Detection of Japanese and English Tweets Where Birthdays are Revealed to Other People

Yasuhiko Watanabe, Naohiro Miyagi, Kenji Yasuda, Norimasa Mukai, Ryo Nishimura, and Yoshihiro Okada
Ryukoku University
Seta, Otsu, Shiga, Japan
Email: watanabe@rins.ryukoku.ac.jp, t120499@mail.ryukoku.ac.jp, t130522@mail.ryukoku.ac.jp,
t130514@mail.ryukoku.ac.jp, r_nishimura@afc.ryukoku.ac.jp, okada@rins.ryukoku.ac.jp

***Abstract*—These days, many people use a social networking service (SNS). When we use SNSs, we carefully protect the privacy of personal information: name, age, gender, address, telephone number, birthday, etc. However, we often reveal birthdays on SNS, not only ours but also of others. Birthday information can threaten our privacy and security when combined with other personal information. In this study, we investigated Japanese and English tweets where birthdays were revealed to other people, including unwanted audiences. We collected 1,000 Japanese tweets and 1,000 English tweets including word "birthday" and found about 30% of the collected Japanese tweets and 70% of the English tweets were tweets revealing someone's birthdays to other people. Furthermore, about 70% of Japanese tweets and 90% of English tweets revealing someone's birthdays to other people were ones where receivers' birthdays were revealed. We obtained 88% accuracy when we applied support vector machine (SVM) machine learning techniques to classify Japanese and English tweets including word "birthday" into ones revealing birthdays of senders, receivers, and others. However, the recall rate of Japanese and English tweets revealing senders' birthdays were only 17% and 30%, respectively.**

Keywords–birthday; personal information; Twitter; SNS; privacy risk.

I. INTRODUCTION

These days, many people use a social networking service (SNS). These users, especially young users, tend to disclose personal information on their SNS profiles seemingly without much concern for the potential privacy risks. They seem to believe the benefits of disclosing personal information in order to use SNSs is greater than the potential privacy risks. Furthermore, they often reveal personal information on SNSs, not only theirs but also of others. For example, (exp 1) is a comment on a Facebook user profile.

(exp 1) I hope you had an amazing birthdayyy!

This comment was time-stamped. As a result, anyone, including unwanted audiences, could understand this user's birthday even if the user did not disclose his/her birthday on the profile. Also, we often find tweets where we can understand someone's birthday.

(exp 2) *Atashi no tanjyobi ha 8 gatu youka yo, Risshu tte itte 1 nen de mottomo atsui hi rashii wane–. Koyomi no ue deha dayo?*
(My birthday is August 8th, that is, the beginning day of autumn, and seems to be the hottest day of the year. Well, it is according to the calendar, you know?)

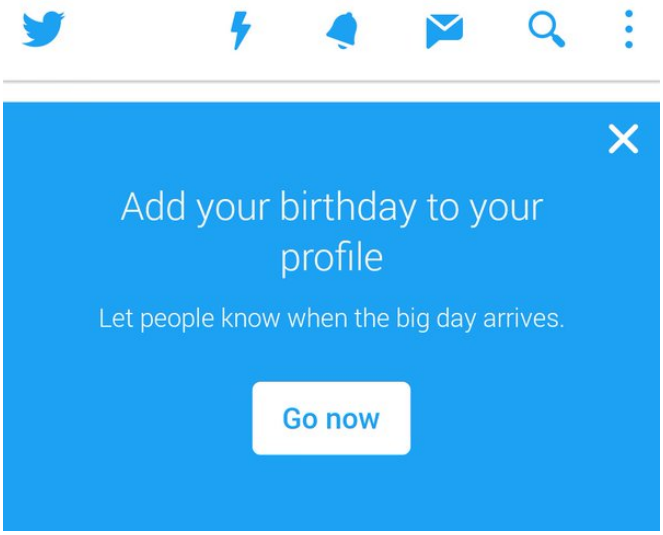

Figure 1. Twitter recommends us to add our birthdays to our profiles.

(exp 3) *@kahuhi kahuhi san tanjyobi omedetou goza-imasu!!*
(@kahuhi Mr. kahuhi, happy birthday!!)

Both (exp 2) and (exp 3) are tweets on Twitter. The sender of (exp 2) disclosed her birthday by herself. On the other hand, the sender of (exp 3) revealed his/her friend's birthday. In this paper, we focus on birthday information because we treat it different than other personal information. For example, if someone revealed our name, address, age, gender, telephone number, or social security number on a SNS, we would get upset with him/her for doing it. On the other hand, interestingly, if someone revealed our birthday in his/her birthday message on a SNS, like (exp 3), most of us would appreciate what he/she does, like (exp 4) and (exp 5).

(exp 4) *message kureta minna arigatou. yoi tanjyobi ni narimashita* – (＊^^＊)
(Thank you for birthday messages. I have a nice birthday – (＊^^＊))

(exp 5) *@taguma6 reina no mama no tanjyobi oboete kurete runyane, arigatou, sasuga*
(@taguma6 I'm glad to hear that you remember my mother's birthday. Thank you. Amazing.)

Birthday messages often give us opportunities to start new communications. As a result, as shown in Fig. 1, Twitter recommends us to add our birthday to our profiles. It is likely that these kinds of recommendations let SNS users discount the potential risks related to disclosing personal information. However, birthday information can be linkable to a specific individual when it is combined with other information. In order to deal with the privacy risks, it is important to investigate how we disclose or reveal personal information on SNSs, not only ours but of others. Birthday information especially should be investigated carefully because we treat it different than other personal information. Furthermore, it is important to investigate whether unwanted audiences can collect revealed personal information automatically. To solve these problems, we investigated Japanese tweets where birthdays are revealed to other users and showed how Japanese Twitter users communicate with each other about their birthdays [1]. In this paper, we investigate not only Japanese tweets but also English tweets where birthdays are revealed to other users. Furthermore, we discuss whether unwanted audiences can collect revealed birthday information from tweets by using machine learning techniques.

