

APPROACHES TO AUTOMATED ANSWER SCORING

TARANDEEP SINGH WALIA, AMARPAL SINGH, GURPREET SINGH JOSAN

Abstract: The Abstract represents technology has been available to assist teachers in grading objective tests for several years. However, these true-false and multiple choice tests do not capture the deeper aspects of student learning. It represents the need of Automated answer scoring system is felt in the educational sector.

It represents Automated Scoring (AS) is a measurement technology in which computers evaluate written (not handwritten) work. Automated Scoring is defined as the act of assigning scores to essays automatically based upon some algorithms. Automated Scoring will be advantageous in terms of fairness, less human resource, cost and timely feedback. NLP have major tasks such as discourse analysis, morphological segmentation, parsing, word sense disambiguation and information extraction etc. AS can choose some tasks from NLP for further evaluation. AS systems are a combination of various techniques such as – NLP (Natural Language Processing) along with, Statistics, Artificial Intelligence (Machine Learning), Linguistics and Web Technologies, Text Categorization, annotated large corpora etc. It focuses different AES systems focus on different aspects, they evaluate different numbers of features. Different Automated Scoring systems have different approaches. But in all, it discusses the most related approach to this research. It also focuses on methodology used for Automated Answer Scoring.

Keywords: Automated Essay Scoring(AES), Natural Language Processing(NLP).

INTRODUCTION :Technology has been available to assist teachers in grading objective tests for several years. However, these true-false and multiple choice tests do not capture the deeper aspects of student learning. Essay writing can be used to assess this deeper learning, which includes a student's ability to synthesis his/her thoughts, and argue for propositions. Gradually, the need of Automated answer scoring system is felt in the educational sector. In fact, some organizations have already started the use of such system.

Compared with human rater, Automated Scoring will be advantageous in terms of fairness, less human resource, cost and timely feedback[13]. Automated answer scoring system is supposed to be presenting a new set of challenges for educational studies. Many researches indicate that AS systems can be used to analyze semantic characteristics of an essay and include more such features to score essays. Automated Scoring will be a very significant research subject due to its applicability in various scenarios. Valuation of huge amount of student essays within stipulated time frame, with feed back will be a real challenge. At present, the few AES are available but with little success to evaluate human written (not handwritten) essays automatically. Following

diagram shows the general working of automatic scoring system.

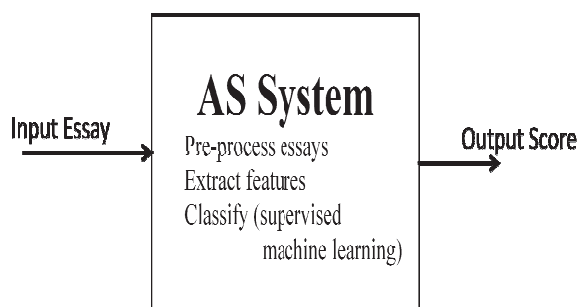


Fig: Automated Scoring (AS) System

Automated Scoring receives an answer text as an input and outputs a score based upon various features of the text. While generating the score, the input text passes through various modules like pre-processing feature extraction and classification etc. to decide which score should be assigned to an essay[18].

1.1 Pre-defined Features

As per Hongbo Chen and Ben He, 2013, there are four types of Pre-defined features that indicate the essay quality, including lexical, syntactical, grammar and fluency, content and prompt-specific features. A brief description of these four classes of features is given below[6].

Lexical features:

- Statistics of word length

- Word level
- Unique words
- Spelling errors

Syntactical features:

- Statistics of sentence length
- Subclauses
- Sentence level.
- Mode, preposition, comma

Grammar and fluency features:

- Word bigram and trigram
- Part-of-Speech(POS) bigram and trigram

Content and prompt-specific features:

- Essay length
- Word Vector similarity
- Semantic Vector similarity
- Text coherence

1.2 AS AND NLP

Today, AS is still a difficult, intricate and interesting issue for researchers in artificial intelligence and natural language processing though many English AS systems have been proposed and developed but with little success. Current automatic essay-scoring techniques are inappropriate for scoring the content of an essay because they either rely on grammatical measures of quality or machine learning techniques, neither of which identifies statements of meaning (propositions) in the text. So, deep natural language processing techniques are required to automatically extract meaning from student essays in the form of propositions and match the extracted propositions to the expected response [4].

NLP have major tasks such as discourse analysis, morphological segmentation, parsing, word sense disambiguation and information extraction etc. AS can choose some tasks from NLP for further evaluation. AS systems are a combination of various techniques such as – NLP (Natural Language Processing) along with, Statistics, Artificial Intelligence (Machine Learning), Linguistics and Web Technologies, Text Categorization, annotated large corpora etc.

1.3 Types of Essay

The essay-typed examination can be categorized into two: long essay answers and short essay answers.

The long essay answers are free text essays where the students are given a topic to be discussed in a long essay. This type of essay has common features to be marked by the lecturers such as the style of writing and the contents. The style includes the punctuation and spelling.

