

An Investigation of One Sided Follow Relations between Twitter Users Concerned with Tweets Disclosing Submitters' Personal Information

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Abstract—Nowadays, many people use a Social Networking Service (SNS). Most SNS users are careful in protecting the privacy of personal information: name, age, gender, address, telephone number, birthday, etc. However, some SNS users disclose their personal information that can threaten their privacy and security even if they use unreal name accounts. In this study, we investigated Twitter users who gave likes to tweets disclosing submitters' personal information that potentially threatened submitters' privacy and security. We collected 318 tweets promising to disclose submitters' personal information. Then, we investigated the one sided follow relations between the submitters of these 318 tweets and users who gave likes to them. The results of our survey showed that giving likes to tweets promising to disclose submitter's personal information is not a sufficient trigger to get to follow users. Submitters were careful to follow unfamiliar users even if the users followed them and gave likes to their tweets. Also, users were careful to follow unfamiliar users even if the users followed them and gave likes to the same tweets.

Keywords—personal information; Twitter; SNS; privacy risk; one sided follows; unreal name account user.

I. INTRODUCTION

Nowadays, many people use a Social Networking Service (SNS) to communicate with each other and try to enlarge their circle of friends. SNS users are generally concerned about potential privacy risks. To be specific, they are afraid that unwanted audiences will obtain information about them or their families, such as where they live, work, and play. As a result, SNS users are generally careful in disclosing their personal information. They disclose their personal information only when they think the benefits of doing so are greater than the potential privacy risks. However, some SNS users, especially young users, disclose their personal information on their profiles, for example, real full name, gender, hometown and full date of birth, which can potentially be used to identify details of their real life, such as their social security numbers. In order to discuss the reasons why some SNS users disclose their personal information willingly, it is important to investigate who their intended readers are. However, it is difficult to ask them who their intended readers are. To solve this problem, it is important to investigate who gave responses to their SNS messages disclosing their personal information. This is because, if submitters felt unwanted audiences read and gave responses to their SNS messages disclosing their personal information, they would delete them. In order to investigate who gave responses to SNS messages disclosing submitters' personal information, we investigate Twitter users who gave likes to tweets disclosing submitters' personal information. Furthermore, we investigate follow relations between

users concerned with a tweet disclosing submitter's personal information. In other words, we investigate

- whether a submitter followed users who gave likes to his/her tweets disclosing his/her personal information,
- whether users who gave likes to submitter's tweet disclosing his/her personal information followed the submitter, and
- whether each user who gave a like to a tweet disclosing submitter's personal information followed every other user who gave a like to the same tweet.

In our previous work, we reported mutual follow relations and no follow relations between users concerned with a tweet disclosing submitter's personal information [1]. In this study, we investigate one sided follow relations between them. It is important to investigate one sided follow relations between users because they are bound to happen in the process of acquaintance between users who do not follow each other. By using the results of the investigation, we discuss the groups of submitters and users who gave likes to tweets disclosing submitters' personal information.

The rest of this paper is organized as follows: in Section II, we survey the related works. In Section III, we show how to collect tweets where submitters seemingly disclosed their personal information honestly and detect users who gave likes to them. In Section IV, we investigate one sided follow relations between users concerned with a tweet disclosing submitter's personal information and discuss the groups of submitters and users who gave likes to tweets disclosing submitters' personal information. Finally, in Section V, we present our conclusions.

II. RELATED WORK

Personally identifiable information is defined as information which can be used to distinguish or trace an individual's identity such as social security number, biometric records, etc. alone, or when combined with other information that is linkable to a specific individual, such as date and place of birth, mother's maiden name, etc. [2] [3]. Internet users are generally concerned about unwanted audiences obtaining personal information. Fox et al. reported that 86% of Internet users are concerned that unwanted audiences will obtain information about them or their families [4]. Also, Acquisti and Gross reported that students expressed high levels of concern for general privacy issues on Facebook, such as a stranger finding out where they live and the location and schedule of their classes, and a stranger learning their sexual orientation,



Figure 1. An unreal name account user, *Suzuse*, disclosed her personal profile items in her tweets.

