Automated Essay Scoring: A Cross-Disciplinary Perspective

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The vision of having effective algorithms score student essays should be appealing to the teacher, test publisher, and research scientist. Teachers would be freed of the burden of reading and hand-scoring maybe hundreds of student papers and consequently would be more likely to assign written questions and probe for deeper understanding. Test publishers would be able to score essays for less cost and conceivably provide higher-quality assigned grades. Research scientists, especially readers of this journal, would find this to be a fascinating area, one that merges research from multiple disciplines and having many avenues yearning for exploration.

Shermis and Burstein’s is the first book dedicated to the topic of automated essay scoring (AES). As such, it is destined to be the seminal work in the area. The book is composed of thirteen chapters, each written by a different set of authors. Five of the chapters provide descriptions of five different approaches and form the heart of the book. There are also four chapters on psychometric issues, two on innovations, a formal introduction, and two introductory chapters. The authors are all authorities. The five approaches are described by their developers or major advocates.

As with other forms of artificial intelligence, the task of AES is to accomplish a human goal. This does not mean that the goal needs to be accomplished using the same techniques as humans use. In the case of AES, humans typically read a passage and look for certain prespecified key concepts defined in a scoring rubric. Readers call upon their content knowledge, literary experience, and language skills in evaluating the passage.

The computer cannot possibly score an essay the same way. Rather, AES seeks to use the computer’s special capabilities. The computer can count surface features, examine individual words and phrases, look at word order, stem, identify stop words, parse each sentence, examine sentence-to-sentence relatedness, weigh different features, identify arguments, and compare each new essay to hundreds of prescored essays. The question is whether the results are adequate.

If the goal is to approximate human scores, then the answer is yes for all the approaches. Timothy Keith provides an extremely informative chapter on the predictive validity of several AES programs. The programs tend to yield impressively high correlations with the scores of human raters—generally between .70 and .90 and often between .80 and .85. Further, the correlations of AES with human raters cannot be distinguished from the correlations among human raters. As Ellis Page points out in a chapter describing Project Essay Grade (PEG), AES in a sense “passes the Turing test”—an outside observer cannot tell the difference between the machine and a human. Another way to look at the accuracy of AES is to examine the percentage of
agreement between AES and human scores. In practice, AES scores are considered to
be comparable to human ratings if the two are within one point of each other: “adja-
cent accuracy.” Several chapters report adjacent accuracies of 90–99%. By this criterion,
it is fairly easy for an AES system to be adequate. Adjacency covers much of a scoring
scale—half of a six-point scale and three-fourths of a four-point scale. Further, most
scores are typically in the middle of the score range, again increasing the likelihood
of obtaining a near-perfect adjacent accuracy.

As stated earlier, the heart of the book is the five chapters devoted to different
methods. Three of the methods have been described in the professional literature and
appear to be fairly mature—PEG, which is described by Ellis Page; e-Rater, which is
described by Jill Burstein; and Intelligent Essay Assessor (IEA), which is described by
Thomas Landauer, Darrell Laham, and Peter Foltz. Two additional approaches are pre-
sented. Leah Larkey and Bruce Croft present the details of a Bayesian approach based
on the well-developed text classification literature. Scott Elliot provides a summary of
studies conducted using Intellimetric. The five approaches are all quite different.

PEG and the Bayesian approach are the simplest. Using a large collection of sur-
face features such as average sentence length, frequency of certain transitional words,
number of semicolons, and word rarity, PEG yields extremely impressive AES–human
rater correlations. These surface features appear to be effective proxies for the intrinsic
variables that humans look for. The Bayesian approaches examine the probabilities of
each token (typically a word or a stemmed word) being used in essays in each score
group. Larkey and Croft present a wonderful analysis of a variety of approaches.

On the other end of the spectrum, IEA and e-Rater have a much deeper linguistic
base. IEA examines content, style, and mechanics, with content expressed as independ-
dent measures of semantic quality and the amount of such content. E-Rater examines
discourse structure, syntactic structure, and vocabulary usage. While the underlying
mathematics is different, the two approaches share an underlying philosophy of relying
on natural language processing rather than mechanical features.

If a reader is looking for an understanding of the approaches and potential of
AES, this is the book to read. All the current approaches are presented in one vol-
une. The authors do an excellent job of describing the philosophy and history of their
approaches. Of particular interest are ideas for providing diagnostic and evaluative
feedback that are sprinkled throughout the book. The chapters are, however, quite
independent and in the wrong order. I suggest starting with the introduction, then
moving to the descriptions of the approaches, psychometric issues in AES, and in-
novations in AES. The first two chapters, which are probably intended to provide a
general framework and background, can be skipped without any loss.

Lawrence Rudner is the chief statistician with the Graduate Management Admission Council. He
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