Word meaning disambiguation in an online language learning environment

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Abstract: Polysemous words are words that sound similar and look similar but have different meanings in different contexts. In order to be able to provide the language learners with the right translation in the right context, it is important to understand the intended meaning by the student when they look up a word. Mobile learning does not allow language students to share their intended meaning while looking up a polysemous word. This paper aims to identify the intended meaning by the student based on students' past learned words and current location. The method proposed uses records from the SCROLL system (System for Capturing and Reminding Of Learning Log) to identify the intended meaning by computing the sematic similarity between the vocabulary uploaded by the student, the location and each of the different meanings of the word.

Keywords: Polysemous words, Learning logs, Language Learning

1. Introduction

Words change their meaning from one context to the other. To *book* a hotel for example is not the same thing as reading a *book*. This category of words is called *Polysemous words* and constitute words that sound similar and look similar but have different meanings. Polysemous words are encountered very often - they constitute more than 40% of English words [1]. Polysemous words are confusing for language learning students. The traditional way of learning polysemous words is to present to the student the different definitions of the word in different contexts. From the pedagogical perspective, it is suggested that the meanings should not be presented as one bloc to the student but should be put in a context and restricted to a particular area [2]. However, in a self learning online environment, teachers have less or no control over the learned content. With the rise of smart phones, the use of mobile devices in language learning is a growing trend [3]. Students have more control over their learning pace [4] and the vocabulary they want to learn, but don't have opportunities to communicate which meaning of the word they are looking for.

How do can we identify the meaning a student is looking for in a self-learning online environment? This paper proposes to identify the intended meaning of a student based on the past words that the student chose to learn, the current location, and other looked up words in similar locations. The meaning identification would lead to a correct translation in their intended context.

2. Context in a self learning online environment

In our daily conversations, we can understand the meaning of a polysemous word based on the context of its use. In the sentence: "*I am heading towards the bank.*", bank could mean *a land by the riverside* or a *financial institution*. In a conversation, the location and the previous exchange could help to determine

the meaning of the word *bank*. However, when a student is looking up one word in the online learning environment, the word meaning disambiguation becomes problematic as the context is missing. We propose to use the current location of the student as well as the past vocabulary of the student as a context to identify the intended meaning of the student as shown in Fig.1.
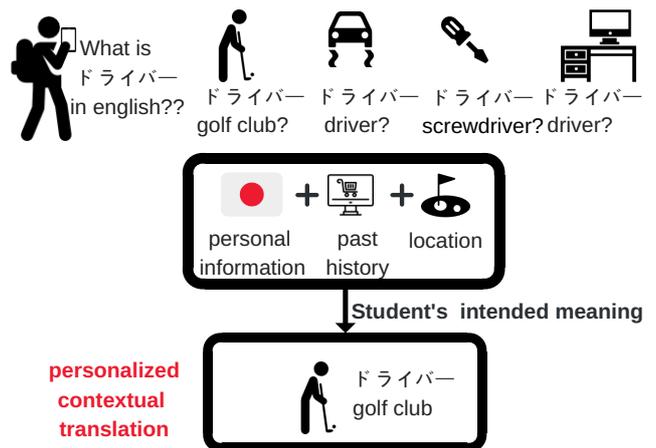
Figure 1: Contextual word meaning disambiguation in a language learning environment.

3. Method

3.1 Scroll System

The online language learning environment used in this study, is the SCROLL System, (System for Capturing and Reminding Of Learning Log). Scroll is a digital record of what language students have learned in daily life. It allows the learners to log the new words or sentences they learned along with photos, audios, videos and location [5]. SCROLL captures what learners are learning as well as its contextual data. The users are then reminded of what they learned in the right place and the right time.