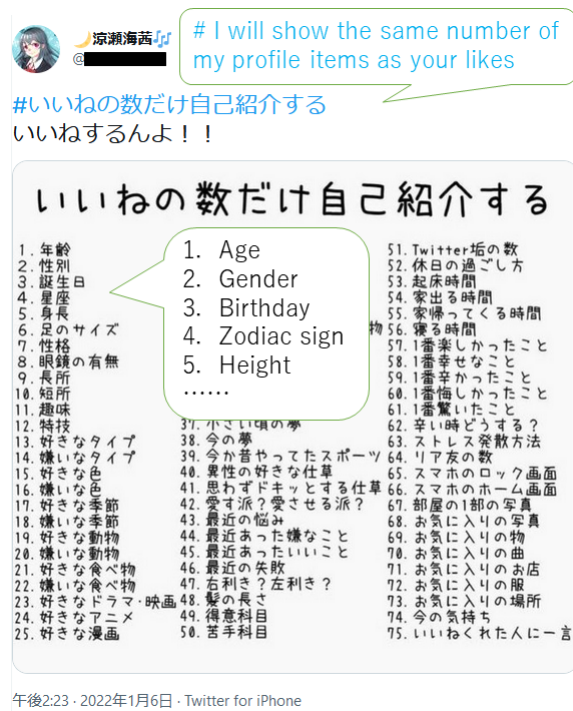


Figure 2. A tweet promising to disclose the same number of submitter’s personal profile items as likes to it.

name of their current partner, and their political affiliations [5]. However, Internet users, especially young users, tend to disclose personal information on their profiles, for example, real full name, gender, hometown and full date of birth, which can potentially be used to identify details of their real life, such as their social security numbers. As a result, many researchers discussed the reasons why young users willingly disclose personal information on their SNS profiles. Barnes argues that Internet users, especially teenagers, are not aware of the nature of the Internet and SNSs [6]. Barth et al. highly questioned whether privacy as a concept is already implanted in SNS users’ perception and social representation [7]. Obar and Oeldorf-Hirsch reported that individuals often ignore privacy and terms of service policies for SNSs [8]. Viseu et al. reported that many online users believe the benefits of disclosing personal information in order to use an Internet site are greater than the potential privacy risks [9]. On the other hand, Acquisti and Gross explain this phenomenon as a disconnection between the users’ desire to protect their privacy and their actual behavior [5]. Also, Livingstone points out that teenagers’ conception of privacy does not match the privacy settings of most SNSs [10]. Alshaikh et al. reported that SNS users were worried about their individual information security especially when SNS organizations changed their privacy terms [11]. Joinson et al. reported that trust and perceived privacy had a strong affect on individuals’ willingness to disclose personal information to a website [12]. Also, Tufekci found that concern about unwanted audiences had an impact on whether or not students revealed their real names and religious affiliation on MySpace and Facebook [13]. The authors also think that most students are seriously concerned about their privacy and security. However, they often underestimate the risk of their online messages and submit them. For example, Watanabe et al. focused on unreal name Twitter users who promised to disclose their personal profile items, analyzed the details of their personal profile items disclosed by themselves, especially their ages, genders, and heights, and showed that most of the

submitters disclosed their ages, genders, and heights honestly [14].

