

Investigation of Inadequate Users in a Q&A Site Who Use Two or More Accounts for Submitting Questions and Manipulating Evaluations

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Abstract—Some users in a question and answer (Q&A) site use multiple user accounts and attempt to manipulate communications in the site. In order to detect these inadequate multiple account users precisely, it is important to investigate them from various points of view. In this paper, we investigate users suspected of manipulating evaluations of their answers by using two or more accounts for submitting many questions. The results of this study will give us a chance to investigate purposes and behaviors of inadequate multiple account users in a Q&A site.

Keywords—multiple account; Q&A site; evaluation manipulation; credibility.

I. INTRODUCTION

These days, many people use question and answer (Q&A) sites, where users share their information and knowledge. Q&A sites offer greater opportunities to users than search engines in the following points:

- 1) Users can submit questions in natural and expressive sentences, not keywords.
- 2) Users can submit ambiguous questions because other users give some supports to them.
- 3) Communications in Q&A sites are interactive. Users have chances to not only submit questions but give answers and, especially, join discussions.

As a result, Q&A sites are promising media. One of the essential factors in Q&A sites is anonymous submission. In most Q&A sites, user registrations are required for those who want to join the Q&A sites. However, registered users generally do not need to reveal their real names to submit messages (questions, problems, answers, comments, etc.). It is important to submit messages anonymously to a Q&A site. This is because anonymity gives users chances to submit messages without regard to shame and reputation. However, some users abuse the anonymity and attempt to manipulate communications in a Q&A site. For example, some users use multiple user accounts and submit messages to a Q&A site inadequately. Manipulated communications discourage other submitters, keep users from retrieving good communication records, and decrease the credibility of the Q&A site. As a result, it is important to detect users suspected of using multiple user accounts and manipulating communications in a Q&A site. In this case, identity tracing based on user accounts

is not effective because inadequate users are likely to hide their true identity to avoid detection. A possible solution is authorship identification based on analyzing stylistic features of messages. In recent years, a large number of studies have been made on authorship identification [1] [2] [3] [4] [5], however, few researchers addressed the identification issues of authors suspected of using multiple user accounts and manipulating communications in a Q&A site. To solve this problem, we proposed methods of detecting

- multiple account users suspected of submitting questions and their answers repeatedly [6], and
- multiple account users suspected of submitting many answers to the same question repeatedly [7].

However, little is known about the purposes and methods of inadequate multiple account users. As a result, it is important to investigate these inadequate multiple account users from various points of view. One example is how many accounts these inadequate users use for submitting questions and manipulating their evaluations. It is natural for them to use two or more user accounts for submitting questions and manipulating evaluations of their answers. It is because they do not want to draw attention to themselves. As a result, in this paper, we investigate users suspected of using two or more user accounts for submitting many questions and manipulating evaluations of their answers.

Finally, we should notice that it is difficult to verify the credibility of our investigation. This is because there is no reliable information about users who used multiple user accounts and manipulated communications in Q&A sites. In order to discuss the credibility of our investigation, we show the results of our investigation in detail. The results of this study will give us a chance to investigate purposes and behaviors of users who use multiple user accounts and intend to manipulate communications in a Q&A site.

The rest of this paper is organized as follows: In Section II, we survey the related works. In Section III, we describe Yahoo! chiebukuro for an example of Q&A sites. In Section IV, we describe how inadequate users use multiple user accounts in Q&A sites. In Section V, we show how we detect users suspected of using two or more accounts for submitting questions and manipulating evaluations of their answers. In

TABLE I. THE NUMBERS OF QUESTIONERS AND THEIR QUESTIONS AND ANSWERS AND THEIR ANSWERS IN YAHOO! CHIEBUKURO (FROM APRIL/2004 TO OCTOBER/2005).

	number of questioners	number of questions	number of answerers	number of answers
the data of Yahoo! chiebukuro	165,064	3,116,009	183,242	13,477,785

Section VI, we show the result of the investigation. Finally, in Section VII, we present our conclusions.

