A Disaster-related Information Gathering Method by Focusing on Tweets Posted Immediately after Retweeting of News Posts about Kumamoto Earthquake

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Abstract - *The usefulness of Twitter for collecting disaster-related information is noticed especially after the Great East Japan Earthquake in 2011. We have studied the use of Twitter posts (tweets) to support victims. To obtain disaster-related information, we focused on tweets posted immediately after retweeting of a disaster-related news post (called sample tweets). In this study, we focus on news posts pertaining to the 2016 Kumamoto Earthquake and analyze sample tweets. The analysis result shows that the majority of the sample tweets were related to the earthquake. In addition, to collect disaster-related tweets automatically by focusing on the tweets immediately after retweeting of news posts, we propose a method to discriminate whether or not the tweets are related to the disaster based on keywords.*

Keywords: disaster-related information, twitter, social media

1 Introduction

After a disaster, victims tune in to television or radio to obtain disaster-related information, such as damage caused to public transportation and lifelines. Twitter is one of the popular social media, where users can post a text message of less than 140 characters or images. The post is called a "tweet." Twitter had approximately 313 million active users as of June 2016 [1]. This communication channel is widely used in Japan. The large number of Twitter users can be attributed to the convenience of posting information. An important advantage of Twitter is its high immediacy. Users can easily post about what they think and feel on Twitter. On Twitter, a user can "follow" someone, i.e., subscribe to someone's tweets. The users can view the tweets of the person they are following on their home timeline. "Retweet" is the reposting of a tweet. Users can share someone else's tweet to their own followers by retweeting.

Many tweets, including safety information and rescue requests, were posted on Twitter during and after the Great East Japan Earthquake of March 11, 2011. Consequently, many victims were rescued using the information available on Twitter posts. Additionally, evacuation centers posted information and alerts that were used by victims who were unable to access television or radio because of long-time blackouts [2]. We study the use of Twitter posts to support victims. After a disaster, major broadcast and newspaper companies announce disaster-related news posts on Twitter. After a news post is posted, some users view and retweet it and then immediately post another tweet. We assume that the tweet posted immediately after retweeting of the news post is related to the disaster. The "extra" information may be useful for supporting victims or assisting rescue activities. In our previous study, we analyzed "sample tweets" posted immediately after retweeting of news posts pertaining to the 2015 Earthquake Off the West Coast of Ogasawara Islands in Japan to prove our assumption [3].

In this paper, we focus on news posts pertaining to the 2016 Kumamoto Earthquake in Japan to replicate the analysis. Then, we show that the majority of the sample tweets are related to the earthquake. In addition, to collet disaster-related tweets automatically by focusing on the tweets posted immediately after retweeting of the news posts, we propose a method to discriminate whether the sample tweets are related to the disaster or not. The rest of the paper is organized as follows. Section 2 explains related studies. Section 3 explains collection of disaster-related tweets and analysis. Section 4 explains the method to discriminate whether the tweets are related to the disaster or not. Lastly, Section 5 concludes the paper.

2 Related studies

Utilization of Twitter posts has been the subject of numerous recent studies. On Twitter, product- and event-related announcement posts are posted by manufacturers and event organizers. Further, numerous users post tweets related to the announcement posts. Some users, in particular, occasionally post tweets that contain additional information that is unavailable in the announcement post. However, tweets containing additional information are not always associated with the announcement post. Tsukamoto, et al. proposed a method for the automatic collection of posts that pertain to an