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Moreover, students receive personalized quizzes to fortify the learning. Figure 2 is a screenshot from the SCROLL system that shows a log inserted by a student for the word *Karaoke*. The student appended a picture and a location when creating the log. A Japanese translation of the word *Karaoke* is automatically provided to the student, and the time is automatically registered.
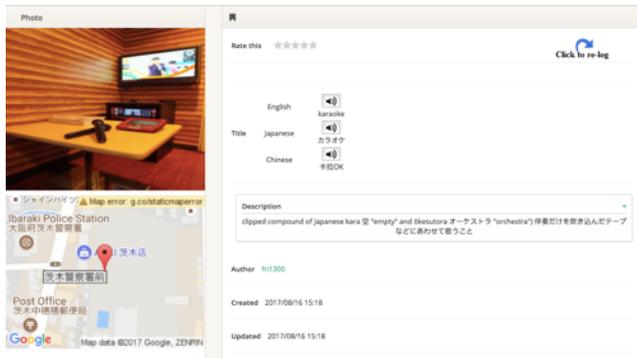
Figure 2: Screenshot from the SCROLL system showing a log inserted by a student.

In order to determine the intended meaning of a polysemous word, we will be the following meta-data included in the logs:

Vocabulary: words that students have learned in the past
User: author identification
location: author identification
Pictures: Uploaded picture of the learned word

Currently SCROLL has 1684 users and contains 25349 logs. The system is used mainly by students learning Japanese.

3.2 Observations

We observed the logs of 20 students. Throughout those observations we could notice that different themes are recurrent in different students' logs. Some students had logs that were constituted by a scientific vocabulary, some students had a vocabulary that included a lot of medical terms, or botanical terms, etc. Moreover, words looked up by a student during the same period of time have usually the same semantic field (book, library, reading, etc.) We assumed that the vocabulary of a student can hint us to and help identifying the intended meaning of an inputted word.

3.3 Contextual word meaning disambiguation.

When using the SCROLL system, Japanese language learners insert logs containing a word in English and learn its Japanese translation. However, if the word is a polysemous word, students get a translation that does not usually reflect the context, the different meanings and the nuances of the word. Moreover, in a self learning environment students don't get the opportunity to explain which meaning of the word they are intending to learn. In order to provide learners with the right translation in the right context, we have to understand their intended meaning. We propose to analyze the past activity of students to extract the meaning they are looking for. We assume that the past activity of a student, the location and other students' logs at similar locations gives a context that can be used to extract the meaning intended by the student when looking up a polysemous word as shown in

Figure 2. The following meta-data is used to predict the meaning the student is looking for:

Past knowledge of the student (vocabulary): to measure the semantic similarity between the past words the student looked up, and each of the meanings of the word we want to disambiguate.

Location: to measure the semantic similarity between the current location of the student, (e.g: cinema, museum, park, etc.) and each of the meanings of the word we want to disambiguate.

Past knowledge of other students at similar locations: : to measure the semantic similarity between the words other students looked up at similar locations and each of the meanings of the word we want to disambiguate.
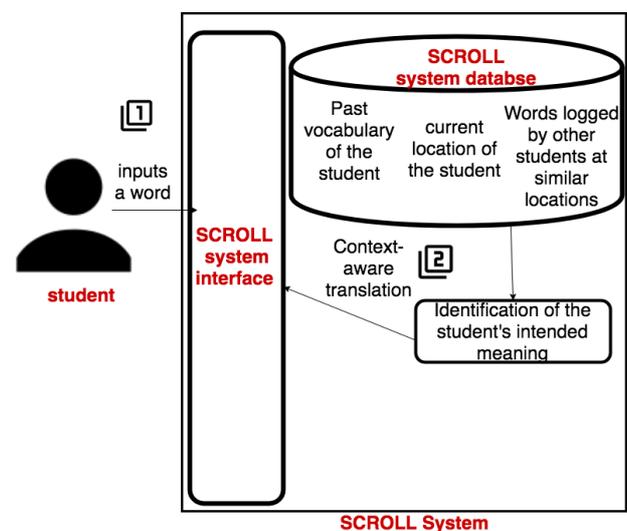
Figure 2: Context aware meaning identification.

In order to identify the intended meaning of the word, we measure the semantic similarity between the past vocabulary of the student, the current location, the vocabulary of other students at different locations and different meaning of the word.