III. A COLLECTION OF TWEETS DISCLOSING SUBMITTERS’ PERSONAL INFORMATION

It is difficult to collect tweets disclosing submitters’ personal information, such as tweets in Figure 1, directly. To solve this problem, we focused on tweets where submitters promised their audiences to disclose the same number of their own personal profile items as likes to their tweets. Figure 2 shows a tweet submitted by *Suzuse* on January 6, 2022. Both in Figure 1 and Figure 2, her screen name is redacted for privacy. Figure 2 shows that *Suzuse* promised her audiences to disclose the same number of her personal profile items as likes to her tweet. Actually, as shown in Figure 1, *Suzuse* submitted four replies disclosing her four personal profile items to her tweet shown in Figure 2 on January 6, 2022. Watanabe et al. reported that Twitter users seemingly disclosed their personal information honestly when they promised to do it, such as *Suzuse*’s tweet in Figure 2 [14]. As a result, it is easy to collect tweets disclosing submitters’ personal profile items when we collect tweets promising to disclose submitters’ personal profile items. Furthermore, they often used the same sentence in their tweets, like a game password, as shown in Figure 2, # *I will show the same number of my profile items as your likes*. In order to collect tweets promising to disclose submitters’ personal profile items, we used the shared sentence as key to collect them. To be specific, we collected these tweets by using Twitter API v2 [15]. Twitter API v2 helps us to collect tweets where the given sentence is used. Also, Twitter API v2 helps us to collect user accounts who submitted a specific tweet and who gave likes to it. Furthermore, it helps us to collect

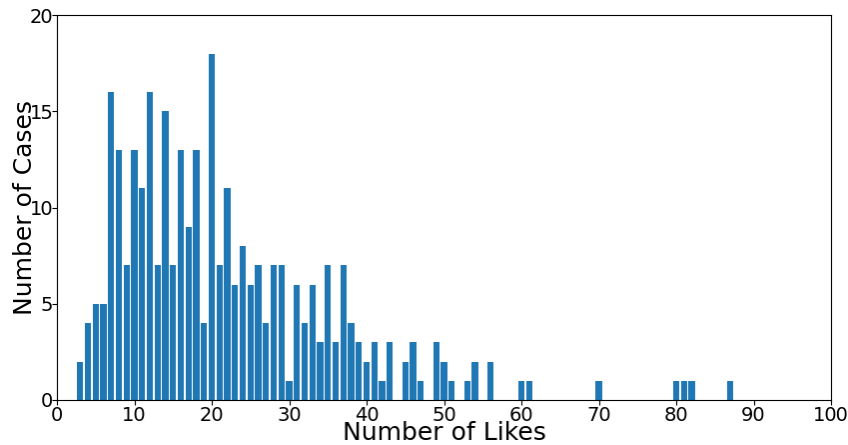


Figure 3. The histogram of the number of likes given to the 318 tweets promising to disclose submitters’ personal information.

user accounts who are followed by a specific user. Every 10 PM, we tried to collect user accounts and their tweets

- that contained # I will show the same number of my profile items as your likes
- that were submitted in the past 24 hours, and
- that were given one or more likes.

After we obtained the tweets promising to disclose submitters’ personal profile items, we tried to collect

- user accounts who gave likes to the obtained tweets and
- user accounts followed by the submitters of the obtained tweets and the users who gave likes to them

once daily for a week. Finally, we collected 318 Japanese tweets promising to disclose submitters’ personal information. These 318 tweets were submitted from December 30, 2021 to January 31, 2022 by 317 users. One out of the 317 users submitted two tweets promising to disclose his personal information on January 12 and 17, 2022. These 318 tweets were given 7060 likes by 6325 users within a week after they were submitted. Figure 3 shows the histogram of the number of likes given to the obtained 318 tweets promising to disclose submitters’ personal information. Figure 4 shows the daily number of likes given to the obtained 318 tweets in the investigation period. Day *N* in Figure 4 means that *N* days have passed since the obtained tweet was submitted and our investigation started. Day 6 was the last day of the investigation period. Figure 4 shows that 77 % of likes were given on Day 0. 30 tweets out of the 318 tweets were deleted within a week after they were submitted.

IV. ONE SIDED FOLLOW RELATIONS BETWEEN USERS CONCERNED WITH TWEETS DISCLOSING SUBMITTERS’ PERSONAL INFORMATION

In this section, we investigate one sided follow relations between users who communicated through tweets disclosing submitters’ personal information. To be specific, we survey

- Twitter users who submitted tweets promising to disclose the same number of their own personal profile items as likes and