Table 1. Detail of the news posts

	Account / posted date and time Original tweet Tweet translated in English
n_1 (92 samples)	Yahoo! News, @YahooNewsTopics / 9:28pm, Apr 14, 2016 【地震情報】 yahoo.jp/eEWiyO [Earthquake Information](URL)
n_2 (64 samples)	Yahoo! News, @YahooNewsTopics / 9:38pm, Apr 14, 2016 【熊本で震度 7 の地震】 yahoo.jp/BQt8u8 [An earthquake of seismic intensity 7 in Kumamoto] *(URL)*
n_3 (79 samples)	Yahoo! News @YahooNewsTopics / 9:42pm, Apr 14, 2016 【熊本で震度 7 の地震 津波なし】14 日午後 9 時 26 分ごろ、熊本県熊本地方で震度 7 を観測する強い地震があった。この地震による津波の心配はない。 [An earthquake of seismic intensity 7 in Kumamoto. No Tsunamis] There was a powerful earthquake of seismic intensity 7 in Kumamoto on April 14th at about 9:26 pm. There is no worry about a tsunami with this earthquake.
n_4 (69 samples)	Yahoo! News @YahooNewsTopics / 10:28pm, Apr 15, 2016 【熊本地震 物資の支援焦らずに】地震が発生した熊本県に「支援物資を送りたい」との問い合わせが相次ぐ。担当者は「態勢が整うまで待ってほしい」と呼びかけ。 yahoo.jp/HeLr-r [Kumamoto Earthquake, do not be in a hurry to send relief supplies] Since the earthquakes struck off Kumamoto, there have been many inquiries for sending relief supplies to Kumamoto. A person in charge said "please wait until we make preparations ready to receive relief supplies." *(URL)*
n_5 (76 samples)	Yahoo! Weather/Disaster @Yahoo_weather / 1:37am, Apr 16, 2016 【4 月 16 日　熊本県で震度 6 強の地震 津波に注意】2016 年 4 月 16 日 1 時 25 分ごろ、熊本で震度 6 強の地震がありました。津波注意報が出ています。海岸には近づかないで下さい。 https://twitter.com/Yahoo_weather/status/721014639643926528 [16th April, An earthquake of seismic intensity upper 6 in Kumamoto. Tsunami warnings] There was an earthquake of seismic intensity upper 6 in Kumamoto on April 16th, 2016 at about 1:25am. There are tsunami warnings with this earthquake. Do not be close to the coasts. *(URL)*
n_6 (72 samples)	Yahoo! News @YahooNewsTopics / 4:52am, Apr 16, 2016 【熊本 16 日の地震が「本震」か】気象庁は 16 日午前 1 時 25 分ごろ発生した M7.3 の地震が本震で、14 日の最大震度 7 の地震は前震と考えられるとの見解。 yahoo.jp/KgH1ty [Kumamoto, the earthquake on the 16th might be the main shock] From Japan Meteorological Agency of view, the earthquake of magnitude 7.3 occurred on April 16th at about 1:25 am might be the main shock, and the earthquake of seismic intensity 7 occurred on the 14th might be the foreshock. *(URL)*
n_7 (98 samples)	Yahoo! News @YahooNewsTopics / 2:24pm, Apr 15, 2016 【熊本 16 日の地震が「本震」】気象庁は 16 日午前 1 時 25 分ごろ発生した M7.3 の地震が、14 日夜から熊本地方で起きている一連の地震の「本震」だと発表。 [Kumamoto, the earthquake on the 16th was the main shock] Japan Meteorological Agency announced the earthquake of magnitude 7.3 occurred at about 1:25 am was the main shock of the string of earthquakes which have been striking off around Kumamoto since the night of April 14th.
n_8 (69 samples)	Yahoo! News @YahooNewsTopics / 9:54am, Apr 16, 2016 【阿蘇山 小規模な噴火が発生】気象庁によると、阿蘇山がきょう午前 8 時 30 分に噴火。気象庁は「一連の地震とは直接関連がないとみている」。 http://yahoo.jp/zupVA7 [Mt. Aso, occurred a small-scale eruption] Japan Meteorological Agency reported a small-scale eruption of Mt. Aso today at 8:30 am. From their view, it is not directly related to the string of earthquakes. *(URL)*
n_9 (66 samples)	Yahoo! News @YahooNewsTopics / 8:38pm, Apr 17, 2016 【熊本地震 空き巣など通報 20 件】警察庁によると、熊本市を中心に空き巣や事務所荒らしの通報が約 20 件あった。益城町や南阿蘇村では同様の通報はないという。 [Kumamoto Earthquakes, 20 cases of burglaries were reported] National Police Agency announced there have been about 20 reports of burglaries at empty houses and offices around Kumamoto-shi (Kumamoto city). There have not been the sort of reports in Mashik-machi (Mashiki town), and Minamiaso-mura (Minamiaso village).

announcement post immediately after retweeting on Twitter [4]. However, this study was not concerned with disaster-related information.