The rest of this paper is organized as follows: In Section II, we survey the related works. In Section III, we report how we disclose or reveal birthday information on Twitter. In Section IV, we discuss whether unwanted audiences can collect revealed birthday information from tweets by using machine learning techniques. 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, 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. In order to discuss this phenomenon, many researchers investigated how much and which type of information are revealed in SNSs, especially, in Facebook. Stutzman investigated Facebook profiles of University of North Carolina at Chapel Hill freshmen and found that 96.2% of them published their birthdays on their Facebook profiles, 74.7% their political views and 83.2% their sexual orientation [6]. Gross and Acquisti investigated Facebook profiles of Carnegie Mellon University students and found that 87.8% of them reveal their birth date on their profiles, 39.9% list their phone number, and 50.8% list their current residence [7]. Taraszow et al. observed Facebook profiles of 131 young people (68 females and 63 males, ages ranged from 14 to 29 years) and found that all participants disclosed their birthdays and 54.2% list their hometowns on their Facebook profiles [8]. Taraszow et al. also observed Cypriot Facebook users and found that they were willing to share personal information. All of them published their real names, 97% revealed their gender, 97% published their facial profile pictures, 51% indicated their hometowns and 88% published their date of birth [9]. Huffaker and Calvert studied 70 teenage bloggers and found that 70% of them published their first names, 20% list their full names, 67% list their ages, and 39% list their birthdays [10]. Based on these results, researchers discussed the reasons why users willingly disclose personal information on their SNS profiles. Dwyer concluded in her research that privacy is often not expected or undefined in SNSs [11]. Barnes argues that Internet users, especially teenagers, are not aware of the nature of the Internet and SNSs [12]. Hirai reported that many users had troubles in SNSs because they did not mind that strangers observed their communication with their friends [13]. Viseu et al. reported that many online users believe the benefits of disclosing personal information in order to use an Internet site is greater than the potential privacy risks [14]. 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 [15]. Joinson et al. reported that trust and perceived privacy had a strong affect on individuals' willingness to disclose personal information to a website [16]. 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 [17].

Next, we survey studies that focus on the issue of potential privacy risks of disclosing personal information. Birthday information alone cannot threaten the privacy and security of users. However, it can expose users' identities and threaten their privacy when combined with other personal information disclosed in their profiles. Sweeney reported 87% of Americans can be uniquely identified from a birth date, five-digit zip code, and gender [18]. Acquisti and Gross reported the existence of a potential ability to reconstruct users' social security numbers utilizing a combination of information often found in profiles, such as their full name, date of birth and hometown [5]. Many banks and credit-card companies recommend their customers to select a personal identification number (PIN) that cannot be easily guessed, for example, birth date [19] [20]. Bonneau et al. investigated 805 participants and found that 23% of them chose their PINs representing dates [21]. Furthermore, Bonneau et al. asked users about the significance of the dates in their PINs: 29% of them used their own birthday, 26% the birthday of a partner or family member, and 25% an important life event like an anniversary or graduation. As a result, we should be aware of the potential privacy risks on SNSs and manage our personal information carefully. SNSs do not force users to reveal personal information. However, we think, they actually recommend and encourage them to do so. As shown in Fig. 1, Twitter recommended users to add their birthdays on their Twitter profiles. On the other hand, Twitter enables each user to set the visibility preferences for his/her birthday on the profile from options [22] [23]:

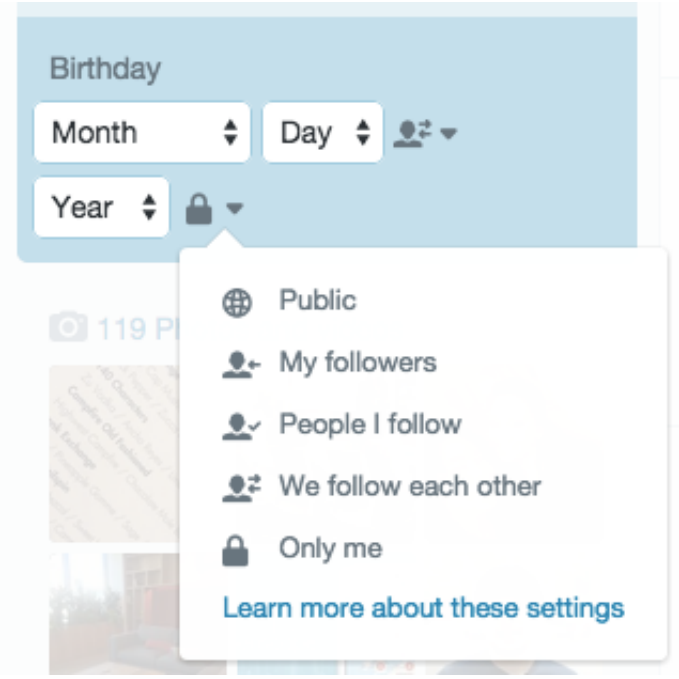

Figure 2. A Twitter user can set the visibility preferences for his/her birthday on the profile.

- public,
- limited audience, or
- closed.

Fig. 2 shows a Twitter profile where a user sets the visibility preferences for his/her birthday. However, even if a user set it closed, his/her birthday would be revealed to others when the following kind of tweets was submitted.

(exp 6) *@446xx110rn tanjyobi omedetou!!*
(@446xx110rn Happy birthday!!)

We found many tweets where someone's birthdays were revealed and linked to specific Twitter accounts. We may say that Fig. 1 and Fig. 2 show a disconnection between the Twitter's desire to protect their users' privacy and their actual behavior.

III. Investigation of Tweets Where Birthdays are Revealed to Other People

In this section, we show how we disclose or reveal birthday information on Twitter.

A. The investigation object

We collected

- 1,000 Japanese tweets including word "*tanjyobi* (birthday)" in December 2015 and
- 1,000 English tweets including word "birthday" in December 2016.

We used these 2,000 tweets for investigating tweets where birthdays were revealed to other people.

Tweets can be classified into three types [24]:

- reply
  A reply is submitted to a particular person. It contains "@username" in the body of the tweet. For example, (exp 3), (exp 5), and (exp 6) are replies.
- retweet
  A retweet is a reply to a tweet that includes the original tweet.
- normal tweet
  A normal tweet is neither reply nor retweet. For example, (exp 2) and (exp 4) are normal tweets. Normal tweets are generally submitted to general public.

Fig. 3 shows the numbers and percentages of normal tweets, replies, and retweets in the 1,000 Japanese tweets. As shown in Fig. 3, there were no retweets in the 1,000 Japanese tweets. On the other hand, Fig. 4 shows the numbers and percentages of normal tweets, replies, and retweets in the 7,085,267 Japanese tweets obtained in November and December 2012 by using the streaming API [25]. The comparison of Fig. 3 with Fig. 4 shows that word "*tanjyobi* (birthday)" was used more frequently in replies than normal tweets. We classified these 1,000 Japanese tweets into three types:

TYPE S tweets where senders' birthdays were disclosed by themselves,
TYPE R tweets where receivers' birthdays were revealed by senders, and
TYPE N tweets where no one's birthdays were revealed.