II. RELATED WORKS

One of the essential factors of the Internet is anonymity. Joinson discussed the anonymity on the Internet from various points of view [8]. These days, many users abuse the anonymity. Take Sybil attack for example. In a Sybil attack, the attacker intends to gain large influence on a peer-to-peer (P2P) network by creating and using a large number of pseudonymous identities [9] [10]. Sybil attacks are cheap and efficient way to gain large influence on P2P networks [11]. Similarly, in human online communities, such as, web-based bulletin boards, chat rooms, and blog comment forms, many users are thought to use multiple user accounts inadequately and submit inadequate messages, such as, deceptive opinion spams. In recent years, a large number of studies have been made on authorship identification [1] [2] [3] [4] [5], however, few researchers addressed the identification issues of authors suspected of using multiple user accounts and manipulating communications in the Internet. One of the difficulties of this problem is that we did not have sufficient number of examples of inadequate multiple account users. To solve this problem, some researchers tried to extract inadequate submissions by using heuristic methods based on text similarities and ranking results [12] [13]. On the other hand, the authors of [14] pointed that these heuristic methods were insufficient to detect inadequate submissions precisely, and showed they could detect inadequate submissions precisely when they used large number of examples of inadequate submissions. However, they obtained examples of inadequate submissions by using Amazon Mechanical Turk [15]. The examples of inadequate submissions created by workers in Amazon Mechanical Turk have the following problems.

- Little is known about the purposes and methods of inadequate submissions. As a result, it is possible that their instructions to workers in Amazon Mechanical Turk were insufficient.
- There are unreliable workers in Amazon Mechanical Turk [16].

As a result, it is important to obtain inadequate submissions from the Internet. To solve this problem, we proposed methods of detecting inadequate multiple account users and their submissions [6] [7]. However, as mentioned, little is known about the purposes and methods of inadequate multiple account users. As a result, it is important to investigate these inadequate multiple account users and their inadequate submissions from various points of view.

III. YAHOO! CHIEBUKURO

Yahoo! chiebukuro is one of the most popular community sites in Japan. Users of Yahoo! chiebukuro submit their ques-

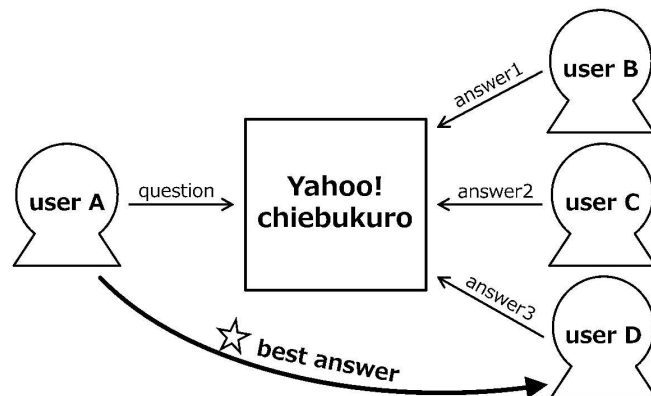


Figure 1. An example of how to use Yahoo! chiebukuro.

tions and answers in the next way.

- user registrations are required for those who want to join Yahoo! chiebukuro.
- users do not need to reveal their real names to submit their questions and answers.
- each user can submit his/her answer only one time to one question.
- The period limit for accepting answers is one week. However, questioners can stop accepting answers before the time limits.
- After the time limits, questions with no answers are removed and cannot be referable. On the other hand, questions with answers can be referable.
- each questioner is requested to determine which answer to his/her question is best and give a *best answer* label to it.