The short essay-typed answers are written in short sentences where the style is not important for marking. Marking short answer essay is relying heavily on the contents of the essays only. Marking short answer essay typed examination differs from marking the free test essay, where the score of the latter is the total of the style and contents[11].

1.4 Various Tools for Automatic Grading Essays

While different AES systems focus on different aspects, they evaluate different numbers of features. Presently there are three major developers of automated essay scoring: (1) Electronic Essay Rater (E-rater) developed by the Educational Testing Service (ETS) of America, (2) IntelliMetric developed by Vantage Learning, and (3) Intelligent Essay Assessor (IEA) developed by Pearson Knowledge Technologies[12].

2. Approaches to Automated Answer Scoring

Different Automated Scoring systems have different approaches. But in all, the most related approach to this research includes:

Unsupervised Technique

An unsupervised technique to select a set of good essays from a large selection of essays written on the same topic. They use a 'bag of words' approach which does not require deep parsing. The approach is based on the content of individual essays and the divergence of the individual essay from the collection when the collection is considered as one large essay. They discussed the approach with the help of Kullback-Liebler divergence, which is used in text mining application to compute similarities between essays. The result indicates that the use of this feature does not assist in the process of selection of good essay, the accuracy was lower at 30%.(Arijit& Sunil,2011)

The AES also uses an unsupervised learning approach based on a voting algorithm. They use **unsupervised** approach and does not

require any reference text to build computational learning model. They evaluate their approach on a set of essays, written by different people, on a single topic. The scoring scheme is based on feature information and the similarities between essays. The advantage of unsupervised approach is that it can be applied to any language with a little modification because it does not use any specific language feature. The disadvantage is that it does not consider organization, style, and grammar features.[17]

Vector Regression approach

AES system using **vector regression**, each essay is represented by the Vector Space Model (VSM). They take both the words and part-of-speech tag into account instead of just the part-of-speech tag. They use the simple model and CVA(content vector analysis) model. They get 86% precision given the two scores deviation compared to human raters.[16]

The K-Nearest Neighbour (KNN) algorithm for AES. With the different methods of feature selection, they are able to achieve 76% accuracy.[9]

An effective AES system based on computer-based CET4(College English Test). The features belong to three domains: language quality, content and organization, are involved in their system to figure out the feature collection with high correlation coefficient. A novel classify algorithm is designed to reduce the negative effects from skewed data and improve the accuracy. Experiment results show the scoring from AES is of high accuracy with Human raters. KNN has the best performance in our AES system with the accuracy over 62%.[15]

To implement the system, it give score on several features, including the surface features such as the number of words, number of sentence, average word length, average sentence length etc. and complex features such as grammar checking, sentences, whether the essay is off-topic, the similarity to full-score essays. For the surface feature, we used The K-Nearest Neighbour (KNN) algorithm for text categorization is applied to CET(College English Test) essays. The value of each vector is expressed by the term frequency and inversed document frequency (TF-IDF) weight. The TF and information gain (IG) methods are used to select features by predetermined features.

The content vector analysis model is suitable for us because it use no training essays based on different topic. The process can see as follows:

Remove the stopwords

Put all the words except stopwords in the vector

Calculate the tfidf weight

Calculate the CVA(Conent Vector Analysis) of essay

Essays with higher score usually have more consistent and similar with the topic. This feature is important and very effective because teachers always have some references when they score essays. The higher the similarity value, the higher the score of the essay.

The advantages of VSM has simple model based that allows computing a degree of similarity, ranking documents and partial matching etc. But the disadvantages are that long documents are poorly represented, different vocabulary won't be supported and the order of document is lost.[15],[16]

Short Answer Scoring Approach

Scoring the short answers essay typed examination requires to compare the similarity of sentences from the answer scripts and scoring scheme. Sentence similarity is defined as sentences that have similar meaning but they are different because of the words used or their construction structure. Marking short answer essay is relying heavily on the contents of the essays only. It consists of the following modules:

- i. Shallow syntactic analysis
- ii. Pronoun resolution
- iii. Morphology
- iv. Morphology and negation
- v. Filling in the semantic gaps
- vi. Matching

The answers will be mapped automatically in the mapping module. The mapping module enables to score specific ideas. It is not suitable for scoring open ended essays. The marking is performed by extracting the grammatical relations from the student answers and marking scheme.[11]

3. Objective and Scope

The major aim of this research work is to develop Automatic answer scoring system. The sub objectives to achieve this aim are:

1. Development of resources, like collection of questions and their reference answers, lexicons, corpus etc.

2. Identification of language specific and independent features.
3. Developing statistical model or rule based model
4. Developing scoring mechanism based upon features and rules
5. Testing system on already defined metrics

Once this system has been developed, it can be used in number of ways in different scenarios.

The system will assist teachers' classroom assessment and help to overcome time, cost, reliability, and generalizability issues in writing(not hand writing) assessment. Responding manually to student papers is a burden for teachers. Particularly if they have number of students and if they assign frequent writing assessment, providing individual feedback the student essays might be time consuming. AS system can be very useful because they can provide the student with a score as well as feedback within seconds.