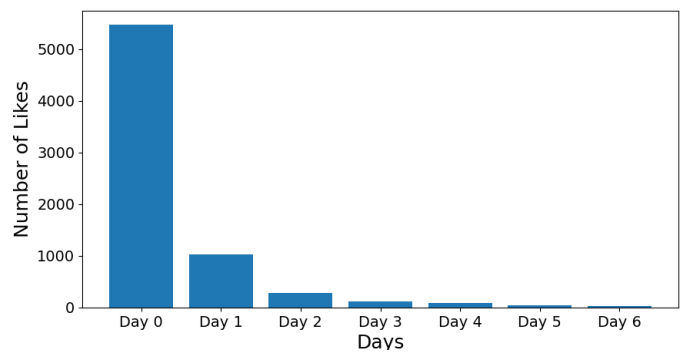


Figure 4. The daily number of likes given to the obtained 318 tweets since the tweets were submitted.

- Twitter users who gave likes to these tweets and investigate
 - whether an user who submitted tweets promising to disclose his/her personal information followed users who gave likes to his/her tweets,
 - whether users who gave likes to tweets promising to disclose submitter’s personal information followed the submitter, and
 - whether users who gave likes to a tweet promising to disclose submitter’s personal information followed each other.

After collecting user accounts of submitters and users who gave likes to submitters’ tweets, we analyze the relations between them. The relations between a submitter and an user who gave a like to submitter’s tweet can be classified into four types:

- mutual follow relation: the submitter and the user mutually followed each other.
- one sided follow relation (from the submitter): the submitter followed the user, however, the user did not follow the submitter.
- one sided follow relation (to the submitter): the user followed the submitter, however, the submitter did not follow the user.

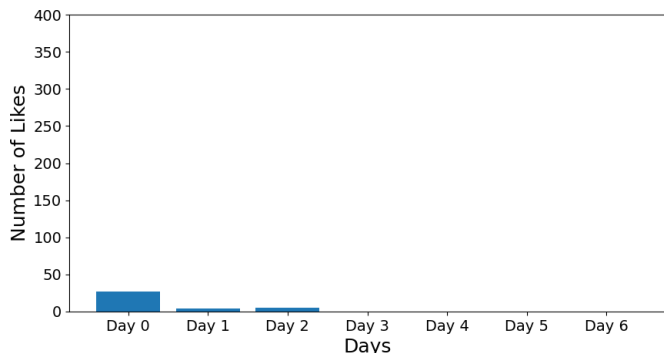


Figure 5. The daily number of likes given by users who did not follow submitters but were followed by the submitters in the investigation period.

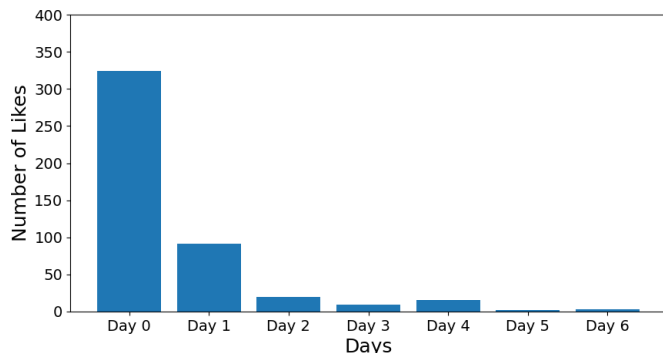


Figure 6. The daily number of likes given by users who followed submitters but were not followed by the submitters in the investigation period.

- no follow relation: the submitter and the user did not follow each other.

Figure 5 shows the daily number of likes given by users who did not follow submitters but were followed by the submitters in the investigation period. On the other hand, Figure 6 shows the daily number of likes given by users who followed submitters but were not followed by the submitters in the investigation period. Figure 5 and Figure 6 show that users who did not follow submitters but were followed by the submitters gave less likes than those who followed submitters but were not followed by the submitters. Furthermore, we analyze the relations among users who gave likes to submitter’s tweet. They can also be classified into three types: mutual follow relation, on sided follow relation, or no follow relation.

