

# Automated Essay Scoring

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## Abstract

Automated essay scoring systems are used in evaluating and scoring student essays written based on a given prompt. Recent advances in Deep Learning and Natural Language Processing have produced state of art results in this task. The performance of these systems are approaching human level according to the evaluation metrics, but their qualitative performance in actual scenarios is not explored. In this paper we explore these systems perform in real life scenarios as compared to other non-neural models. We also explore some ways to overcome these shortcomings.

## 1 Introduction

There is a recent surge in use of deep learning for the task of automated essay scoring. These models have shown to out perform the traditional models based on hand coded features and currently have the state of art performance in this task. The current state of art model is from Taghipour et al. (?) and the state of art non-neural model is EASE (?). In this paper we explore the performance of deep-learning based systems on real life scenarios. We try to see if their performance is actually better than traditional non-neural based models in qualitative sense.

Essay writing is usually a part of the student assessment process. Several organizations, such as Educational Testing Service (ETS)(?), evaluate the writing skills of students in their examinations. Because of the large number of students participating in these exams, grading all essays is very time-consuming. Thus, some organizations have been using AES systems to reduce the time and cost of scoring essays. Therefore, it is of prime importance that we understand the metrics that these

new models are actually using to score the essays.

The following instructions are directed to authors of papers submitted to ACL-2017 or accepted for publication in its proceedings. All authors are required to adhere to these specifications. Authors are required to provide a Portable Document Format (PDF) version of their papers. **The proceedings are designed for printing on A4 paper.**

## 2 General Instructions

Manuscripts must be in two-column format. Exceptions to the two-column format include the title, authors' names and complete addresses, which must be centered at the top of the first page, and any full-width figures or tables (see the guidelines in Subsection 2.6). **Type single-spaced.** Start all pages directly under the top margin. See the guidelines later regarding formatting the first page. The manuscript should be printed single-sided and its length should not exceed the maximum page limit described in Section 4. Pages are numbered for initial submission. However, **do not number the pages in the camera-ready version.**

By uncommenting `\aclfinalcopy` at the top of this document, it will compile to produce an example of the camera-ready formatting; by leaving it commented out, the document will be anonymized for initial submission. When you first create your submission on softconf, please fill in your submitted paper ID where `***` appears in the `\def\aclpaperid{***}` definition at the top.

The review process is double-blind, so do not include any author information (names, addresses) when submitting a paper for review. However, you should maintain space for names and addresses so that they will fit in the final (accepted) version. The ACL 2017 L<sup>A</sup>T<sub>E</sub>X style will create a titlebox space of 2.5in for you when `\aclfinalcopy` is

commented out.

## 2.1 The Ruler

The ACL 2017 style defines a printed ruler which should be presented in the version submitted for review. The ruler is provided in order that reviewers may comment on particular lines in the paper without circumlocution. If you are preparing a document without the provided style files, please arrange for an equivalent ruler to appear on the final output pages. The presence or absence of the ruler should not change the appearance of any other content on the page. The camera ready copy should not contain a ruler. (L<sup>A</sup>T<sub>E</sub>X users may uncomment the `\aclfinalcopy` command in the document preamble.)

Reviewers: note that the ruler measurements do not align well with lines in the paper – this turns out to be very difficult to do well when the paper contains many figures and equations, and, when done, looks ugly. In most cases one would expect that the approximate location will be adequate, although you can also use fractional references (*e.g.*, the first paragraph on this page ends at mark 114.5).

## 2.2 Electronically-available resources

ACL provides this description in L<sup>A</sup>T<sub>E</sub>X2e (`acl2017.tex`) and PDF format (`acl2017.pdf`), along with the L<sup>A</sup>T<sub>E</sub>X2e style file used to format it (`acl2017.sty`) and an ACL bibliography style (`aclnatbib.bst`) and example bibliography (`acl2017.bib`). These files are all available at [acl2017.org/index.php?article\\_id=9](http://acl2017.org/index.php?article_id=9). We strongly recommend the use of these style files, which have been appropriately tailored for the ACL 2017 proceedings.