4. Significance

Automated Scoring has become a hot issue in the research of natural language processing. The essay score given by human rater is mostly affected by rater's personal will, emotion and energy. An essay scored highly by one rater may receive a low score from another

rater. Even the same rater probably gives different scores for the same essay at different times. Thus, the fairness of answer scoring cannot be guaranteed. On the other hand, AS will perform fair scoring, can be repeated again and again with consistency and removes almost all the drawbacks of manual scoring. The research in this direction will open new dimensions for researchers as it is an interdisciplinary work.

5. Methodology

The system to be developed is planned to follow two step process. The first step is analyzing the input essay in order to detect possible errors, such as spelling errors and syntactic errors. The second step is comparing the input essay with given answers essay to identify the semantics, and differences as errors. To evaluate the performance of the system, the output produced by the system is compared with the result provided by human raters.

The system will accept student's answer as input and provide feedback which includes style, discourse analysis, ideas and plagiarism. The scoring is performed by extracting the grammatical relations from the student essay and scoring scheme.

References

1. Ali Muftah Ben, Mohd Juzaidin, "AES for Short Answers in English Language", Published by Journal of Computer Science, Volume:9 Number:10 ISSN:1549-3636, 2013.
2. Arjit De, Sunil Kumar, "An Unsupervised Approach to Automated Selection of Good Essays", Published by IEEE, Volume:11, 2011.
3. Chirag Parikh, Parimal Patel, "Performance Evaluation of AES Algorithm on Various Development Platforms", Published in the proceedings of Published by International Conference on Computer Engg. & Tech., IEEE, Volume:1 2009.
4. Deirde Kerr, Hamid, "Automatic Short Essay scoring using NLP to extract semantic information", Published by National Center for Research on Evaluation, Standards, and Student Testing (CRESST), 2013.
5. Hongbo Chen, Ben He, Baobon Li, "A Ranked-based Learning Approach to Automated Essay Scoring", Published in Proceedings of CGC '12, IEEE Computer Society Washington, DC, USA, 2012.
6. Hongbo Chen, Ben He, " AES by Maximizing Human-machine Agreement", Published in proceeding of National/International Conference on Empirical Methods in Natural Language Processing, Pages 1741-1752, 2013.
7. Ian Blood, "Automated Essay Scoring: A Literature Review", Retrievable at <http://www.tc.columbia.edu/tesolalwebjournal>
8. Leah S. Larkey, "Automated Essay Grading using Text Categorization techniques", Retrievable at www.cs.umass.edu./larkey, 2010.

9. Li Bin, Lu Jun, Yao Jian “Automated essay scoring using the KNN Algorithm”, Published by IEEE Computer Society, Volume: 1, 2008.
10. Luis Tandalla, “Scoring Short Answer Essays”, Published by International Journal of Comp. Sci. & Tech.(IJCST), Volume:2 Number:1, 2012.
11. Mohd Juzaidin Ab Aziz, Fatimah Dato’ Ahmad, “Automated Marking System for Short Answer Examination (AMS-SAE)”, Published by International Journal of Advanced Computer Science and Applications(ISIEA), IEEE, Volume:3 Number:1,2009.
12. Semire Dikli , “Automated Essay Scoring”, Published by Turkish Online Journal of Distance Education, 2006. Volume:7 Number:1 Article:5.
13. Somaye Toranj, Dariush Nejad, “Automated versus Human Essay scoring: A Comparative Study”, Published by IASCSIT Press, Singapore,Volume:33, 2012.
14. Wael H. Gomma, Aly A., “Short Answer grading using String similarity And Corpus based similarity”, Published by International Journal of Advanced Computer Science and Applications IJACSA, Volume:3, 2012.
15. Yali Li, Yonghong Yan, “Automated essay scoring system for CET4”, Published by Education Technology & Computer Science, IEEE Computer Society, Volume:2 Number:1, 2010.
16. Yali Li, Yonghong Yan, “ An effective Automated essay scoring system using support Vector regression”, Published in proceeding of Intelligent Computation Technology and Automation(ICICTA), IEEE Computer Society, Place: Hunan, Dates:12-14 Jan, 2012.
17. Yen-Yu Chen, Chien, “ An Unsupervised Automated Essay Scoring System”, Published by IEEE Computer Society, Volume:25, 2010.
18. Yongwei Yang, “ A Review of Strategies for Validating Computer-Automated Scoring”, Published by Lawrence Erlbaum Associates, Inc., Volume:15 Number:4 2002.
19. Yulan He, Siu Cheung Hui, “An Ensemble Approach for Semantic Assessment of Summary writings”, Published by International Conference on Computer Engg. & Tech., IEEE, 2009, Volume:1.

* * *

Tarandeep Singh Walia, Research Scholar, Punjab Technical University, Jalandhar
Dr. Amarpal Singh, Principal, KCET, Amritsar
Dr. Gurpreet Singh Josan, Assistant Professor, Punjabi University, Patiala,