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

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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 Aion1, 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-All 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

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1 AION Online, http://www.aiononline.com
Table 1: Summary of the basic network characteristics.

<table>
<thead>
<tr>
<th></th>
<th>Friendship</th>
<th>Trade</th>
<th>Whisper</th>
<th>Mail</th>
<th>Shop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bot-All</td>
<td>21,511</td>
<td>108,575</td>
<td>12,889</td>
<td>22,906</td>
<td>19,283</td>
</tr>
<tr>
<td>Bot-Bot</td>
<td>4,063</td>
<td>14,423</td>
<td>1,717</td>
<td>3,803</td>
<td>19,710</td>
</tr>
<tr>
<td>H.-H.</td>
<td>40,345</td>
<td>894,129</td>
<td>173,532</td>
<td>158,017</td>
<td>189,433</td>
</tr>
<tr>
<td>H.-All</td>
<td>46,396</td>
<td>1,070,862</td>
<td>231,527</td>
<td>21,373</td>
<td>21,511</td>
</tr>
</tbody>
</table>

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.

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

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4. REFERENCES