Figure 1 shows that user A submitted one question to Yahoo! chiebukuro and three users, user B, user C, and user D answered the question, and then, user A selected user D's answer as a best answer. In this study, we used the data of Yahoo! chiebukuro for observation and examination. Chiebukuro means pearls of wisdom. The data of Yahoo! chiebukuro was published by Yahoo! JAPAN via National Institute of Informatics in 2007 [17]. This data consists of about 3.11 million questions and 13.47 million answers which were posted on Yahoo! chiebukuro from April/2004 to October/2005. In the data, each question has at least one answer because questions with no answers were removed. In order to avoid identifying individuals, user accounts were replaced with unique ID numbers. By using these ID numbers, we can trace any user's questions and answers in the data. Table I shows

- the numbers of questioners and their questions in the data, and
- the numbers of answerers and their answers in the data.

In Table I, the number of questioners is the number of users who submitted one or more questions to Yahoo! chiebukuro from April/2004 to October/2005. Also, the number of answerers is the number of users who submitted one or more answers to Yahoo! chiebukuro from April/2004 to October/2005.

IV. SUBMISSIONS BY USING MULTIPLE USER ACCOUNTS

There are many reasons why users in a Q&A site use multiple user accounts. First, we discuss a proper reason. In Yahoo! chiebukuro, users do not need to reveal their real names to submit their questions and answers. However, their submissions are traceable because their user accounts are attached to them. Because of this traceability, we can collect any user's submissions and some of them include clues of identifying individuals. As a result, to avoid identifying individuals, it is reasonable and proper that users change their user accounts or use multiple user accounts. However, the following types of submissions by using multiple user accounts are neither reasonable nor proper.

TYPE QA One user submits a question and its answer by using multiple user accounts (Figure 2 (a)).

We think that the user intended to manipulate the submission evaluation. For example, in Yahoo! chiebukuro, each questioner is requested to determine which answer is best and give a *best answer* label to it. These evaluations encourage answerers to submit new answers and increase the credibility of the Q&A site. We think, the user repeated this type of submissions because he/she wanted to get many best answer labels and be seen as a good answerer.

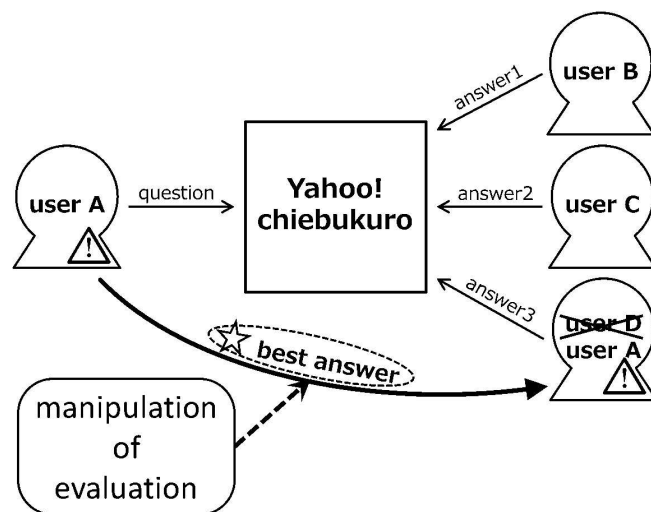
TYPE AA One user submits two or more answers to the same question by using multiple user accounts (Figure 2 (b)).

We think that the user intended to dominate or disrupt communications in the Q&A site. To be more precise, the user intended to

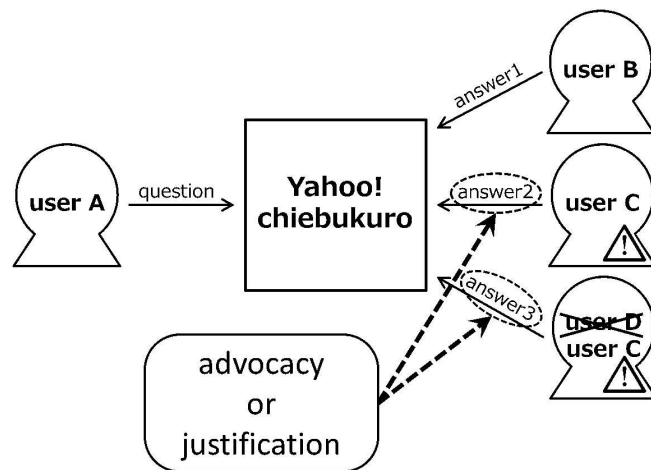
- manipulate communications by advocating or justifying his/her opinions, or
- disrupt communications by submitting two or more inappropriate messages.

