Quick View of Descriptive Answers of Quiz by Auto-Extracted Keywords

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Abstract: In this paper, we develop a system that helps teachers to make an effective improvement based on answers of a quiz in descriptive answer style. Grasping students' understandings is necessary for effective improvements for teachers. The system enables teachers to grasp understandings even before students finish their answers. First, it provides keywords that are automatically extracted from answers. Then, it shows related phrases or related answers according to teachers' selection of keyword. As a result, teachers can grasp interested phrases quickly. It makes improvement of classes effective.

Keywords: Quiz, e-Learning system, text mining, keyword extraction

Introduction

Grasping students' misunderstandings are important for teachers to make their lecture effective. But, it is hard for teachers in large classes. Most easy way to grasp students' misunderstandings is to make a quiz. Some teachers use clickers, which allow students to answer by using electronic devices [1]. With clicker, students can answer for true/false questions, multiple choice questions, or numeric questions. Teachers easily grasp responses of all students. Since clicker accepts only selective answers or numerical values, teachers need to prepare quizzes carefully to grasp students' misunderstandings correctly. Quizzes in descriptive answer style would be preferred for such purpose. Students need to answer such kind of quizzes with their own words.

Though the effectiveness of quiz in a descriptive answer style, it is hard for teachers to grasp all answers in a short time. As a result, some teachers avoid quizzes in descriptive answer style, though its effectiveness. E-learning systems, such as Moodle [2] or Blackboard Learning System [3], can summarize answers in short time by using information technologies. Many researchers have developed systems to analyze/visualize answers, especially descriptive ones. Since sets of answers have difference characteristics with general document collections, some methods that are based on general text mining techniques have a room for improvement.

In this article, we propose a supporting system for teachers to quiz in a large class. The system enables teachers to grasp descriptive answers in short time. It means that they can improve their classes just after quizzes. Teachers can grasp answers by phrases that include a keyword, which is suggested by the system automatically. The system does not require any model answers, teachers can quiz without special preparations. To develop such system, we discuss an interface of grasping answers and a method to suggest keywords.

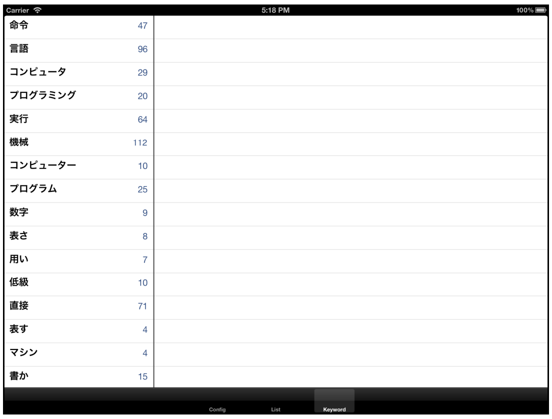
1. Requirements to analyze descriptive answers of a quiz

In this section, we discuss various text-mining techniques for descriptive answers, and state our problem. There are many techniques to support teachers with many documents submitted by students. Ishioka et al. developed JESS (Japanese Essay Scoring System) [4]. It scores Japanese essays by three features: rhetoric, organization, and content. It provides a score and a diagnosis for each essay. Villalon et al. developed Concept Map to visualize conceptual understandings [5]. It visualizes concepts and their relation as a map from students' compositions. Though these techniques are useful for their purpose, they may not work well for our purpose. They do not provide information related to misunderstandings directly.

To develop effective supporting system for quizzes, there are three requirements as follows. The first requirement is that the system provides useful information related misunderstandings of students. It is just our purpose. The second requirement is that the system can accepts incomplete answers to analyze. It is related to the quick improvements as mentioned above. The third requirement is that the system does not require any additional preparations for a quiz. It is related to the advantage of quizzes in descriptive answer style. Teachers can quiz with less preparations than other answer style, they only require a question: no model answers, or no choices for students. The requirement implies to keep this advantage. In addition, we assume all answers are in Japanese. Most of conventional methods do not satisfy the second requirement. They perform deep analysis, which need complete answers.

2. E-Learning system for quizzes and its improvement

We propose a new interface for teachers as shown in fig. 1. It consists of three views: keyword view, phrase view, and answer view. At first, the system shows a keyword view. The view provides a list of words in order of their importance. Here, "importance" represents how effective the word is to grasp misunderstandings. We discuss it in the next chapter. A teacher selects a keyword on the keyword view. Then, the teacher gets related phrases on the phrase view. Finally, the teacher can read whole answers that contain selected phrases on the answer view. We explain this flow with fig. 1. It shows the result of a quiz "*Explain the term*: *machine language*" after 7 minutes elapsed (not finished). 80 students are answering the quiz. Fig. 1 (a) is the keyword view. The view provides keywords with their frequency in the order of importance. They are *instruction* (47 times), *language* (96 time), *computer* (29 times), and so on. After a teacher selects keyword (2^{nd} word: *language*), the system provides the phrase view on the right side of keyword view as fig. 1 (b). On the phrase view, the system provides phrases that are heading/tailing with the selected keyword with their frequency. In this case, there are 5 phrases tailing with *language* and 7 phrases heading with *language*. In this case, the system extracts a train of 6 morphemes as a phrase, and shows only phrases that are appeared multiple times. When the teacher selects a phrase, the system show answers that contain the selected phrase in answer view as fig. 1 (c). In this case, the system shows three answers that contain the phrase *be a language*. With the proposed interface, teachers can grasp misunderstandings without confused by a flood of characters. They follow a their flow to marking answers naturally. It would useful for grasping answers.