Figure 3: Screenshot from the SCROLL system showing the student past knowledge of a student looking for the meaning of the word driver

Figure 3 shows an example. The student looked up the word *driver*. However, the word driver has different meanings and different translations in Japanese for each of those meaning:

- Person who drives a vehicle: ドライバ (doraiba)
- Train driver: 運転士 (untenshi)
- Mass driver : マスドライバー (masu doraiba)
- Computing ： 仮想デバイスドライバ (kasoo debaisu doraiba)
- Golf club: ドライバー (doraiba)
- Screwdriver (British English): ドライバー (doraiba)

In order to understand which meaning the student is looking for, we look at the previous knowledge. In this case, the word looked up just before the word driver is stepladder. The semantic distance between the words srewdriver and stepladder is smaller than the semantic distance between the word stepladder and each of the words: car driver, train driver, computer driver, mass driver and golf club. We can conclude that the meaning the student is looking for is screwdriver, and that the translation that should be given is ドライバー (doraiba).

3.4 Intended meaning identification

In order to identify the intended mearning we define the following:

- A student has many logs: $log_1, log_2, ..., log_{n-1}$
- A student's log is constituted by a word inputted by the student, an image, a location and a time of input. The images are not uploaded by all students. Around 30% of English logs contain pictures.

$$Log = \{word, image, location, time\}$$

- A word has 1 or more meanings.

$$word = \{meaning_1, meaning_2, ..., meaning_{n}\}$$

- A vocab (vocabulary) is constituted by all the words inputted by the student (except the word the student is currently inputting).

$$vocab = \{word_1, word_2, ..., word_{n-1}\}$$

- The identified meaning is the one with the highest semantic similarity between each meaning of the word and the location, vocabulary and vocabulary of other students at similar location.

$$\begin{aligned} &identified\ meaning \\ &= \max\{similarity(meaning_1, (location, vocab)), \\ &\quad similarity(meaning_2, (location, vocab), ... \\ &\quad similarity(meaning_{n-1}, (location, vocab)\} \end{aligned}$$

4. Preliminary evaluation

In order to evaluate the identification of intended words, we collected 70 polysemous words searched by users of SCROLL system., collected from 20 users. The users had an average vocabulary size of 32.5 words. The collected words have pictures associated to them, uploaded by the user. For each of those words, we measured the semantic similarity between every different meaning of the word and the vocabulary of the user. The meaning that has the biggest semantic similarity with the vocabulary of the user is supposed to be the meaning intended by the user. In order to evaluate the accuracy of the result we manually compare the obtained meaning with the uploaded picture. 85.714% of the obtained meanings ` corresponded to the picture uploaded by the user. The semantic similarity was similar between the vocabulary of users and meanings that are semantically close (e.g.: Fan: 'an apparatus with rotating blades that creates a current of air for cooling or ventilation and a handheld device, typically folding' and 'shaped like a segment of a circle when spread out, that is waved so as to cool the person holding it'). In that case, the results were often erroneous.

5. Conclusion and Discussion

We proposed a method to determine the intended meaning by the student when they are looking up a polysemous word. The method is applied in the context of mobile learning. The main features of mobile learning that benefit students during the learning process are accessibility, immediacy, interactivity and situating of instructional activities [6]. However, mobile learning does not allow language students to share their intended meaning while looking up a polysemous word. In order to do so, the proposed method uses records from the SCROLL system (System for Capturing and Reminding Of Learning Log) to analyze the previous activity of students and extract the intended meaning from it. We assumed that the students' past learned words and location can be used to predict the meaning intended by the student when looking up a polysemous word. We identified the intended meaning by computing the sematic similarity between the vocabulary uploaded by the student and each of the different meanings of the word. The preliminary results show that the intended meaning corresponded to the picture uploaded by the student 85.714 % of the times.

Previous work used word meaning disambiguation methods for a better profiling of users. This work uses the user profile for a word disambiguation. We assumed that the students' past learned words can be used to predict the meaning intended by the student when looking up a polysemous word.

In future works more factors should be taken into consideration for the identification of the intended meaning such as:

Time: to measure the similarity between the current word the student is looking up and the set of words the student looked up at the same period of time.

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