An Active Communication Mechanism for e-Learning by Analyzing SNS User Behavior

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***Abstract*—This paper presents an active communication mechanism based on SNS user behavior (e.g., likes, shares, replies) in e-learning. For this, we propose a novel automatic link generation method by considering users' knowledge and interests during the conversation on SNS. The method generates two kinds of links to promote user communication in e-learning, 1) knowledge support for receivers who receive posts from senders, and 2) conversation evoked support for receivers to offer the information regarding senders. Through this, the mechanism can provide knowledge appropriate to each user in e-learning. In this paper, we discuss our proposed user characteristic extraction using Facebook pages.**

***Index Terms*—link generation; user characteristics; feature word extraction; communication; e-learning;**

I. Introduction

In recent years, MOOC is now a new form of education for students who want to attend courses at any level or cannot access traditional education due to time, geographic accessibility, or other reasons. However, it is difficult to maintain student motivation for self-learning. Currently, many students can collaborate during online courses through SNS, such as Facebook and Twitter. Liao et al. [1] and Chen et al. [2] investigated the use of SNS in online education. Students can communicate with each other when they use post threads on SNS. Because of the different levels of knowledge between students, the communication cannot proceed smoothly. It is a problem that we need to solve in this research. Therefore, it is necessary to extract user characteristics from SNS user behavior, which indicate users' knowledge and interests, and supplement the users' posts with related information (e.g., search results, Wikipedia pages, lecture videos, or other friends' information) in the post thread.

In this work, the goal is to develop a novel automatic link generation method by analyzing SNS user behavior from users' posts in e-learning. The proposed method generates two kinds of links: 1) knowledge support for receivers who receive posts from senders, and 2) conversation evoked support for receivers to offer the information regarding senders (see Fig. 1). Although several automatic link generation methods for web sites have been studied [3], [4], they have focused on web pages for knowledge support only, they do not solve the mentioned issues about user communication in e-learning.

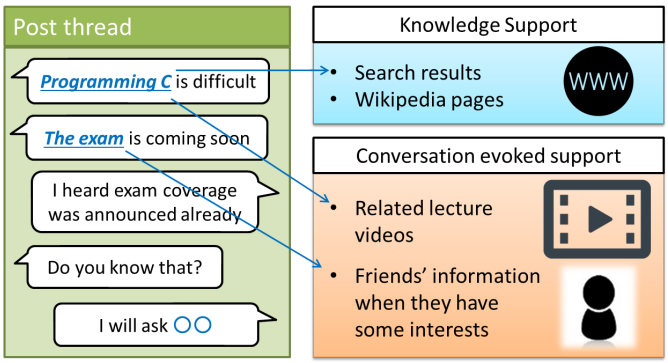

Fig. 1. Conceptual diagram of automatic link generation

Other researches about for user behavior on news sites [5], did not consider the relationships between users. In this paper, we first extract user characteristics by analyzing SNS user behavior in e-learning from their posts. Then, we can detect users' relationships based on the user characteristics. Thus, 1) links of knowledge support are attached to posts by using search results or Wikipedia pages of unknown vocabulary words for receivers, and 2) links of conversation evoked support for receivers to offer the information regarding senders are attached to posts by using related lecture videos about topics of the posts or other friends' information when they have the same interests. The proposed novel method then promotes users to communicate with each other during the conversation in e-learning.

II. Active Communications for e-Learning

In this section, we describe the proposed link generation method for active communications in e-learning. The proposed method extracts user characteristics by analyzing user behavior from their posts, and selects vocabulary words as links based on user characteristics from their posts, and selects vocabulary words as links based on user characteristics. We first extract feature words of each user from users' posts as user characteristics. Then, the low or high weight vocabulary words as link candidates based on users' relationships. The

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link information is classified into two kinds: 1) knowledge support and 2) conversation evoked support.