(a) Keyword view

(b) Phrase view

(c) Answer view

Figure 4: Teacher's view of proposed system

3. Keyword extraction technique

Since the new interface provides only keywords at first, the extraction of keywords decides the effect of it. In this section, we propose a keyword extraction method for our new interface. Because of the second requirement, we cannot use complicated techniques to estimate importance of each word. Fortunately, MeCab [6], a famous Japanese language morphological analyzer, works even for incomplete answers. By using MeCab, we get morphemes divided from a given text and a word class of each morpheme. We try to estimate importance of each word (a subset of morphemes) from this information. Since the purpose is to extract keywords, we focus only on nouns, verbs, and adjectives in the following discussion.

In general, words that appear in various documents are common words. On the other hand, words that appear only in particular documents may be misspelled words. It is not similar for answers. Words that appear in many answers would be essential words to answer the quiz. Fig. 2 shows this relationship. Here *corpus* means the set of general documents, and *answers* means the ones for particular quiz.

Based on this idea, we estimate the importance of a word by using the function as shown in fig. 3. The figure is a contour graph of the importance corresponding to two input values, the frequency in corpus and the frequency in answers. We use a radial basis function as the function. Here, each frequency is regularized into the range [0,1]. By using this function, the system can automatically estimate importance of each word only by frequency of each word. In addition, the system accept incomplete answers for analysis.

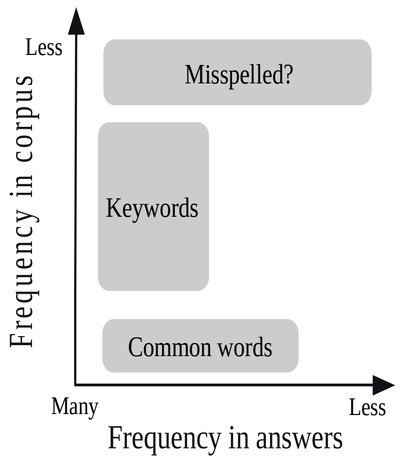


Figure 2: Relationship between type of words and their frequency

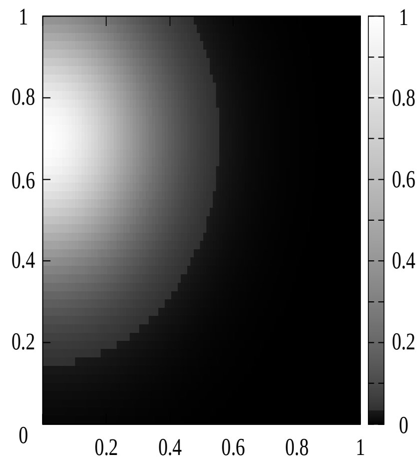


Figure 3: Evaluation function for importance of a word

4. Demonstration

In this section, we demonstrate auto-extraction of keywords. To estimate importance of each word, we use Google's n-gram data [7] as a corpus. It shows frequency of each morpheme in all web pages that are crawled by Google at June 2007. There are 2,565,424 morphemes from 20,036,793,177 sentences.

We apply our system to answers of following quizzes in the course "Introduction to Computer Engineering I and Exercise" for the 1st grade students in our department. Since all quizzes are done in Japanese, we show translated answers in this article.

Quiz 1: *Why is high level programming language needed? Answer with three keywords: Machine language, Program, and Binary code.*
This quiz is an example that keywords are indicated. A sample answer is that "*It is hard for programmers to develop programs in machine language, which is in binary code, directly. They develop programs in high level programming languages that adopt human friendly elements to use.*" There are 80 answers for this quiz.

Quiz 2: *Explain the term "Compiler" in the broad sense.*
This quiz is an example that does not have any requirements for expression. A sample answer is that "*A program that translates source codes in a high level programming language into object code, which is based on a machine language.*" Keywords would be *translate, source code*, and *object code*, and so on. There are 83 answers.

Table 1 shows the result of estimation, which shows top 10 words in importance. Table 1 (a) shows that keywords indicated by the question are ranked in top 10 words. Table 1 (b) contains expected keywords. In addition, keywords in these tables would be useful for answering each question. These results show a validity of our proposal.

Table 1: Estimated Importance

(a) Quiz 1

Word		Importance
Language	(言語)	0.775
Computer	(コンピュータ)	0.714
Programming	(プログラミング)	0.699
Machine	(機械)	0.577
Convert	(変換)	0.572
High level	(高級)	0.572
Execute	(実行)	0.547
Program	(プログラム)	0.502
Use	(用い)	0.445
Description	(表記)	0.397

(b) Quiz 2

Word		Importance
Convert	(変換)	0.827
Programming	(プログラミング)	0.824
Translate	(翻訳)	0.759
Object	(オブジェクト)	0.738
Compile	(コンパイル)	0.723
Language	(言語)	0.720
Compiler	(コンパイラ)	0.678
In the broad sense	(広義)	0.639
Computer	(コンピュータ)	0.631
Source	(ソース)	0.557

5. Conclusion

In this article, we aim to develop a supporting system for quizzes, which are regard as a method to aware students' misunderstandings. The system supports for teachers to grasp misunderstandings quickly. It satisfies three requirements: (1) provides effective information, (2) accept incomplete answers, and (3) do not need special preparations. The proposed system provides keywords, phrases, whole answers in a step-by-step manner as necessary. Teachers would find students' misunderstandings quickly, since they can get necessary information in each phase. In addition, we discuss the method to extract keywords automatically. The proposed method estimates importance of each word only by its frequency in answers and a corpus. As a result, teachers do not need to prepare for analysis, and the system extracts keywords even during a quiz.

Acknowledgements

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