On the other hand, numerous studies focusing on the high immediacy of Twitter as the medium to collect disaster-related information have been recently reported. For example, Goto, et al. developed a system that generates answers extracted from Twitter in response to a question about a disaster [5]. Takahata, et al. proposed a system showing information of temporary evacuation centers on a map that can be used by stranded victims in disaster situations [6]. Nareta, et al.

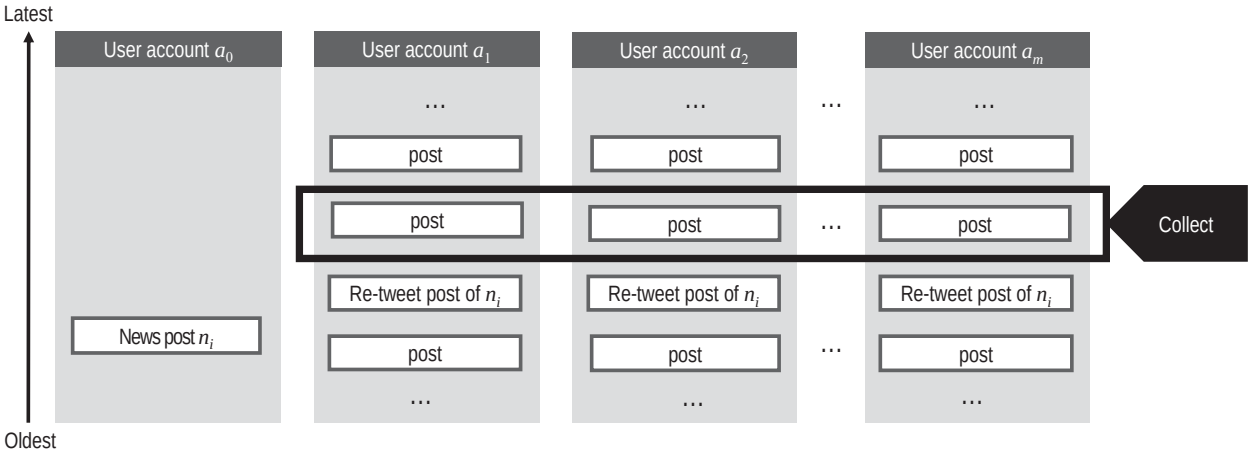

Fig. 1. Collection of sample posts

proposed a system that delivers support information based on Twitter information to victims [7]. Uchida, et al. proposed a system that extracts and categorizes disaster-related Twitter information and renders the result on a map [8]. Kitajima, et al. proposed a method to evaluate the profitability of disaster-related tweets using a neural network [9].

3 Collection of posts and analysis

3.1 Post sampling

Tsukamoto et al. focused on tweets that were immediately posted after retweeting of an announcement post and showed that such tweets are related to the text of the news post [4]. However, the study considered announcement posts related to movies, soccer games, new products of convenience stores, and television programs. On the other hand, in this study, we focus on disaster-related news posts. This study can improve the information reliability of our previous studies [6-9], which aimed to support victims.

We focus on news posts pertaining to the 2016 Kumamoto Earthquake. In particular, this study considers 9 news posts on mass media accounts of Yahoo! news. The news posts, n_1-n_9, are shown in Table 1. These posts are arranged in chronological order. Next, tweets posted by a user (a_1, a_2, …, a_m) immediately after retweeting of the news post n_i were collected as shown in Fig. 1. These collected tweets are called "sample tweets" in this paper. A web application [10] was used to collect the sample tweets based on the following manner:

- The application collects "tweets immediately after retweeting" of a news post by approximately 100 recent retweeting users.
  - Tweets submitted more than 10 minutes after retweeting are not treated as "tweets immediately after retweeting" and are eliminated.
  - If the account has more than 3200 posts after the retweeting of the news post, the account is eliminated.