Table I shows the classification result of the 1,000 Japanese tweets. We corrected the classification result reported in our previous study [1]. Especially, we carefully classified replies submitted to user accounts that were not open to the public. In our previous study [1], all the replies submitted to closed user accounts were classified into TYPE N. However, in this study, replies disclosing senders' birthdays and receivers' birthdays are classified into TYPE S and TYPE R, respectively, although they were submitted to closed user accounts. As shown in Table I, there were 326 tweets revealing senders' or receivers' birthdays. Furthermore, the number of tweets revealing receivers' birthdays (234 tweets) was more than twice the number of tweets revealing senders' birthdays (92 tweets). In this study, a tweet where someone's birthday was revealed but could not be linked to a specific Twitter account was classified into TYPE N: tweets where no one's birthdays were revealed. For example, the birthdays of *oniichan* (brother) in (exp 7) and *Chihiro Iwasaki* in (exp 8) were revealed but could not be linked to their Twitter accounts. As a result, in this study, these tweets were classified into TYPE N.

(exp 7) *kyou ha jikkei no tanjyobi! oniichan tanjyobi omedetou – ! 18 kin kaikin toka otona yana...*
(Today is my elder brother's birthday! Happy birthday, brother. Now, you can watch movies for adults only...)
(exp 8) *Iwasaki Chihiro san no tanjyobi nanoka*
(Today is the birthday of Chihiro Iwasaki.)

Chihiro Iwasaki was a famous Japanese artist.

Fig. 5 shows the numbers and percentages of normal tweets, replies, and retweets in the 1,000 English tweets. As with the Japanese tweets, Fig. 5 shows that there were no retweets in the 1,000 English tweets. On the other hand, Fig. 6 shows the numbers and percentages of normal tweets, replies, and retweets in the 31,253,241 English tweets obtained in

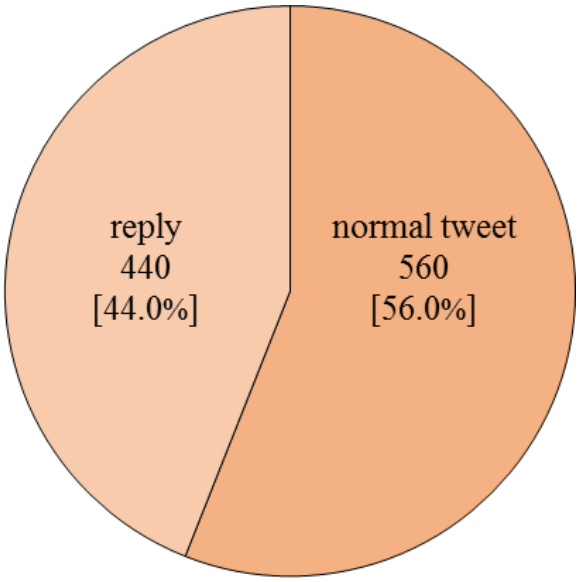

Figure 3. The percentages of normal tweets, replies, and retweets in the 1,000 Japanese tweets including "*tanjyobi* (birthday)" (in December 2015).

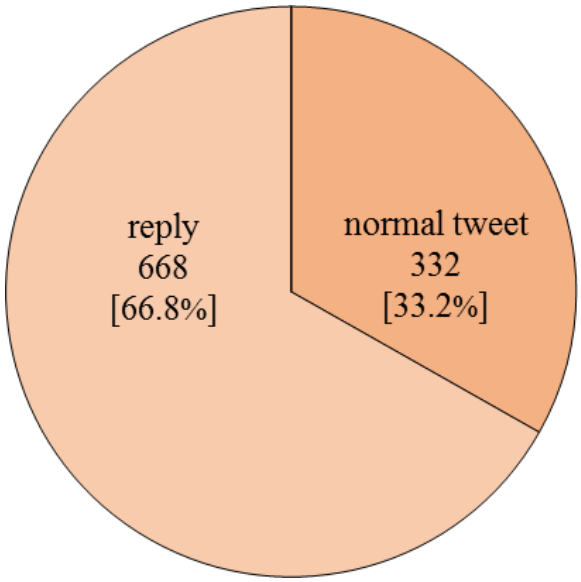

Figure 5. The percentages of normal tweets, replies, and retweets in the 1,000 English tweets including "birthday" (in December 2016).

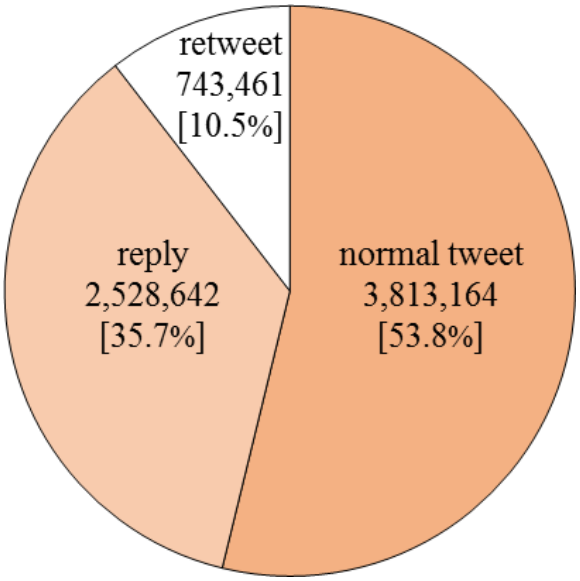

Figure 4. The percentages of normal tweets, replies, and retweets in the 7,085,267 Japanese tweets (in November and December 2012).

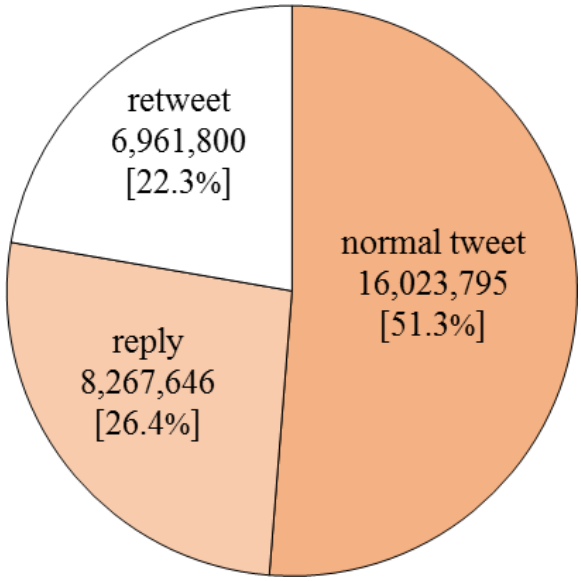

Figure 6. The percentages of normal tweets, replies, and retweets in the 31,253,241 English tweets (in November and December 2012).