TYPE AA submissions are more similar to Sybil attacks in P2P networks than TYPE QA submissions. The more answers inadequate users submit by using multiple user accounts, the easier they manipulate or disrupt communications in a Q&A site.

These two types are not all types of inadequate submissions. However, these kinds of submissions seriously disrupt communications in a Q&A site. Especially, TYPE QA submissions are serious because users can manipulate evaluations of messages by repeating TYPE QA submissions. Manipulated evaluations discourage other submitters, keep users from retrieving good communication records, and decrease the credibility of the



(a) TYPE QA: one user submits a question and its answer by using multiple user accounts. (In this case, user A submits a question and its answer by using two user accounts.)



(b) TYPE AA: one user submits two or more answers to the same question by using multiple user accounts. (In this case, user C submits two answers by using two user accounts.)

Figure 2. Two types of inadequate submissions: TYPE QA and TYPE AA.

Q&A site. Furthermore, we think we cannot use knowledge and countermeasures obtained in studies of Sybil attacks in P2P networks because TYPE QA submissions are different from Sybil attacks. In a Sybil attack, the more pseudonymous identities the attacker uses, the easier he/she gain large influence on a P2P network. On the other hand, in a TYPE QA submission, the inadequate user can get a best answer label by using only two user accounts. To solve this problem, we proposed methods of detecting multiple account users suspected of repeating TYPE QA submissions [6]. However, little is known about the purposes and methods of inadequate multiple account users. As a result, it is important to investigate these inadequate multiple account users from various points of view. For example, it is important to investigate how many accounts these inadequate users use for submitting questions

and manipulating evaluations of their answers. Inadequate multiple account users can be classified into two types:

- inadequate users each of whom use one user account for submitting questions and manipulating evaluations of his/her answers, and
- inadequate users each of whom use two or more user accounts for submitting questions and manipulating evaluations of his/her answers.

In this study, we investigate the latter type of users, in other words, users suspected of using two or more user accounts for submitting questions and manipulating evaluations of their answers.

V. DETECTION OF USERS SUSPECTED OF USING TWO OR MORE ACCOUNTS FOR SUBMITTING QUESTIONS AND MANIPULATING EVALUATIONS

Suppose that one user intends to manipulate evaluations of his/her answers, submitted by using user account a , and repeats TYPE QA submissions by using two user accounts, q_1 and q_2 . In this case, it is expected that we observe the following abnormal submissions:

- user a submits too many answers to questions submitted by user q_1 and q_2 ,
- user q_1 and q_2 receive too many answers from user a , and
- user q_1 and q_2 give too many best answer labels to user a 's answers.

In order to detect users who intend to manipulate evaluations of their answers and submit many questions by using two or more user accounts, we propose a method which consist of the following two steps:

- 1) We first detect user pairs of questioner and answerer, which are suspected of repeating TYPE QA submissions, as shown in Figure 2, by using three hypotheses: Hypothesis QA1, QA2, and QA3.
- 2) We detect users who are answerers in two or more user pairs detected by using Hypothesis QA1, QA2, and QA3.