Let us consider one example. As shown in Figure 2, a Twitter user, *Suzuse*, submitted a tweet promising her audiences to disclose the same number of her own personal profile items as likes on January 6, 2022 at 2:23 PM. We detected her tweet on the same day at 10:00 PM, and then, recorded that she received ten likes and submitted ten replies disclosing her ten personal profile items on January 6, 2022. After that, every 10 PM, we tried to check whether someone gave likes to her tweet and analyzed the relations between *Suzuse* and users who gave likes to her tweet by the day. For example, on January 7, 2022, we detected one more user gave a like to her tweet and recorded that *Suzuse* received eleven likes from eleven users by the day. Then, we analyzed the relations between *Suzuse* and each of the eleven users and confirmed that each of the eleven users followed *Suzuse* and she followed seven of them. As a result, the relations between *Suzuse* and the seven users were mutual follow relations. On the other hand, the relations between *Suzuse* and the other four users were one sided follow relations: these four users followed *Suzuse* but she did not follow them. Furthermore, we analyzed the relations among the eleven users who gave likes to her tweet by January 7, 2022. There were 55 cases to choose two out of the eleven users. In three cases out of the 55 cases, two users followed each other. On the other hand, in the other 52 cases, two users did not follow each other. As a result, the relation of three cases were mutual follow relations and the relations of the other 52 cases were no follow relations. On January 12, 2022, we confirmed that eleven users gave eleven likes to her tweet on January 6, 2022, as shown in Figure 2, and finished the investigation on her tweet.

A. One Sided Follow relations between submitters and users who gave likes to submitters’ tweets

At first, we discuss the cases where submitters followed users who gave likes to their tweets, but the users did not follow the submitters. We call the follow relations between these submitters and users *one sided follow relations (from submitters)*. In order to discuss this type of follow relation, we introduce the ratio of one sided follow relations (from submitters) between a submitter and users who gave likes to his/her tweet. Suppose that the number of users who gave likes to tweet t is n and m of them do not follow the submitter of tweet t but are followed by him/her. Then, the ratio of one sided follow relations (from submitters) between the submitter of tweet t and the users who gave likes to it, $P_{OSFfromS}(t)$, is defined as follows:

$$P_{OSFfromS}(t) = \frac{m}{n}$$

Figure 7 shows the distribution of the ratio of one sided follow relations (from submitters) between the submitters of the obtained 318 tweets and the users who gave likes to them. Furthermore, Figures 7 (a) and (b) shows the distribution of them investigated on the Day 0 and Day 6, respectively. As shown in Figure 7, the ratio in each case was less than 0.2. There were few cases where two or more users who had one sided follow relations (from submitters) with a submitter gave likes to his/her tweet promising to disclose his/her personal information.

Next, we discuss the cases where submitters did not follow users who gave likes to submitters’ tweets, but the users followed the submitters. We call the follow relations between these submitters and users *one sided follow relations (to submitters)*. In order to discuss this type of follow relation, we introduce the ratio of one sided follow relations (to submitters) between a submitter and users who gave likes to his/her tweet. Suppose that the number of users who gave likes to tweet t is n and m of them follow the submitter of tweet t but are not followed by him/her. Then, the ratio of one sided follow relations (to submitters) between the submitter of tweet t and the users who gave likes to it, $P_{OSFtoS}(t)$, is defined as follows:

$$P_{OSFtoS}(t) = \frac{m}{n}$$

Figure 8 shows the distribution of the ratio of one sided follow relations (to submitters) between the submitters of the obtained