TABLE I. THE CLASSIFICATION RESULT OF THE 1,000 JAPANESE TWEETS OBTAINED IN DECEMBER 2015 (BY HUMAN EXPERTS).

TYPE	whose birthday is revealed	normal tweet	reply	total
TYPE S	sender	56	36	92
TYPE R	receiver	0	234	234
TYPE N	no one	504	170	674
	total	560	440	1,000

TABLE II. THE CLASSIFICATION RESULT OF THE 1,000 ENGLISH TWEETS OBTAINED IN DECEMBER 2016 (BY HUMAN EXPERTS).

TYPE	whose birthday is revealed	normal tweet	reply	total
TYPE S	sender	62	21	83
TYPE R	receiver	0	604	604
TYPE N	no one	270	43	313
	total	332	668	1,000

November and December 2012. As with Japanese tweets, the comparison of Fig. 5 with Fig. 6 shows that word "birthday" was used more frequently in replies than normal tweets. Table II shows the classification result of the 1,000 English tweets. As shown in Table II, 70% of the 1,000 English tweets were tweets revealing someone's birthdays to other people. Furthermore, 90% of English tweets revealing someone's birthdays to other people were ones where receivers' birthdays were revealed.

B. Tweets where birthdays are revealed

1) Tweets where senders' birthdays are revealed (TYPE S): In order to start new communications on Twitter, many users submitted tweets where their birthdays were disclosed by themselves. The point is that senders disclosed their birthdays not only in normal tweets but replies. Both (exp 9) and (exp 10) were normal tweets where senders' birthdays were disclosed by themselves.

(exp 9) *kyou tanjyobi nanode dareka nonde kudasai!!!!*
(Today is my birthday. Does anyone keen to go drinking with me!!!!)

(exp 10) *shi-a-wa—se suggoi tanoshii tanjyobi deshita–!!! minasan no okagedesu. arigatou gozaimasu. toriaezu ashi itasugiru. hayo ie tsukan ka na-n*
(H-A-P-P-Y I had a very happy birthday!!! I do appreciate you. Thank you. Just say my foot hurts. I want to go home soon.)

On the other hand, (exp 11) was a reply where sender's birthday was disclosed by himself/herself.

(exp 11) @*takutwu_w takuto kun– kyou tanjyobi nanda oiwai rep hoshii na*
(@takutwu_w Takuto kun–, today is my birthday. Give me your birthday message, please.)

As shown in Table I and Table II, senders' birthdays were disclosed in normal tweets more frequently than replies. (exp 9) and (exp 10) were normal tweets and the senders of them wanted to communicate with anyone. On the other hand, (exp 11) was a reply and the sender of it wanted to communicate with a particular person (@takutwu_w). However, all of (exp 9), (exp 10), and (exp 11) were submitted for starting new communications on Twitter. On the other hand, (exp 12) was a reply where the sender disclosed her birthday not because she wanted to start a new communication but because she was asked when her birthday was.

(exp 12) @*kmns6_n teru-chan kon* (＊´∇｀＊) *sou nano–kinou tanjyobi deshita. arigatoune–* ♡ *mata hitotsu toshi wo totte shimatta wa zutto nannimo itte kurenai kara akirame tetanda kedo, ureshii* ♪
(@kmns6_n Teru-chan hello (＊´∇｀＊) Yes. Yesterday was my birthday. Thank you ♡ I got another year older again. I have got your birthday message out of my mind because you said nothing for a long time. I am happy ♪)

All of (exp 9), (exp 10), (exp 11), and (exp 12) were submitted within one day of senders' birthdays. On the other hand, (exp 13) and (exp 14) were not. The senders of (exp 13) and (exp 14) disclosed their birthdays by showing the dates.

(exp 13) *boku no tanjyobi ha, 2007 nen 9 gatsu 20 nichi goro da nya–* (＾＾)
(My date of birth is September 20, 2007 –(＾＾))

(exp 14) @*alex_hayate shigusa...uwame dukai toka? a, tanjyobi ha 8 gatsu nanoka desu*
(@alex_hayate gesture... up-from-under look? Oh, my birthday is August 7.)

The sender of (exp 15) disclosed his birthday by showing not the date but the festival day, *Tanabata*, when he was born.

(exp 15) *bokura no tanjyobi wa tanabata. orihime to hikoboshi ga, chotto shita kiseki wo purezento shite kurerun da.*
(Our birthday is Tanabata. Orihime and Hikoboshi will give us a little miracle.)

All of (exp 9), (exp 10), (exp 11), (exp 12), (exp 13), (exp 14), and (exp 15) were classified into TYPE S. On the other hand, (exp 16) was classified into TYPE N: tweets where no one's birthdays were revealed. This is because the sender of (exp 16) disclosed his birthday by using a metaphorical expression, mid-summer Christmas Eve. As a result, we determined that sender's birthday of (exp 16) was unclear. We shall discuss tweets classified into TYPE N later.

(exp 16) @*keirin55keigo @yuma123007 manatsu no Christmas Eve ga boku no tanjyobi!*
(@keirin55keigo @yuma123007 mid-summer Christmas Eve is my birthday!)

Sender's birthday of (exp 17) was also unclear. The sender of (exp 17) disclosed her birthday by showing not the date but whom she shared the same birthday with.

(exp 17) *masaka no furukawa yuuki kun to onaji tanjyobi ww majime ni ureshii desu*
(Oh, I share the same birthday with Yuuki Furukawa kun ww Very happy.)

Yuuki Furukawa in (exp 17) was an actor and his birthday might be published. However, we did not understand his birthday with just (exp 17). As a result, we determined that sender's birthday of (exp 17) was unclear. In this study, tweets where birthdays were revealed unclearly, such as (exp 16) and (exp 17), were classified into TYPE N.

2) Tweets where receivers' birthdays are revealed (TYPE R): As shown in Table I and Table II, tweets where receivers' birthdays were revealed by senders were all replies. Furthermore, almost half of Japanese replies including word "*tanjyobi* (birthday)" were ones revealing receivers' birthdays. Also, 90% of English replies including word "birthday" were ones revealing receivers' birthdays. Tweets revealing receivers' birthdays were almost birthday messages to them, such as (exp 18).