## 2.3 Format of Electronic Manuscript

For the production of the electronic manuscript you must use Adobe's Portable Document Format (PDF). PDF files are usually produced from L<sup>A</sup>T<sub>E</sub>X using the *pdflatex* command. If your version of L<sup>A</sup>T<sub>E</sub>X produces Postscript files, you can convert these into PDF using *ps2pdf* or *dvipdf*. On Windows, you can also use Adobe Distiller to generate PDF.

Please make sure that your PDF file includes all the necessary fonts (especially tree diagrams, symbols, and fonts with Asian characters). When you print or create the PDF file, there is usually an option in your printer setup to include none,

all or just non-standard fonts. Please make sure that you select the option of including ALL the fonts. **Before sending it, test your PDF by printing it from a computer different from the one where it was created.** Moreover, some word processors may generate very large PDF files, where each page is rendered as an image. Such images may reproduce poorly. In this case, try alternative ways to obtain the PDF. One way on some systems is to install a driver for a postscript printer, send your document to the printer specifying "Output to a file", then convert the file to PDF.

It is of utmost importance to specify the **A4 format** (21 cm x 29.7 cm) when formatting the paper. When working with *dvips*, for instance, one should specify `-t a4`. Or using the command `\special{papersize=210mm,297mm}` in the latex preamble (directly below the `\usepackage` commands). Then using *dvipdf* and/or *pdflatex* which would make it easier for some.

Print-outs of the PDF file on A4 paper should be identical to the hardcopy version. If you cannot meet the above requirements about the production of your electronic submission, please contact the publication chairs as soon as possible.

## 2.4 Layout

Format manuscripts two columns to a page, in the manner these instructions are formatted. The exact dimensions for a page on A4 paper are:

- Left and right margins: 2.5 cm
- Top margin: 2.5 cm
- Bottom margin: 2.5 cm
- Column width: 7.7 cm
- Column height: 24.7 cm
- Gap between columns: 0.6 cm

Papers should not be submitted on any other paper size. If you cannot meet the above requirements about the production of your electronic submission, please contact the publication chairs above as soon as possible.

## 2.5 Fonts

For reasons of uniformity, Adobe's **Times Roman** font should be used. In L<sup>A</sup>T<sub>E</sub>X2e this is accomplished by putting

```
\usepackage{times}
\usepackage{latexsym}
```

in the preamble. If Times Roman is unavailable, use **Computer Modern Roman** (L<sup>A</sup>T<sub>E</sub>X2e’s default). Note that the latter is about 10% less dense than Adobe’s Times Roman font.

Type of Text	Font Size	Style
paper title	15 pt	bold
author names	12 pt	bold
author affiliation	12 pt	
the word “Abstract”	12 pt	bold
section titles	12 pt	bold
document text	11 pt	
captions	11 pt	
abstract text	10 pt	
bibliography	10 pt	
footnotes	9 pt	

Table 1: Font guide.

## 2.6 The First Page

Center the title, author’s name(s) and affiliation(s) across both columns. Do not use footnotes for affiliations. Do not include the paper ID number assigned during the submission process. Use the two-column format only when you begin the abstract.

**Title:** Place the title centered at the top of the first page, in a 15-point bold font. (For a complete guide to font sizes and styles, see Table 1) Long titles should be typed on two lines without a blank line intervening. Approximately, put the title at 2.5 cm from the top of the page, followed by a blank line, then the author’s names(s), and the affiliation on the following line. Do not use only initials for given names (middle initials are allowed). Do not format surnames in all capitals (*e.g.*, use “Mitchell” not “MITCHELL”). Do not format title and section headings in all capitals as well except for proper names (such as “BLEU”) that are conventionally in all capitals. The affiliation should contain the author’s complete address, and if possible, an electronic mail address. Start the body of the first page 7.5 cm from the top of the page.