Figure 2 shows an example of a news post pertaining to the 2015 Earthquake Off the West Coast of Ogasawara Islands and its sample tweets. Example 1 shows that the user seems surprised at the news post about the intensity level of the earthquake. Example 2 shows that the user was scared after observing the seismic intensity map on the news post. Therefore, the tweet can be related to the news post. Additionally, the tweet includes ">RT" or "rt," which indicates a retweeted post (i.e., news post). Example 3 does not contain information about the earthquake; the tweets gives the operation status of a railway line. The URL in the tweet refers to a webpage showing the operational status of the railway line, in addition to the information, "Tokaido Shinkansen (Super express train) has been suspended in both directions." Here, although the suspension of Shinkansen could not be deduced from the news post alone, we recognize the suspension of Shinkansen by seeing both the news post and the sample tweet (Example 3). In other words, the sample tweet includes extra information that cannot be deduced from the text of the news post.

3.2 Evaluation

For each news post (n_1, n_2, …, n_9), tweets posted immediately after retweeting of the news post were collected. Next, 11 persons (judges) judged whether each sample tweets belonged to Category A or B as follows.

Category A: The sample tweet is related to the text of the news post.

Category B: The sample tweet includes extra information that cannot be deduced from the text of the news post.

We assume that the sample posts categorized into Category A or B are disaster-related tweets.

