An Intelligent Assessment Mechanism for Online Short Text

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Abstract

In this work, an intelligent online short text assessment mechanism that detects whether the learners address the expected discussion issues is proposed. The concept maps related to the learning topics are first outlined by the instructor. After each learner issues a short text post on the online discussion platform, a feature selection approach is adopted to derive the input parameters of a Support Vector Machines (SVMs) classifier. The classifier then determines if the learners' posts are related to the concept maps previously outlined by the instructor. Notably, a feedback rule construction mechanism is used to issue feedback messages to learners in cases where the online short text assessment mechanism detects that the learners have strayed astray from the expected learning topics in their posts. The experimental results revealed that the proposed approach achieved very good classification results and verified its effectiveness.

Keywords

Online Short Text Assessment; Hotspot Algorithm; Intelligent Tutoring Systems; Support Vector Machines

Introduction

With the development of information technology, computers can be used to effectively relieve teachers' workloads, although it is not possible for computers to entirely substitute a teacher’s role in the class. In this work, we present a tool which can effectively assist teachers by automatically examining students' online short texts during online discussion to determine the degree to which these posts address the various learning topics. The students could receive some suggestions in the form of feedback messages if the evaluation of the learners’ posts was irrelevant to the expected learning topics. The experimental results illustrated the effectiveness of the application of the proposed algorithms to the implementation of an online short text diagnostic tool for an online discussion platform. In addition, the feedback form from the instructor revealed that the proposed tool can also alleviate the teaching load of teachers, thereby allowing them to put more time and effort into designing effective teaching strategies.

The remainder of the paper is organized as follows. The details of the proposed online short text assessment mechanism are presented in Section 2. Section 3 addresses and discusses the experimental results. Conclusions are set out in Section 4.

Architecture of Online Short Text Assessment Mechanism

The proposed online short text assessment mechanism consists of three major components, including the curriculum support module, the text classifier, and the feedback module. First, students issue their posts during online discussion, and then the text classifier is employed to check if a student’s post is related to the discussion topics given by the teacher. Finally, the feedback module will then determine if it is necessary to send a feedback message to the student, according to the classification results.

Curriculum Support Module

Curriculum support module not only supports teachers and students as they collect the supplementary learning materials, but also allows teachers to establish the discussion topics on the discussion board. In this work, the students were expected to focus on the discussion of three main learning topics, including how to fly far away, how to fly straight, and how to fly stably. Under the subtopics, the related concepts included the airfoil size, the center of gravity, the throwing angle, the throwing strength, and the shape of the airplane’s nose.
**Text Classifier**

Text classification is the task of automatically classifying documents into categories from a predefined set. The content of a document is usually illustrated as a vector in the term space, where terms consist of words, phrases, or any other indexing units used to define the contents of a text. A term weighting method represents how much the term contributes to the semantics of a document, and is designed to improve the effectiveness of text classification.

In this work, the feature extraction module first extracts the keywords from the students' posts. Next, the key words were replaced by synonyms recorded in the database. Then, a keyword merging approach is adopted to filter some combinations of individual keywords that are most related as the input features for the classifier. The weights of the keyword combinations were then calculated as the input vectors of a Support Vector Machines (SVMs) classifier at the next stage. The SVMs classifier will check if a student's post is related to the discussion topics given by the teacher.

1) **Feature Extraction Module**

It is necessary to build a synonym database, since people may use different words to represent the same meaning. All synonyms are replaced by the unitary word to ease the computation complexity of the following analysis before processing word segmentation.

**Term Weighting Computation:** For text categorization (TC), a term weighting method that prefers high-frequency terms in the positive category has been widely studied as a way to represent the importance of a term contributing to the semantics of a document. For example, a term weight computation method was proposed in to improve the terms' discriminating power of TC. The experimental results indicated that the new term weighting method outperforms traditional methods. Although term weighting methods help in making possible more efficient and accurate classification, the collected terms are often biased and limited to the training set. This means when the training set and test set are not from the same source, the performance of the classification is significantly degraded. Mohaqeqi et al. (Mohaqeqi, Soltanpoor, and Shakery, 2009) thus applied a concept graph in their work to improve the classification of documents from unknown sources. The weight of a specific term is determined by multiplying relevance frequency of a specific term with the number of occurrences of the term in the documents, and the relevance frequency of a term is defined as,

$$RF = \log_2 \left(2 + \frac{p}{\max(1,n)} \right), \quad (1)$$

where \(p\) denotes the number of documents in the positive category that contain a specific term, and \(n\) represents the number of documents in the negative category that contain this term. Notably, a minimal denominator is used to avoid the occurrence of a zero divisor. Besides, two is placed as the first term on the right-hand side of the equation if there is no document in the positive category that contains this specific term.