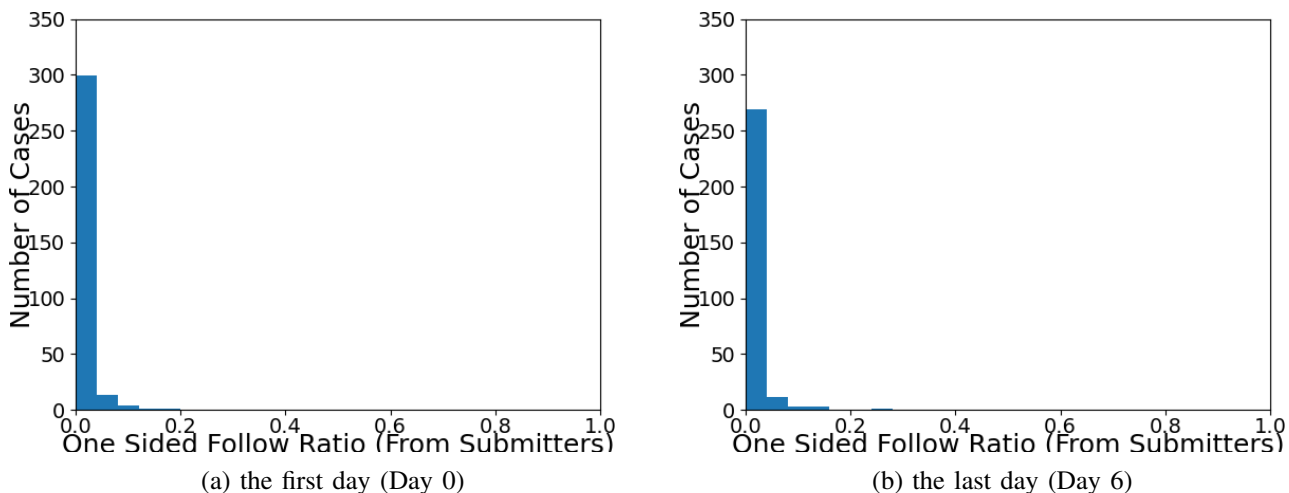


Figure 7. The histograms of the ratio of one sided follow relations (from submitters) between the submitters of the obtained 318 tweets and the users who gave likes to them on the first day (Day 0) and the last day (Day 6) of the investigation period.

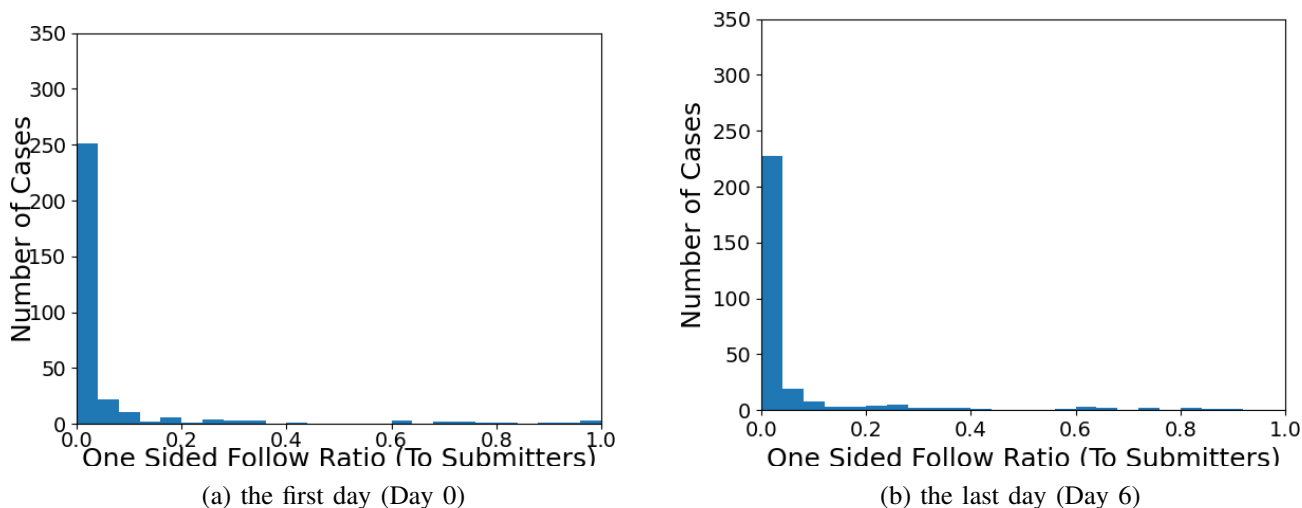


Figure 8. The histograms of the ratio of one sided follow relations (to submitters) between the submitters of the obtained 318 tweets and the users who gave likes to them on the first day (Day 0) and the last day (Day 6) of the investigation period.