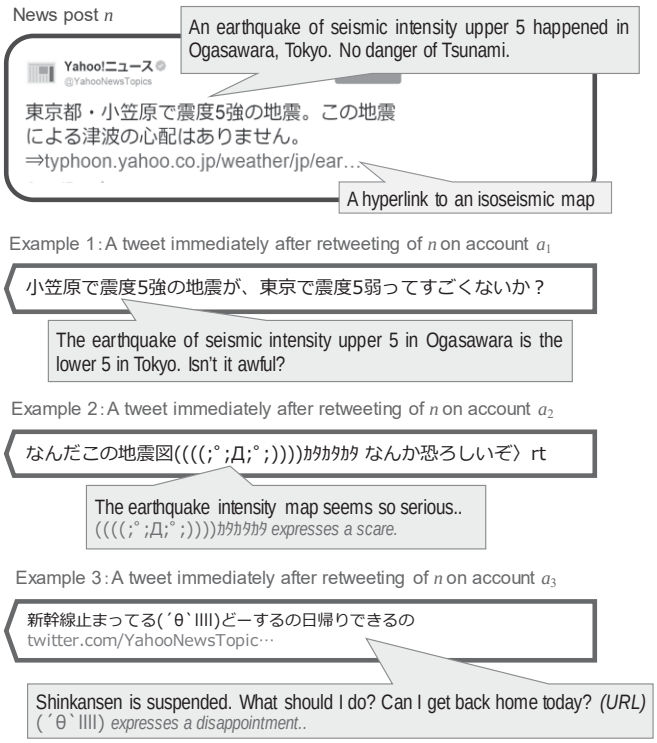

Fig. 2 Example of sample posts

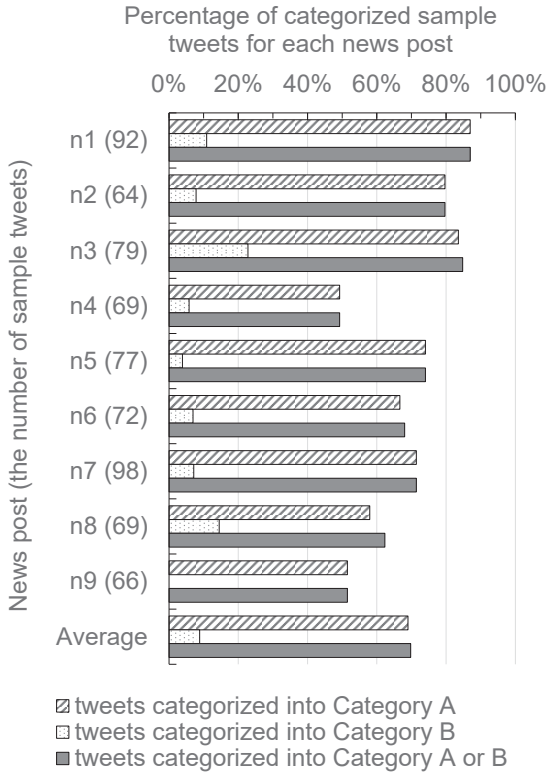

Fig.3 Result of analysis

Figure 3 shows the ratios of the sample tweets that were categorized into categories A, B, and A or B by more than half the judges (6 or more). Here, we discuss the ratio of tweets categorized into Category A or B. The highest value was 87.0% for n_1, and the lowest value was 49.3% for n_4. The average value for all news posts was 69.8%, i.e., the majority of all sample tweets were related to the news post. The result indicates that we can obtain disaster-related tweets by focusing on the tweets posted immediately after retweeting of the news posts.

4 Discrimination of disaster-related tweets using keywords

To collect disaster-related tweets automatically, in this section, we discuss a method to automatically discriminate whether or not the collected sample tweets are related to the disaster.

4.1 Discrimination method

We assume that disaster-related tweets include one or more keywords that are also included in the news post. The procedure is as follows. First, the text of the news post (URLs of other pages and hashtags are excluded) is input to Yahoo! Keyphrase Service [11] to extract "key phrases." The service outputs importance scores of the key phrases, but we did not consider those scores in this study. Second, the key phrases are input to a morphological analysis service Unidic-MeCab [12]. The output words of the morphological analysis service are called "keywords" in this paper. The key phrases and keywords extracted from each news post are shown in Table 2. The discrimination procedure taking n_3 as an example is as follows. The key phrases of n_3 are 震度 (seismic intensity), 熊本県熊本地方 (Kumamoto region, Kumamoto Prefecture), 震度 7 (seismic intensity 7), 地震津波 (earthquake, tsunami), 強い地震 (powerful earthquake), 14 日午後 9 時 26 分ごろ (about 9:26 pm, 14th), and 心配 (worry). Then, the keywords obtained by the morphological analysis are 震度, 熊本, 県, 熊本, 地方, 震度 7, 地震, 津波, 強い, 地震, 14 日, 午後, 9 時, 26 分, ごろ, and 心配. Since the key phrases sometimes include compound nouns, we use keywords which are converted to simplex nouns. Table 2 shows key phrases, and keywords for each news post. Here, we intentionally did not convert the nouns corresponding to the following three cases. First, compound nouns that contain the combination of a noun and prefix/postfix are not divided into simplex nouns (*1 in Table 2). Second, series of numerals are not divided into each numeral (*2 in Table 2). Lastly, since numerals following M means magnitude of the earthquake (as a well-known fact), the words are not divided into each word (*3 in Table 2). Then, we discriminate the tweet including more than one keywords as the disaster-related tweet.