(exp 18) @*nami_1215_ nami tanjyobi omedetou!!!*
(@nami_1215_ Nami happy birthday!!!)

Birthday messages were mainly submitted into Twitter on receiver's birthdays. However, we often found belated birthday messages on Twitter, such as (exp 19).

(exp 19) @*identity_u 1 nichi okure desu kedo, tanjyobi omedetou gozaimasu?*
(@identity_u one day late, but anyway, happy birthday?)

Belated birthday messages can be classified into two types:

- belated birthday messages from which we can understand when receivers' birthdays were, and
- belated birthday messages from which we cannot understand when receivers' birthdays were.

For example, (exp 19) is classified into the former type. On the other hand, (exp 20) and (exp 21) are classified into the latter type. This is because it is unclear how late (exp 20) was submitted into Twitter from receiver's birthday. Also, it is unclear how early (exp 21) was submitted into Twitter before receiver's birthday. In this study, the former type of tweets were classified into TYPE R. On the other hand, the latter type of tweets were classified into TYPE N.

(exp 20) *@ayaka_li_u3u ayaka osoku natta kedo tanjyobi omedetou*
(@ayaka_li_u3u ayaka, belated happy birthday to you)

(exp 21) *@0218tom0 tanjyobi wa, mada, dakedo, tanjyobi omedetou?? ToMo ga, shiawase tte omotte kuretara, watasi ha, cho shiawase dayo??*
(@0218tom0 a little bit early, but, happy birthday?? If ToMo feels happy, I am very happy, aren't I??)

3) Tweets revealing no one's birthdays (TYPE N): Tweets where birthdays could not be linked to specific Twitter accounts, such as (exp 22), (exp 23), and (exp 24), were classified into TYPE N: tweets where no one's birthdays were revealed.

(exp 22) *ke-taman tanjyobi omedetou –*
(ke-taman happy birthday –)

(exp 23) *kyou ha daisuki na aya chan no tanjyobi!!!*
(Today is my favorite Aya's birthday!!!)

(exp 24) *@hokoa_a Valentine Day- yade w Jingu no tanjyobi ww tsuraa www watashi ha iroiro dashi sugite tsurai ww*
(@hokoa_a Valentine's Day w Jingu's birthday ww hard www I had a hard time of it ww)

(exp 25) was also classified into TYPE N. This is because it is unclear whether (exp 25) was submitted on sender's birthday or before.

(exp 25) *@AhyonCulturismo,@is9_miku N? ore heno tanjyobi puresento youi shite kureteru no ? sho–ga nai na–. morai ni ittya ou kana* (^○^)
(@AhyonCulturismo,@is9_miku Oh? Do you prepare a present for me? Oh, well. I'm gonna get it (^○^))

It is unclear whose birthday live streaming the sender of (exp 26) provided. As a result, (exp 26) was classified into TYPE N.

(exp 26) *kyou ha 0ji kara kossori tanjyobi oiwai CAS shimasu* (● ´ ω ` ●)
(I will secretly provide a happy birthday live streaming from midnight tonight (● ´ ω ` ●))

It is clear that the sender of (exp 27) and chiipopo shared the same birthday. However, it is unclear when their same birthday was. As a result, (exp 27) was classified into TYPE N.

(exp 27) *watashi chiipopo to tanjyobi onaji yawa*
(I share the same birthday with chiipopo.)

TABLE III. FEATURES USED IN SVM METHOD FOR DATA TRAINING AND CLASSIFYING JAPANESE TWEETS AND ENGLISH TWEETS INCLUDING WORD "*tanjyobi* (BIRTHDAY)" AND "BIRTHDAY", RESPECTIVELY.

$s1$	word unigrams of the tweet
$s2$	word bigrams of the tweet
$s3$	the number of words in the tweet
$s4$	word unigrams of the first sentence of the tweet
$s5$	word bigrams of the first sentence of the tweet
$s6$	the number of words in the first sentence of the tweet
$s7$	the last word of the first sentence of the tweet
$s8$	character unigrams of the tweet
$s9$	character bigrams of the tweet
$s10$	character 3-grams of the tweet
$s11$	the length of the tweet
$s12$	character unigrams of the first sentence of the tweet
$s13$	character bigrams of the first sentence of the tweet
$s14$	character 3-grams of the first sentence of the tweet
$s15$	the length of the first sentence of the tweet
$s16$	whether the tweet is a reply

The senders of (exp 28) and (exp 29) showed what had happened or would happen on their birthdays. However, they did not show when their birthdays were. As a result, (exp 28) and (exp 29) were classified into TYPE N.

(exp 28) *22 sai no tanjyobi ni* -20 °C *no yukiyama de fuhatsudan shori shiteta.*
(On my 22th birthday, I did bomb disposal work in a snowy mountain, minus 20 degrees.)

(exp 29) *tanjyobi ni intern kakutei shita shini tai*
(I have to work on an internship program on my birthday. I'd rather die.)

The sender of (exp 30) asked the receiver when her birthday was. We could not understand her birthday with just (exp 30). As a result, (exp 30) was classified into TYPE N.

(exp 30) *iku chan kyou tanjyobi jya nakatta?*
(Iku chan. Is today your birthday?)

Tweets dealing with topics related to "birthday", but not someone's birthday, such as (exp 31) and (exp 32), were classified into TYPE N.

(exp 31) *jissai, 2/29 umare no hito tte inno?? koseki ni 2/29 tte touroku shitara 4 nen ni 1 kai shika tanjyobi konai yona.*
(Actually, are there people born on Feb.29?? If the birthdays were registered correctly, they would have their birthday every four years.)

(exp 32) *@BBCNNHK douse nara suihanki to nanige nai kaiwa shite tanjyobi oboete kureru tekina yatsu ga eena*
(@BBCNNHK I might as well buy a rice cooker that deduces my birthday from a daily chat.)