In this work, each student's post was graded by the teacher during the training process. The grading showed the degree of relevance between the post and the expected discussion topics. To meet our requirement, we revised the method presented in (Lan, Tan, Su, and Lu, 2009) with four weighting levels transformed from the grades given by the teacher. The final weight of a specific term is then derived by,

$$TW = \left( \sum_{i=1}^{p+n} WL_i \cdot TF_i \right) \cdot RF, \quad (2)$$

where \(p\) denotes the number of documents in the positive category that contain a specific term, and \(n\) represents the counts of documents in the negative category that contain this term. \(WL_i\) stands for weighting level of the \(i^{th}\) post graded by the teacher, and \(TF_i\) denotes the term occurrences of the \(i^{th}\) post.

2) **Keyword Merging Module**

**Step 1:**

List the keywords with the 10% highest TW values.

**Step 2:**

Based on the order of the keywords obtained at Step 1, use an association rule mining algorithm, HotSpot algorithm (Agrawal and Choudhary, 2011) to find the top-ranked keyword combinations that are most related.

**Step 3:**

The expert confirms the results obtained at Step 3.
Step 4:
Recalculate the TW values for all parameters.

3) SVM Classifier
SVMs have recently been gaining in popularity due to their numerous attractive features and impressive empirical performance (Vapnik, 1998). The main difference between the SVMs and conventional regression techniques is that the former adopt the structural risk minimization (SRM) approach, as opposed to the empirical risk minimization (ERM) approach commonly used in statistical learning. The SRM tries to minimize an upper bound on the generalization rather than minimizing the training error, and is expected to perform better than the traditional ERM approach. Moreover, the SVM is a convex optimization, which ensures that the local minimization is the unique minimization.

Feedback Module
After students had issued their posts during online discussion, the feedback module analyzed the students’ posts. The feedback messages obtained from the corresponding entries in the database were shown to the student immediately in the case that feedback was determined to be necessary. If the feedback module found that the messages displayed on the screen still could not prompt the students to effectively input appropriate sentences related to the given issues, the system would inform the teacher that it had provided another alternative feedback message.

Experimental Results
To verify the effectiveness of the proposed collaborative online short text assessment mechanism, one class of junior high school participated in the study. After the teacher of a Natural Science course gave a detailed description of how to build a toy plane during a traditional classroom teaching activity, the students were assigned into separated groups and then worked together to make a paper airplane using a plain piece of A4 size paper.

The students were asked to login to the platform after the cessation of classroom teaching activities, and they received feedback messages whenever the proposed mechanism detected that the students’ posts deviated from the expected design issues. A question asking how to build an aircraft that would fly as long and as far as possible using a plain piece of A4 size paper was given to the students. As mentioned in Section 2.1, the students were expected to focus on the discussion of three main learning topics, including how to fly far, how to fly straight, and how to fly stably. The platform kept students’ posts in the database and evaluated whether the students’ posts were related to these design issues.

We first examine the performance of the SVMs classifier by observing its classification results. 62 sample posts were collected during online discussion. Table 1 shows the confusion matrices of the proposed work; and Table 2 lists the classification rates for the proposed work. We can observe that the recognition rate, recall rate, and precision rate for the proposed work can reach up to 93.54%, 97.36% and 92.5%, respectively. Therefore, the effectiveness of the proposed online short text assessment mechanism is verified.

<table>
<thead>
<tr>
<th>Predicted class</th>
<th>Related to learning topics</th>
<th>Unrelated to learning topics</th>
</tr>
</thead>
</table>
| Actual class:
Related to learning topics | 37                        | 1                          |
| Unrelated to learning topics | 3                         | 21                         |

**TABLE 2. CLASSIFICATION RESULTS OF THE PROPOSED ALGORITHM**

<table>
<thead>
<tr>
<th></th>
<th>Recognition rate</th>
<th>Recall rate</th>
<th>Precision rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>93.54%</td>
<td>97.36%</td>
<td>92.5%</td>
</tr>
</tbody>
</table>

To verify whether the hints or feedback provided by the learning-assistance tool were appropriate, two short questionnaires were given to students with the questions “Is the learning system able to provide you with appropriate hints or feedback?” and “Are you satisfied with the usage of the online discussion platform?” Among the 29 participants, 27 believed that the hints or suggestions were useful when they went off-topic during the assigned projects and 28 students were satisfied with the usage of the online discussion platform.

Conclusion
An intelligent online short text assessment mechanism was proposed in this research. The proposed work is able to automatically detect whether or not students’ posts during online discussion have addressed the related learning issues. Once the system detects that students’ discussions have strayed from the subject material imparted in the learning activities, a feedback
rule construction mechanism provides timely hints or suggestions to the students. The experimental results revealed that the online short text assessment mechanism proposed in this study achieves satisfactory performance for assessing online short texts collected at the class of junior high school.

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REFERENCES


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