Hypothesis QA1, QA2, and QA3 are as follows:

a) Hypothesis QA1: If user a did not submit abnormally too many answers to user q 's questions, we would expect that user a submitted at most $N_{QA1}(q, a)$ answers to user q 's questions.

$$N_{QA1}(q, a) = P_{QA1}(q) \times ans(a) \quad (1)$$

where $ans(a)$ is the total number of answers submitted by user a and $P_{QA1}(q)$ is the probability that an user selects one question randomly and the question is one of user q 's questions. Because each user of Yahoo! chiebukuro can submit his/her answer only one time to one question, $P_{QA1}(q)$ is

$$P_{QA1}(q) = \frac{qst(q)}{N_{qst}} \quad (2)$$

where $qst(q)$ is the number of questions submitted by user q and, as shown in Table I, N_{qst} is the total number of

questions in the data of Yahoo! chiebukuro. If this hypothesis is rejected by an one-sided binomial test, we determine that user a submitted abnormally too many answers to user q 's questions.

The binomial test is an exact test of the statistical significance of deviations from a theoretically expected binomial distribution of observations into two categories [18]. There are two types of binomial tests: one sided binomial test or two sided binomial test. When the critical area of a distribution is one-sided, in other words, it is either greater than or less than a certain value, but not both, only the one-sided binomial test is generally applicable. In this study, the distribution area is one-sided, we use the one-sided binomial test.

b) Hypothesis QA2: If user q did not receive abnormally too many answers from user a , we would expect that user q received at most $N_{QA2}(q, a)$ answers from user a .

$$N_{QA2}(q, a) = P_{QA2}(a) \times qst(q) \quad (3)$$

where $qst(q)$ is the total number of questions submitted by user q and $P_{QA2}(a)$ is the probability that an user received one answer from user a when user a selected one question randomly and answered it. Because each user of Yahoo! chiebukuro can submit his/her answer only one time to one question, $P_{QA2}(a)$ is

$$P_{QA2}(a) = \frac{ans(a)}{N_{qst}} \quad (4)$$

where $ans(a)$ is the number of answers submitted by user a and, as shown in Table I, N_{qst} is the total number of questions in the data of Yahoo! chiebukuro. If this hypothesis is rejected by an one-sided binomial test, we determine that user q received abnormally too many answers from user a .

c) Hypothesis QA3: If user q did not give abnormally too many best answer labels to user a 's answers, we would expect that user q gave at most $N_{QA3}(q, a)$ best answer labels to user a 's answers.

$$N_{QA3}(q, a) = P_{QA3}(q) \times f_{QA}(q, a) \quad (5)$$

where $f_{QA}(q, a)$ is the number of answers submitted by user q to user q 's questions, and $P_{QA3}(a)$ is the best answer ratio of user a .

$$P_{QA3}(a) = \frac{bestans(a)}{ans(a)} \quad (6)$$

where $ans(a)$ is the number of answers submitted by user a and $bestans(a)$ is the number of best answers in user a 's answers. However, if user j satisfies one of the following conditions:

- all user a 's answers were selected as best answers, in other words,

$$ans(a) = bestans(a) \quad (7)$$

- Hypothesis QA3aux, the auxiliary hypothesis for Hypothesis QA3, is rejected, in other words, it is considered that user a received too many best answer labels,

we set $P_{QA3}(a)$ as follows:

$$P_{QA3}(a) = \frac{N_{bestans}}{N_{ans}} = \frac{N_{qst}}{N_{ans}} \quad (8)$$

TABLE II. THE DETECTION RESULT OF USERS SUSPECTED OF USING TWO OR MORE USER ACCOUNTS FOR SUBMITTING QUESTIONS AND MANIPULATING EVALUATIONS OF THEIR ANSWERS

significance levels for QA1, QA2, QA3, and QA3aux	UP_{BT}	$UP_{two_or_more}$	A_{BT}	$A_{two_or_more}$
0.00005	814	329	581	96
0.00001	603	222	450	69
0.000005	537	188	408	59
0.000001	424	135	333	44
0.0000005	407	129	319	41
0.0000001	337	104	266	33
0.00000005	325	101	257	33
0.00000001	278	86	220	28