IV. DETECTION OF TWEETS WHERE BIRTHDAYS ARE REVEALED TO OTHER PEOPLE

If we detect tweets revealing someone's birthdays automatically, we can give warnings to users before they submit their

TABLE IV. THE SVM CLASSIFICATION RESULT OF THE 1,000 JAPANESE TWEETS INCLUDING WORD "*tanjyobi* (BIRTHDAY)".

whose birthday is revealed	SVM result			
	sender	receiver	no one	recall
sender	16	5	71	0.17
receiver	0	212	22	0.91
no one	3	18	653	0.97
precision	0.84	0.90	0.88	

TABLE V. THE SVM CLASSIFICATION RESULT OF THE 560 JAPANESE NORMAL TWEETS INCLUDING WORD "*tanjyobi* (BIRTHDAY)".

whose birthday is revealed	SVM result			
	sender	receiver	no one	recall
sender	7	0	49	0.13
receiver	0	0	0	—
no one	1	3	500	0.99
precision	0.88	0.00	0.91	

TABLE VI. THE SVM CLASSIFICATION RESULT OF THE 440 JAPANESE REPLIES INCLUDING WORD "*tanjyobi* (BIRTHDAY)".

whose birthday is revealed	SVM result			
	sender	receiver	no one	recall
sender	9	5	22	0.25
receiver	0	212	22	0.91
no one	2	15	153	0.90
precision	0.82	0.91	0.78	

TABLE VII. THE SVM CLASSIFICATION RESULT OF THE 1,000 ENGLISH TWEETS INCLUDING WORD "BIRTHDAY".

whose birthday is revealed	SVM result			
	sender	receiver	no one	recall
sender	25	12	46	0.30
receiver	1	595	8	0.99
no one	28	34	251	0.40
precision	0.46	0.93	0.82	

TABLE VIII. THE SVM CLASSIFICATION RESULT OF THE 332 ENGLISH NORMAL TWEETS INCLUDING WORD "BIRTHDAY".

whose birthday is revealed	SVM result			
	sender	receiver	no one	recall
sender	20	0	42	0.32
receiver	0	0	0	—
no one	25	1	244	0.90
precision	0.44	0.00	0.85	

TABLE IX. THE SVM CLASSIFICATION RESULT OF THE 668 ENGLISH REPLIES INCLUDING WORD "BIRTHDAY".

whose birthday is revealed	SVM result			
	sender	receiver	no one	recall
sender	5	12	4	0.24
receiver	1	595	8	0.99
no one	3	33	7	0.16
precision	0.56	0.93	0.37	

tweets where someone's birthdays are revealed. In this section, we discuss whether we can automatically detect tweets where someone's birthdays are revealed by using machine learning techniques.

In this study, we used the support vector machine (SVM) for data training and classifying. Table III shows feature $s1 \sim s16$ used in machine learning on experimental data. $s1 \sim s7$ were obtained by using the results of morphological analysis on experimental data. In the experiments, we used a Japanese morphological analyzer, JUMAN, for word segmentation of Japanese tweets [26]. Also, we used the TreeTagger for annotating English tweets with part-of-speech and lemma information [27] [28] [29]. $s8 \sim s10$ and $s12 \sim s14$ were obtained by extracting character N-gram from experimental data. Odaka et al. reported that character 3-gram is good for Japanese processing [30]. $s4 \sim s7$ and $s12 \sim s15$ were obtained from first sentences of tweets. This is because, we thought, clue expressions of birthday messages are often found at first sentences of tweets.

In this study, we used the 1,000 Japanese tweets and 1,000 English tweets investigated in Section III for the experimental data. We conducted this experiment using TinySVM [31]. Table IV shows the experimental result of the 1,000 Japanese tweets. The experimental result was obtained with 10-fold cross-validation. As shown in Fig. 3, the experimental data of the Japanese tweets consisted of 560 normal tweets and 440 replies. We divided the experimental result of the 1,000 Japanese tweets (Table IV) into those of 560 normal tweets (Table V) and 440 replies (Table VI). On the other hand, Table VII shows the experimental result of the 1,000 English tweets. As shown in Fig. 5, the experimental data of the English tweets consisted of 332 normal tweets and 668 replies. We also divided the experimental result of the 1,000 English tweets (Table VII) into those of 332 normal tweets (Table VIII) and 668 replies (Table IX).

As shown in Table IV, 881 Japanese tweets were classified correctly and 119 tweets incorrectly in this experiment. 76 tweets out of the 119 incorrectly classified tweets were ones where senders' birthdays were revealed. As shown in Table IV, the recall of Japanese tweets revealing senders' birthdays were 17%. As shown in Table V and Table VI, many Japanese normal tweets and replies revealing senders' birthdays were classified incorrectly into tweets revealing no one's birthdays. On the other hand, as shown in Table VII, 871 English tweets were classified correctly and 129 tweets incorrectly in this experiment. 58 tweets out of the 129 incorrectly classified tweets were ones where senders' birthdays were revealed. As shown in Table VII, the recall of English tweets revealing senders' birthdays were 30%. As shown in Table VIII and Table IX, many English normal tweets and replies revealing senders' birthdays were classified incorrectly into tweets revealing no one's birthdays and receivers' birthdays, respectively. As a result, it is difficult to detect Japanese and English tweets revealing senders' birthdays and give warnings to senders before they submit tweets revealing their birthdays. On the other hand, Table IV shows the precision of Japanese tweets revealing senders' and receivers' birthdays were 84% and 90%, respectively. Also, Table VII shows the precision of English

TABLE X. THE CLASSIFICATION RESULT OF THE 500 JAPANESE TWEETS FOR TESTING (IN DECEMBER 2016) (BY HUMAN EXPERTS).

TYPE	whose birthday is revealed	normal tweet	reply	total
TYPE S	sender	34	14	48
TYPE R	receiver	0	168	168
TYPE N	no one	202	82	284
	total	236	264	500

TABLE XI. THE CLASSIFICATION RESULT OF THE 500 ENGLISH TWEETS FOR TESTING (IN DECEMBER 2016) (BY HUMAN EXPERTS).

TYPE	whose birthday is revealed	normal tweet	reply	total
TYPE S	sender	38	5	43
TYPE R	receiver	0	328	328
TYPE N	no one	120	9	129
	total	158	342	500

tweets revealing receivers' birthdays was 93%. Our method is useful for collecting tweets revealing birthdays, especially tweets revealing receivers' birthdays, precisely. As a result, it is easy for attackers to collect birthday information related to specific Twitter accounts by using our method.

Next, we discuss the number of tweets for data training. We conducted closed and open tests to measure the accuracy of the SVM classifier developed by using tweets investigated in Section III. In this experiments, we introduced the following data sets for the open tests:

- 500 Japanese tweets including word "*tanjyobi* (birthday)" (obtained in December 2016) and
- 500 English tweets including word "birthday" (obtained in December 2016).