Table 2 Key phrases and keywords for each news posts

	Key phrases: Result of the key phrase analysis [in English] {importance score}	Key words: Result of the morphological analysis
n_1	地震情報 [earthquake information]{100}	地震, 情報
n_2	震度 [seismic intensity] {100}, 熊本 [Kumamoto] {86}, 地震[earthquake] {77}, 震度 7 [seismic intensity 7] {66}	震度, 熊本, 地震, 震度, 7
n_3	震度 [seismic intensity] {100}, 熊本県熊本地方 [Kumamoto region, Kumamoto Prefecture] {81}, 震度 7 [seismic intensity 7] {66}, 地震津波[earthquake tsunami] {65}, 強い地震 [powerful earthquake] {54}, 14 日午後 9 時 26 分ごろ[14th at about 9:26 pm] {42}, 心配 [worry] {35}	震度, 熊本, 県, 熊本, 地方, 震度, 7, 地震, 津波, 強い, 地震, 14 日*2, 午後, 9 時*2, 26 分*2, ごろ, 心配
n_4	熊本地震物資 [Kumamoto earthquake, supplies] {100}, 問い合わせ [inquiry] {87}, 支援物資 [relief supplies] {86}, 熊本県 [Kumamoto Prefecture] {86}, 担当者 [the person in charge] {77}, 態勢 [preparations] {75}	熊本, 地震, 物資, 問い合わせ,支援, 物資, 熊本, 県, 担当, 者, 態勢
n_5	津波注意報 [tsunami warming] {100}, 震度 6 強 [seismic intensity upper 6] {99}, 熊本県 [Kumamoto Prefecture] {85}, 地震津波 [earthquake, tsunami] {80}, 海岸 [coast] {64}, 2016 年 4 月 16 日 1 時 25 分ごろ [on April 16th , 2016 at about 1:25 am] {43}	津波, 注意, 報, 震度, 6 強*1, 熊本, 県, 地震, 津波, 海岸, 2016 年*2, 4 月*2, 16 日*2, 1 時*2, 25 分*2, ごろ
n_6	本震 [main shock] {100}, M7.3 [magnitude 7.3] {79}, 地震[earthquake] {64}, 前震 [foreshock] {61}, 気象庁 [Japan Meteorological Agency] {48}, 見解 [view] {36}, 最大震度 7 [the maximum seismic intensity 7] {34}, 16 日午前 1 時 25 分ごろ [16th at about 1:25 am] {29}, 熊本 16 日[Kumamoto, 16th] {27}, 14 日 [14th] {8}	本震, M7.3*3, 地震, 前震, 気象, 庁, 見解, 最大, 震度, 7, 16 日*2, 午前, 1 時*2, 25 分*2, ごろ, 熊本, 16 日*2, 14 日*2
n_7	本震 [main shock] {100}, M7.3 [magnitude 7.3] {79}, 地震 [earthquake] {64}, 気象庁 [Japan Meteorological Agency] {48}, 熊本地方 [Kumamoto region] {41}, 一連 [a string of] {38}, 16 日午前 1 時 25 分ごろ [16th at about 1:25 am] {29}, 熊本 16 日 [Kumamoto, 16th] {27}, 発表 [announcement] {24}, 14 日夜 [the night of the 14th] {16}	本震, M7.3*3, 地震, 気象, 庁, 熊本, 地方, 一連, 16 日*2, 午前, 1 時*2, 25 分*2, ごろ, 熊本, 16 日*2, 発表, 14 日*2, 夜
n_8	阿蘇山 [Mt. Aso] {100}, 気象庁 [Japan Meteorological Agency] {80}, 噴火[eruption] {71}, 一連 [a string of] {37},きょう午前 8 時 30 分 [today 8:30 am] {30}, 地震 [earthquake] {29}, 発生 [occur] {27}, 関連 [related]{22}	阿蘇, 山, 気象, 庁, 噴火, 一連,きょう, 午前, 8 時*2, 30 分*2, 地震, 発生, 関連
n_9	南阿蘇村 [Minamiaso-mura] {100}, 益城町 [Mashiki-machi] {94}, 熊本地震空き巣 [Kumamoto earthquake, burglar] {79}, 警察庁 [National Police Agency] {72}, 事務所荒らし [burglar of offices] {71}, 熊本市 [Kumamoto-shi] {67}, 通報 [report] {66}, 中心 [around] {33}, 通報 20 件 [20 cases of reports] {28}	南阿蘇, 村, 益城, 町, 熊本, 地震, 空き巣, 警察, 庁, 事務 ,所, 荒らし, 熊本, 市, 通報, 中心, 通報, 20 件*2

4.2 Evaluation of the method

The sample tweets for each news post were discriminated as mentioned above. In the following, the sample tweets categorized into Category A or B are labelled as group $\boldsymbol{X}$, and the sample posts that include one or more keywords are labelled as group $\boldsymbol{Y}$. Table 3 shows the number of samples categorized into Category A or B ($|\boldsymbol{X}|$), the number of samples including one or more keywords ($|\boldsymbol{Y}|$), and the number of samples corresponding to both $\boldsymbol{X}$ and $\boldsymbol{Y}$ ($|\boldsymbol{X} \cap \boldsymbol{Y}|$). Then, the precision, recall, and F-measure of the method were measured as follows.