318 tweets and the users who gave likes to them. In most cases, the ratio was less than 0.2. However, we found 14 cases where the ratio was more than 0.6. In one case of them, we found that 20 users gave likes to a single tweet promising to disclose submitter’s personal information and all of them had one sided follow relations (to submitters) with the submitter. Figure 8 shows that the number of users who had one sided follow relations (to submitters) with submitters did not decrease. It is probable that submitters were careful to follow unfamiliar users even if the users followed them and gave likes to their tweets.

B. One Sided Follow relations among users who gave likes to submitters’ tweets

We discuss the one sided follow relations among users who gave likes to tweets disclosing submitters’ personal information. In order to discuss this problem, we introduce the ratio

of one sided follow relations among users who gave likes to a tweet. Suppose that the number of users who gave likes to tweet t is n and there are m cases where one user of them follows another user but is not followed by the user. Then, the ratio of one sided follow relations among the users who gave likes to tweet t , $P_{OSFamongU}(t)$, is defined as follows:

$$P_{OSFamongU}(t) = \frac{m}{n(n - 1)/2}$$

Figure 9 shows the distribution of the ratio of one sided follow relations among the users who gave likes to the obtained 318 tweets. In most cases, the ratio was less than 0.1. Figure 9 shows that the number of users who had one sided follow relations with other users did not decrease. It is probable that users were careful to follow unfamiliar users even if the users followed them and gave likes to the same tweets.

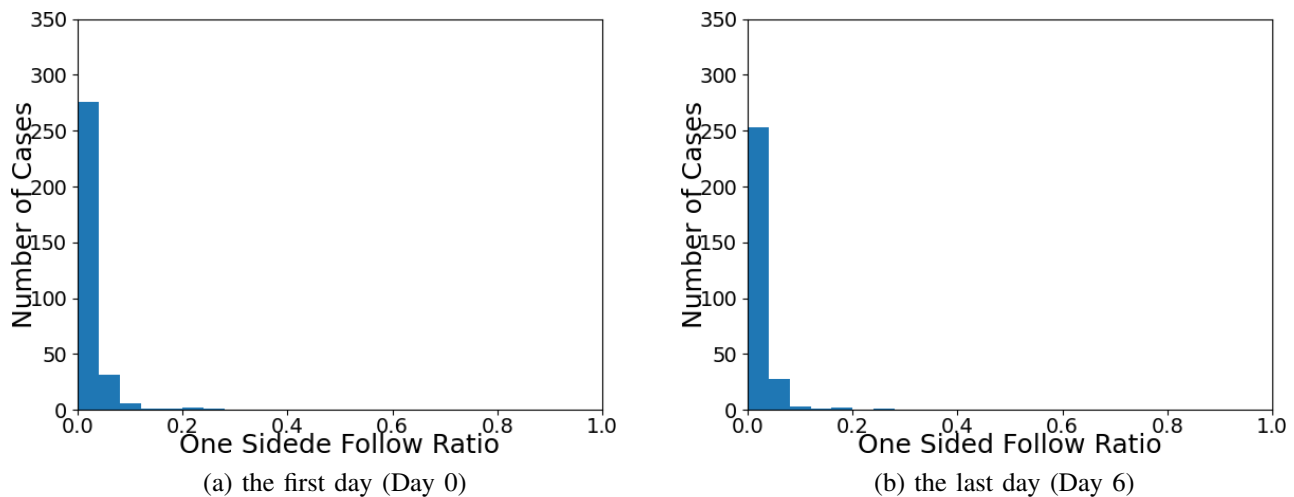


Figure 9. The histograms of the ratio of one sided follow relations among the users who gave likes to the obtained 318 tweets on the first day (Day 0) and the last day (Day 6) of the investigation period.

V. CONCLUSION

In this paper, we investigated the one sided relations between submitters and users who gave likes to submitters' tweets promising to disclose their personal information. The results of our investigation show that giving likes to tweets promising to disclose submitter's personal information is not a sufficient trigger to get to follow users. Submitters were careful to follow unfamiliar users even if the users followed them and gave likes to their tweets. Also, users were careful to follow unfamiliar users even if the users followed them and gave likes to the same tweets.

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