Table X and Table XI show the classification results of the 500 Japanese and English tweets, respectively. There were no duplicate tweets between these data sets and tweets investigated in Section III. The accuracy values in Fig. 7 and Fig. 8 are ten times average values of the accuracy of classifying tweets into ones revealing birthdays of senders, receivers, and others. Fig. 7 and Fig. 8 show that, both in the closed tests and open tests, we obtained about 80% accuracy when we used only 100 tweets for data training. The accuracy was slightly improved as the number of tweets for data training increased. The point is that, as shown in Table IV and Table VII, the recall of tweets revealing senders' birthdays was low even if we used 1,000 tweets for data training. The recall rate of Japanese and English tweets revealing senders' birthdays were only 17% and 30%, respectively. As a result, it is difficult to develop an SVM detecting tweets revealing senders' birthdays.

V. CONCLUSION

Many people willingly disclose their birthdays on their SNS profiles and reveal others' birthdays on their SNS messages. They seem unaware of the potential risks of doing it. Birthday information alone cannot threaten their privacy and security. However, it can expose users' identities and threaten their privacy when combined with other personal

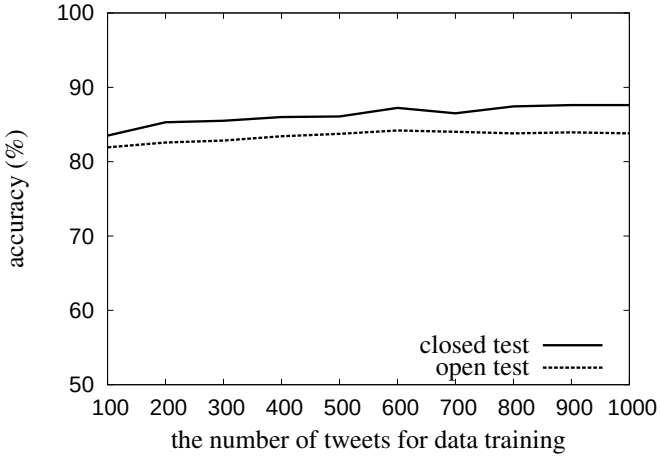

Figure 7. The accuracy of classifying Japanese tweets into ones revealing birthdays of senders, receivers, and others.

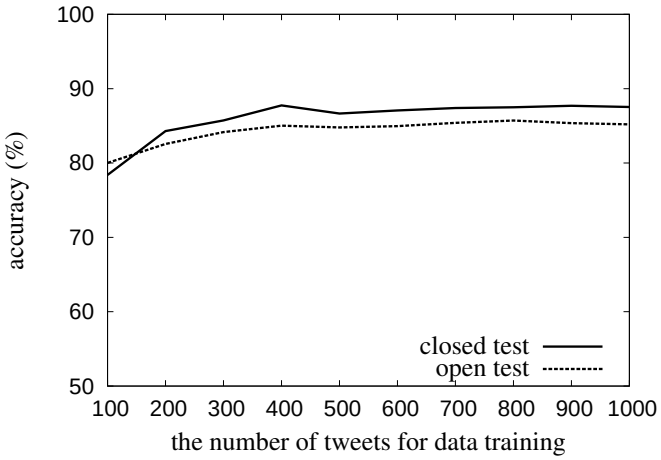

Figure 8. The accuracy of classifying English tweets into ones revealing birthdays of senders, receivers, and others.

information disclosed in their profiles. Interestingly, we treat birthday information different than other personal information. For example, if someone revealed our personal information except birthday on a SNS, we would get upset him/her for doing it. On the other hand, if someone revealed our birthday in his/her birthday message on a SNS, most of us would feel happy and appreciate what he/she does. However, we have not sufficiently investigated how we reveal birthday information on SNSs. As a result, the authors investigated how we reveal birthday information on SNSs, not only ours but of others.

In this study, we investigated tweets where someone's birthdays were revealed to other people. We collected 1,000 Japanese tweets including word "*tanjyobi* (birthday)" and found that about 30% of them were tweets where someone's birthdays were revealed to other people. Furthermore, about 70% of Japanese tweets revealing someone's birthdays were ones where receivers' birthdays were revealed by senders. We also collected 1,000 English tweets including word "birthday" and found that about 70% of them were tweets where someone's birthdays were revealed to other people. Furthermore,

about 90% of English tweets revealing someone's birthdays were ones where receivers' birthdays were revealed by senders. In this study, we proposed a method of detecting tweets revealing someone's birthday by using machine learning techniques. The experimental results showed that our method was able to classify Japanese tweets including word "*tanjyobi* (birthday)" and English tweets including word "birthday" with accuracy of 88% and 87%, respectively. However, the recall of Japanese and English tweets revealing senders' birthday were only 17% and 30%, respectively. As a result, in our method, it is difficult to detect tweets revealing senders' birthdays and give warnings to senders before they submit them. On the other hand, the precision of Japanese tweets revealing senders' and receivers' birthdays were 71% and 82%, respectively. Also, the precision of English tweets revealing receivers' birthdays was 93%. As a result, in our method, it is not difficult to collect tweets revealing birthdays, especially tweets revealing receivers' birthdays, precisely. We recommend that birthday messages should not be sent via SNSs. This is because unwanted audiences can read and collect them. We are now investigating other language tweets where birthdays are disclosed or revealed to other people.

REFERENCES

[1] Y. Watanabe, N. Miyagi, K. Yasuda, R. Nishimura, and Y. Okada, "Detection of tweets where birthdays are revealed to other people," in Proceedings of the Eighth International Conference on Evolving Internet (INTERNET 2016), Nov 2016, pp. 30–35. [Online]. Available: https://www.thinkmind.org/index.php?view=article&articleid=internet_2016_2_30_40049 [accessed: 2017-5-25]

[2] C. Johnson III, Safeguarding against and responding to the breach of personally identifiable information, Office of Management and Budget Memorandum, 2007. [Online]. Available: http://www.whitehouse.gov/omb/memoranda/fy2007/m07-16.pdf [accessed: 2016-10-4]

[3] B. Krishnamurthy and C. E. Wills, "On the leakage of personally identifiable information via online social networks," in Proceedings of the 2Nd ACM Workshop on Online Social Networks, ser. WOSN '09. New York, NY, USA: ACM, 2009, pp. 7–12. [Online]. Available: http://doi.acm.org/10.1145/1592665.1592668 [accessed: 2017-5-25]

[4] S. Fox et al., Trust and Privacy Online: Why Americans Want to Rewrite the Rules, The Pew Internet & American Life Project, 2000. [Online]. Available: http://www.pewinternet.org/2000/08/20/trust-and-privacy-online/ [accessed: 2017-5-25]

[5] A. Acquisti and R. Gross, Imagined Communities: Awareness, Information Sharing, and Privacy on the Facebook. Berlin, Heidelberg: Springer Berlin Heidelberg, 2006, pp. 36–58.

