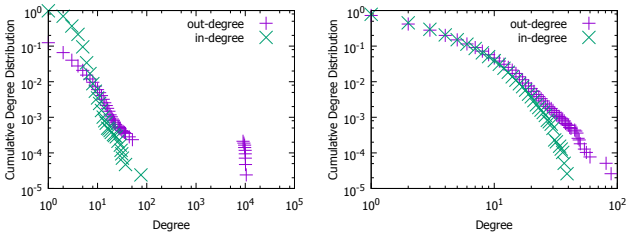

Figure 1: The in- and out-degree distribution of the Bot-All group (left) and the Human-All group (right) in Mail network.

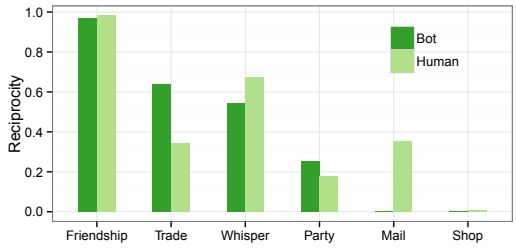

Figure 2: The reciprocity of edges in each interaction network.

pairs out of all connected node pairs. We found that Friendship, Trade, Whisper, and Party networks have the reciprocal property in both the Bot-Bot group and the Human-Human group. Interestingly, the Bot-Bot group is more reciprocal in Trade and Party networks. This fact implies that the main activities of game bots are party-play and trading items. We also confirmed that game bots have the friendship with each other. It seems that users in the same gold-farming group add game bots to their friend list for ease of management. In Whisper network, game bots have reciprocal property. This result explains that game bots share their coordinates with each other. Moreover, game bots have no reciprocal property in Mail network. There are just some game bots that send mails a lot (e.g. item selling spam).

Fig. 3 shows the results for the link overlaps for network pairs. In our study, the similarity about pairwise network overlaps is obtained using Jaccard coefficient. [3] The Bot-Bot group has the link overlaps in six pairwise networks, Party-Friendship, Party-Trade, Party-Whisper, Friendship-Trade, Friendship-Whisper, and Trade-Whisper networks. On the other hand, the Human-Human group has the link overlaps with the other social interactions in all pairwise networks except Shop network. It represents that game bots execute repetitive tasks associated with gold-farming and real-money trading.

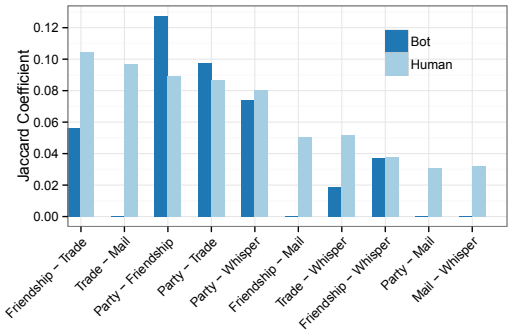

Figure 3: The Jaccard similarity coefficient: pairwise network overlaps indicating the similarity between interactions.

We reported the differences between game bots and human users in the six social interaction networks. Because of the gold-farming and real-money trading, game bots are more active in Friendship, Trade, and Party networks than human users. Besides game bots have no interactions in Mail and Shop network.

In our future study, we will present the triad network motif that shows the interactions visually among three characters in the six distinct networks. Using the Pearson correlation in the pairwise networks, we will investigate that whether a user trades items with many people when the user has a long buddy list or joins the party-play with various users. We believe that this would provide new insight to identify the behavioral pattern of game bots and human users. Finally, we expect to apply the game bot detection through not only the behavior analysis but also the social network analysis.

3. ACKNOWLEDGEMENT

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science, ICT & Future Planning (2014R1A1A1006228).

4. REFERENCES

[1] A. Kang, J. Woo, J. Park, H. Kim. Online Game Bot Detection based on party-play log analysis. *Computers & Mathematics with Application*, 65(9), 2013.

[2] S. Son, A. Kang, H. Kim, T. Kwon, J. Park, H. Kim. Analysis of Context Dependence in Social Interaction Networks of a Massively Multiplayer Online Role-Playing Game. *PLoS ONE*, 7(4), 2012.

[3] J. Onnela, J. Samamaki, J. Hyvonen, G. Szabo, M. Menezes, K. Kaski, A. Barabasi, and J. Kertesz. Analysis of a Large-scale Weighted Network of One-to-one Human Communication. *New Journal of Physics*, 9(6), 2007.