A. Analysis of SNS User Behavior

To analyze SNS user behavior, we first extract high-frequency words from each post of each user by using Yahoo!Web API[1]. Next, we calculate the average weight of each extracted high-frequency word. Then, we extract user characteristics by extracting feature words of each user. We calculate the weight of each word i that appears in each user's posts by the following formula:

$$\frac{\text{weight of } i \text{ by Yahoo!Web API}}{\text{\#posts with } i} \times \frac{\text{total \#posts}}{\text{\#posts with } i} \quad (1)$$

The left part of Eq. (1) calculates the average weight of i that appears in each post. The right part of Eq. (1) as a *IDF* value of i in all posts of each user. In addition, "Like" and "Share" options are available on SNS, to respectively mark your interest or spread the post. Therefore, we can improve the calculation method by adding the numbers of "Like" and "Share" to the weight of each word.

B. Generation of Links in Chats

To generate links in chats between users, we attach the link information to vocabulary words in posts based on users' relationships by using user characteristics (feature words). The link information of knowledge support is to supplement unknown vocabulary words for a receiver; we select the low weight words as unknown vocabulary words in the post as link candidates from extracted feature words of the receiver's characteristic. Then, we attach search results and Wikipedia pages of the low weight words to the post. In Fig. 1, it is determined that there is a lack of knowledge about "C Programming" for the receiver, "C Programming" as a link is generated in the post to the receiver.

The link information of conversation evoked support is to promote user communication for receivers to offer the information regarding senders; we select the high weight words from extracted feature words of the receiver's characteristic, and detect other friends' information (linked through the network with the receiver) related to the post as a link candidate by cosine similarity as the following formula using the high weight words. In Fig. 1, it is determined that a friend is similar to the sender and mention "The exam", "The exam" as a link is generated in the post to the receiver.

$$Sim(\overrightarrow{x}, \overrightarrow{y}) = \frac{\sum_{i=1}^{|V|} x_i \cdot y_i}{\sqrt{\sum_{i=1}^{|V|}(x_i)^2} \cdot \sqrt{\sum_{i=1}^{|V|}(y_i)^2}} \quad (2)$$

$\overrightarrow{x}$ denotes the feature vector of user x, and $\overrightarrow{y}$ denotes the feature vector of user y. $|V|$ is the number of dimensions of the feature vector.

[1]http://developer.yahoo.co.jp/webapi/jlp/keyphrase/v1/extract.html

III. Evaluation

The purpose of this evaluation is to verify whether our proposed method is useful for extracting user characteristics based on SNS user behavior. We acquired posts of public online course pages by using Facebook API[2] as follows:

- A : the latest 50 posts of "Exciting Programming Starting from Elementary School"
- B : the latest 50 posts of "Online Programming Learning Service on APP Development "

A is an online course for programming beginner. B is an online course for programming advanced learners. In this evaluation, we extracted feature words as user characteristics of A and B by using the following four methods:

1) the weight of word i by Eq. (1)
2) 1) $\times$ #likes of posts with i
3) 2) $\times$ #shares of posts with i
4) 3) $+$ 1) for each reply $\times$ #likes for each reply

Here, #likes and #shares for A or B were normalized to fit within 0 to 1. As described above, 1) *TF-IDF* which was calculated from only the text that the user has posted, 2) integrating the value of 1) and the number of likes, which was normalized as the weight, and 3) integrating the value of 2) and the number of shares, which was normalized as the weight. In addition, 4) we verified user characteristic (feature word) by adding the value of 3) to the value of integrating 1) *TF-IDF* for each comment and the number of likes for each comment. Table I shows top-15 feature words of A and B by each method, respectively. Bold words denote the feature words are related to A or B.

We found that many feature words are proper nouns, such as "Graduate School of Information Science and Technology, The University of Tokyo" and "jQuery UI". In all methods, the ranking orders of the same feature words are different, and several feature words are different. For example, the feature word "Kenichirou Mogi" of A rank highest with the method 1), and it is not in methods 2)-4) top-15. From this, the difference between the upper characteristic words calculated from only the information of the sender and the upper characteristic words that including transmission information of the other uses, was found. In this work, high weight feature words as user characteristics is used for extracting the relationships between users. Therefore, these feature words for generating feature vector of each user are useful for both receivers and senders in the chats. According to the correlations between the method 1) and other methods by comparing rankings of top-15 feature words based on Spearman's rank correlation coefficient, the correlation coefficient of methods 1) and 2) is 0.77, the correlation coefficient of methods 1) and 3) is 0.76, and the correlation coefficient of methods 1) and 4) is 0.72. Although the correlations between the method 1) and other methods are similar, the method 4) is different from the method 1) by considering #likes, #shares, and replies. In addition, the correlations between the method 1) and other