- Precision = $|\boldsymbol{X} \cap \boldsymbol{Y}| / |\boldsymbol{Y}|$
- Recall = $|\boldsymbol{X} \cap \boldsymbol{Y}| / |\boldsymbol{X}|$
- F-measure = the weighted harmonic mean of precision and recall.

Figure 4 shows the evaluation result. For precision, the highest value was 1.000 for n_1 and n_2, and the lowest value was 0.714 for n_9. The average value in all news posts was 0.935. This indicates that the use of keywords can discriminate disaster-related tweets with high accuracy. In other words, the collection of sample tweets including one or more keywords is useful for collecting disaster-related tweets. Differences were observed in the precision values among the news posts. Therefore, to collect disaster-related tweets efficiently, we should focus on the news posts for which we expect high precision value. A future direction of our research is to determine which news posts to focus on.

The average of recall was 0.491 and F-measure was 0.627. Since the objective of the study is the collection of disaster-related tweets, sample tweets without disaster-related information should not be included. Therefore, a method with a high precision is desirable.

Table 3. Details of the sample tweets

	Number of samples categorized into Category A or B: $\|X\|$	Number of samples that include one or more keywords: $\|Y\|$	Number of samples corresponding to both X and Y: $\|X \cap Y\|$
n_1	16	16	16
n_2	20	20	20
n_3	49	50	49
n_4	14	15	14
n_5	30	31	30
n_6	30	31	30
n_7	45	47	45
n_8	26	29	26
n_9	10	14	10

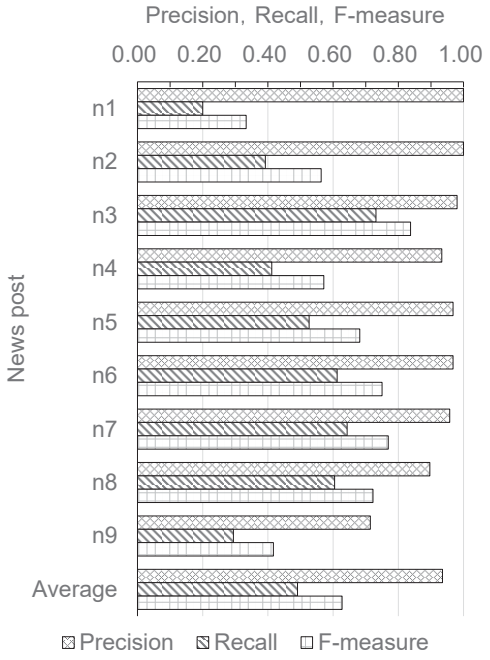

Fig. 4 Evaluation of the discrimination method

5 Conclusion

This study is on the use of information posted on Twitter during or after a disaster in supporting victims. After a disaster, major broadcast and newspaper companies announce disaster-related news on Twitter. These news posts are then retweeted by users. We assume that tweets posted immediately after retweeting of a disaster-related news post are related to the disaster. The information extracted from such tweets will be useful for supporting victims or assisting rescue activities.

To prove the assumption, this study collected and analyzed tweets pertaining to the 2016 Kumamoto Earthquake. In particular, we focused on 9 related news posts and collected tweets posted immediately after retweeting of each news post. Next, for each news post, we evaluated the ratio of the sample tweets that were categorized into Category A or B by more than half of the 11 judges. We found that the majority of all sample tweets were categorized into Category A or B. In addition, to collect disaster-related tweets automatically by focusing on the tweets posted after retweeting of the news posts, we proposed a method that uses keywords to discriminate disaster-related tweets. Then, we showed that the method can discriminate whether or not the posts were related to the earthquake with high accuracy.

In future, we will discuss whether similar results can be obtained from disasters differing in either type or scale. In addition, we plan to develop a system for collecting disaster-related tweets.

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