[6] F. Stutzman, Student life on the Facebook, 2006. [Online]. Available: http://www.ibiblio.org/fred/facebook/stutzman_fbook.pdf [accessed: 2017-5-25]

[7] R. Gross and A. Acquisti, "Information revelation and privacy in online social networks," in Proceedings of the 2005 ACM Workshop on Privacy in the Electronic Society, ser. WPES '05. New York, NY, USA: ACM, 2005, pp. 71–80.

[8] T. Taraszow, E. Aristodemou, G. Shitta, Y. Laouris, and A. Arsoy, "Disclosure of personal and contact information by young people in social networking sites: An analysis using Facebook profiles as an example," International Journal of Media and Cultural Politics, vol. 6, no. 1, 2010, pp. 81–101.

[9] T. Taraszow, A. Arsoy, G. Shitta, and Y. Laouris, "How much personal and sensitive information do cypriot teenagers reveal in facebook?" in Proceedings of the 7th European Conference on E-Learning, 2008, pp. 606–611.

[10] D. A. Huffaker and S. L. Calvert, "Gender, identity, and language use in teenage blogs." Journal of Computer-Mediated Communication, vol. 10, no. 2, 2005. [Online]. Available: http://onlinelibrary.wiley.com/doi/10.1111/j.1083-6101.2005.tb00238.x/full [accessed: 2017-5-25]

[11] C. Dwyer, "Digital relationships in the "myspace" generation: Results from a qualitative study," in Proceedings of the 40th Annual Hawaii International Conference on System Sciences, ser. HICSS '07. Washington, DC, USA: IEEE Computer Society, 2007, p. 19.

[12] S. B. Barnes, "A privacy paradox: Social networking in the united states." First Monday, vol. 11, no. 9, 2006. [Online]. Available: http://firstmonday.org/article/view/1394/1312 [accessed: 2017-5-25]

[13] T. Hirai, "Why does "Enjyo" happen on the Web? : An Examination based on Japanese Web Culture," Journal of Information and Communication Research, vol. 29, no. 4, mar 2012, pp. 61–71. [Online]. Available: http://doi.org/10.11430/jsicr.29.4_61 [accessed: 2017-5-25]

[14] A. Viseu, A. Clement, and J. Aspinall, "Situating privacy online: Complex perception and everyday practices," Information, Communication & Society, 2004, pp. 92–114.

[15] S. Livingstone, "Taking risky opportunities in youthful content creation: teenagers' use of social networking sites for intimacy, privacy and self-expression." New Media & Society, vol. 10, no. 3, 2008, pp. 393–411.

[16] A. N. Joinson, U.-D. Reips, T. Buchanan, and C. B. P. Schofield, "Privacy, trust, and self-disclosure online." Human-Computer Interaction, vol. 25, no. 1, 2010, pp. 1–24. [Online]. Available: www.joinson.com/home/pubs/HCI_journal.pdf [accessed: 2017-5-25]

[17] Z. Tufekci, "Can You See Me Now? Audience and Disclosure Regulation in Online Social Network Sites," Bulletin of Science, Technology & Society, vol. 28, no. 1, 2008, pp. 20–36.

[18] L. Sweeney, "Uniqueness of Simple Demographics in the U.S. Population," LIDAP-WP4 Carnegie Mellon University, Laboratory for International Data Privacy, Pittsburgh, Pennsylvania, 2000. [Online]. Available: http://dataprivacylab.org/projects/identifiability/index.html [accessed: 2017-5-25]

[19] VISA, "Issuer PIN Security Guidelines," http://usa.visa.com/dam/VCOM/download/merchants/visa-issuer-pin-security-guideline.pdf [accessed: 2017-5-25], 2010.

[20] HSBC, "New service for HSBC cards — PIN (personal identification number) change via HSBC ATMs," https://www.hsbc.am/1/2/am/en/new-service-for-hsbc-cards [accessed: 2017-5-25], 2016.

[21] J. Bonneau, S. Preibusch, and R. Anderson, "A birthday present every eleven wallets? the security of customer-chosen banking pins," in The 16 th International Conference on Financial Cryptography and Data Security, 2012, pp. 25–40.

[22] Twitter, "Customizing your profile," https://support.twitter.com/articles/127871 [accessed: 2017-5-25].

[23] ——, "Profile visibility settings," https://support.twitter.com/articles/20172733 [accessed: 2017-5-25].

[24] Y. Watanabe, K. Nakajima, H. Morimoto, R. Nishimura, and Y. Okada, "An investigation of a factor that affects the usage of unsounded code strings at the end of japanese and english tweets," in Proceedings of the Seventh International Conference on Evolving Internet (INTERNET 2015), Oct 2015, pp. 50–55. [Online]. Available: https://www.thinkmind.org/index.php?view=article&articleid=internet_2015_2_40_40038 [accessed: 2017-5-25]

[25] Twitter, Inc. The Streaming APIs. [Online]. Available: https://dev.twitter.com/streaming/overview [accessed: 2017-5-25]

[26] S. Kurohashi and D. Kawahara, JUMAN Manual version 5.1 (in Japanese). Kyoto University, 2005.

[27] H. Schmid, "Probabilistic part-of-speech tagging using decision trees," in Proceedings of the International Conference on New Methods in Language Processing, Manchester, UK, 1994.

[28] ——, "Probabilistic part-of-speech tagging using decision trees," in New Methods in Language Processing, ser. Studies in Computational Linguistics, D. Jones and H. Somers, Eds. London, GB: UCL Press, 1997, pp. 154–164.

[29] ——, "Improvements in part-of-speech tagging with an application to german," in Natural Language Processing Using Very Large Corpora, ser. Text, Speech and Language Processing, S. Armstrong, K. Church, P. Isabelle, S. Manzi, E. Tzoukermann, and D. Yarowsky, Eds. Dordrecht: Kluwer Academic Publishers, 1999, vol. 11, pp. 13–26.

[30] T. Odaka et al., "A proposal on student report scoring system using n-gram text analysis method," The transactions of the Institute of

Electronics, Information and Communication Engineers. D-I, vol. 86, no. 9, sep 2003, pp. 702–705.

[31] Taku Kudoh. TinySVM: Support Vector Machines. [Online]. Available: http://chasen.org/taku/software/TinySVM/index.html [accessed: 2017-5-25]