[2]https://developers.facebook.com/

TABLE I
TOP-10 FEATURE WORDS OF A AND B

Method	A	B
1)	**Kenichiro Mogi**, **Nikkei software**, **debate**, **Graduate School of Information Science and Technology**, **The University of Tokyo, Kuramoto Daishi**, innovation, self-expression, **industrial competitiveness conference**, **robot programming teaching materials**, **programming compulsory subject**, **Newsweek Japanese version**, **trilingual**, **study Roh**, **Mitsuru Sugaya**, account every single	**CSS3**, **EdTech JAPAN Pitch Festival vol.4**, **go to jappan**, **Higher or Lower**, **IE KMD Venture Day Tokyo**, **jQuery UI**, **Tech academy**, **u-note**, **parallax**, Engineering, good, **SF JAPAN NIGHT semi Finals team**, learning, **Now we're hiring a great web designer**, **SF JapanNight**
2)	**Hour of Code Japan**, **Graduate School of Information Science and Technology, The University of Tokyo**, **programming compulsory**, **scratch Di**, **Prof. Yoshiaki Hashimoto**, **PC away**, a few lines, **study Roh**, **Show&Tell**, **Touch& Try**, **Code.org**, **World Business satellite**, self-expression, **Minecraft EDU, robot programming**	**CSS3**, **jQuery UI**, **Thanks for Five Thousand Fans**, learning, u-note, **Higher of Lower**, feedback, **SF JAPAN NIGHT semifinalists decision**, **intern**, **we'll launch a radical web wervice which**, **Trello**, **Pyhonista**, **Now we're hiring a great web designer**, **SF Japan Night**, This new service has already decided
3)	**scratch Di**, **Graduate School of Information Science and Technology, The University of Tokyo**, **Show &Tell**, **Touch &Try**, **Prof. Yoshiaki Hashimoto**, **Hour of Code Japan**, **PC away**, **study Roh**, **robot programming**, **Code.org**, **World Business Satellite**, **programming a compulsory subject**, **Nikkei style**, the former, co-workers	**Yukihiro Matsumoto**, learning, **object-oriented scripting language**, **jQuery UI**, **server-side scripting language**, tab, **SF JAPAN NIGHT semi fainalists decision**, **Higher or Lower**, **the three-column layout**, already learned, inquiry, voice, learning situation, **Mats, CSS3**
4)	nowadays, **education**, **scratch Di**, **faculty side**, **Graduate School of Information Science and Technology, The University of Tokyo**, **Show &Tell**, **Touch &Try**, **compulsory**, **high school**, **Nikkei BP booth**, challenge, **Prof. Yoshiaki Hashimoto**, maximum, case, **Hour or Code Japan**	very, sue, **Yukihiro Matsumoto**, learning, **Koushou Kawasoe**, **object-oriented scripting language**, **jQuery UI**, **server-side language ban**, tab, **SF JAPAN NIGHT semifinalists decision**, Higher or Lower, **three-stage assenmbly layout**, already learned, inquiry, voice

methods are not high, we could confirm that the feature words are different by using these four methods.

As discussed above, many proper nouns that do not require knowledge assistance. Conversely, common words are widely used, they are not useful for our proposed system. In the future, we need to improve the calculation method to remove the common words for extracting user characteristics.

IV. CONCLUSION

In this paper, we proposed an active communication mechanism in e-learning based on SNS user behavior. The platform automatically generates two kinds of links to promote user communication in e-learning, 1) knowledge support for receivers, and 2) conversation evoked support for receivers to offer the information regarding senders. Finally, we evaluated the user characteristic extraction from posts by comparing proposed four methods. in addition, compared the usefulness of the calculation of the user characteristics by using the Facebook posts information.

In the future, we plan to enhance the proposed method based on the experimental results and verification experiments will be carried out for many more post data. Furthermore, we will extract the relationships between users by constructing the matrix based on SNS user behavior.

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