UP_{BT} is the number of user pairs which are detected by binomial tests based on Hypothesis QA1, QA2, QA3, and QA3aux. $UP_{two_or_more}$ is the number of user pairs the answers of which were found in two or more user pairs detected by binomial tests. A_{BT} is the number of answers which are found in user pairs detected by binomial tests based on Hypothesis QA1, QA2, QA3, and QA3aux. $A_{two_or_more}$ is the number of answers which are found in two or more user pairs detected by binomial tests based on Hypothesis QA1, QA2, QA3, and QA3aux.

where $N_{bestans}$ is the total number of best answers. $N_{bestans}$ is equal to N_{qst} because each question has one best answer. If this hypothesis is rejected by one-sided binomial test, we determined that user q gave abnormally too many best answer labels to user a 's answers.

d) *Hypothesis QA3aux*: If user a did not receive abnormally too many best answer labels, we would expect that user a received at most $N_{QA3aux}(a)$ best answer labels.

$$N_{QA3aux}(a) = P_{QA3aux} \times ans(a) \quad (9)$$

where P_{QA3aux} is the average best answer ratio.

$$P_{QA3aux} = \frac{N_{bestans}}{N_{ans}} = \frac{N_{qst}}{N_{ans}} \quad (10)$$

If this hypothesis is rejected by one-sided binomial test, we consider that user a received abnormally too many best answer labels.

VI. RESULT OF THE INVESTIGATION

To evaluate our method, we conducted the detection of users suspected of using two or more user accounts for submitting many questions and repeating TYPE QA submissions, and manipulating evaluations of their answers in a Q&A site. In this experiment, the target users were all submitters in the data of Yahoo! chiebukuro. As shown in Table I, the numbers of the target questioners and answerers in the data of Yahoo! chiebukuro are 165,064 and 183,242, respectively.

In our method, we varied the significance levels for Hypotheses QA1, QA2, QA3, and QA3aux from 0.00005 to 0.00000001. They were extremely low because we intend to detect extreme abnormal submissions. Table II shows the results of this experiment.

As shown in Table II, 59 users were detected when the significance level was 0.000005. We should notice that 28 users of them were detected when the significance level was 0.00000001. It shows that many users were detected although the significance level was extremely low. As we expected, there are many users suspected of repeating TYPE QA submissions and manipulating evaluations of their answers by using two or more user accounts for submitting questions.

We checked questions and answers submitted by the detected user pairs and found that some other questioners were criticized for their unfair best answer selections. For example, user 233650 was criticized that he/she selected user 678451's answers as best answers repeatedly and unfairly. After criticized for his/her unfair best answer selection, user 233650 stopped submitting any questions to Yahoo! chiebukuro. Our method is useful for detecting these suspicious users. Furthermore, if we detect and take care of these suspicious users, we can avoid unnecessary frictions between users.

VII. CONCLUSION

In this study, we investigated users suspected of using two or more user accounts for submitting questions and manipulating evaluations of their answers. We first discuss reasons why users in a Q&A site use multiple user accounts. We think many users use multiple user accounts reasonably and properly, however, some users use multiple user accounts improperly. For example, there seem to be users who use two or more user accounts for submitting questions and manipulating evaluations of their answers. However, little is known about the purposes and methods of these inadequate users. As a result, in order to investigate these inadequate users, we proposed a detecting method based on binomial test in this paper. Then, we applied our method to the data of Yahoo! chiebukuro, and found that many users suspected of using two or more user accounts for submitting questions and manipulating evaluations of their answers although the significance level was extremely low. We intend to use the results of this study for further investigation of purposes and behaviors of inadequate multiple account users in Q&A sites. For example, it is important to investigate which and how many categories inadequate multiple account users tried to manipulate evaluations. Also, it is important to analyze what inadequate multiple account users mentioned in their questions and answers. Furthermore, we intend to avoid unnecessary frictions between users in Q&A sites by detecting and taking care of these inadequate users.

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