The title, author names and addresses should be completely identical to those entered to the electronical paper submission website in order to maintain the consistency of author information

Command	Output	Command	Output
<code>\a</code>	ä	<code>\c c</code>	ç
<code>\^e</code>	ê	<code>\u g</code>	ğ
<code>\i</code>	ì	<code>\l</code>	ł
<code>\.I</code>	İ	<code>\~n</code>	ñ
<code>\o</code>	ø	<code>\H o</code>	ö
<code>\'u</code>	ú	<code>\v r</code>	ř
<code>\aa</code>	å	<code>\ss</code>	ß

Table 2: Example commands for accented characters, to be used in, *e.g.*, BIB<sub>T</sub>E<sub>X</sub> names.

among all publications of the conference. If they are different, the publication chairs may resolve the difference without consulting with you; so it is in your own interest to double-check that the information is consistent.

**Abstract:** Type the abstract at the beginning of the first column. The width of the abstract text should be smaller than the width of the columns for the text in the body of the paper by about 0.6 cm on each side. Center the word **Abstract** in a 12 point bold font above the body of the abstract. The abstract should be a concise summary of the general thesis and conclusions of the paper. It should be no longer than 200 words. The abstract text should be in 10 point font.

**Text:** Begin typing the main body of the text immediately after the abstract, observing the two-column format as shown in the present document. Do not include page numbers.

**Indent:** When starting a new paragraph. Use 11 points for text and subsection headings, 12 points for section headings and 15 points for the title.

## 2.7 Sections

**Headings:** Type and label section and subsection headings in the style shown on the present document. Use numbered sections (Arabic numerals) in order to facilitate cross references. Number subsections with the section number and the subsection number separated by a dot, in Arabic numerals. Do not number subsubsections.

**Citations:** Citations within the text appear in parentheses as (Gusfield, 1997) or, if the author’s name appears in the text itself, as Gusfield (1997). Using the provided L<sup>A</sup>T<sub>E</sub>X style, the former is accomplished using `\cite` and the latter with `\shortcite` or `\newcite`. Collapse multiple citations as in (Gusfield, 1997; Aho and Ullman, 1972); this is accomplished with the provided style using commas within the `\cite` command, *e.g.*, `\cite{Gusfield:97,Aho:72}`. Ap-

output	natbib	previous ACL style files
(Gusfield, 1997)	\citep	\cite
Gusfield (1997)	\citet	\newcite
(1997)	\citeyearpar	\shortcite

Table 3: Citation commands supported by the style file. The citation style is based on the natbib package and supports all natbib citation commands. It also supports commands defined in previous ACL style files for compatibility.

pend lowercase letters to the year in cases of ambiguities. Treat double authors as in (Aho and Ullman, 1972), but write as in (Chandra et al., 1981) when more than two authors are involved. Collapse multiple citations as in (Gusfield, 1997; Aho and Ullman, 1972). Also refrain from using full citations as sentence constituents.

We suggest that instead of

“(Gusfield, 1997) showed that ...”

you use

“Gusfield (1997) showed that ...”

If you are using the provided L<sup>A</sup>T<sub>E</sub>X and BibT<sub>E</sub>X style files, you can use the command \citet (cite in text) to get “author (year)” citations.

If the BibT<sub>E</sub>X file contains DOI fields, the paper title in the references section will appear as a hyperlink to the DOI, using the hyperref L<sup>A</sup>T<sub>E</sub>X package. To disable the hyperref package, load the style file with the nohyperref option: \usepackage[nohyperref]{acl2017}

**Digital Object Identifiers:** As part of our work to make ACL materials more widely used and cited outside of our discipline, ACL has registered as a CrossRef member, as a registrant of Digital Object Identifiers (DOIs), the standard for registering permanent URNs for referencing scholarly materials. As of 2017, we are requiring all camera-ready references to contain the appropriate DOIs (or as a second resort, the hyperlinked ACL Anthology Identifier) to all cited works. Thus, please ensure that you use BibT<sub>E</sub>X records that contain DOI or URLs for any of the ACL materials that you reference. Appropriate records should be found for most materials in the current ACL Anthology at <http://aclanthology.info/>.

As examples, we cite (Goodman et al., 2016) to show you how papers with a DOI will appear in the bibliography. We cite (Harper, 2014) to show how papers without a DOI but with an ACL Anthology Identifier will appear in the bibliography.

As reviewing will be double-blind, the submitted version of the papers should not include the authors’ names and affiliations. Furthermore, self-references that reveal the author’s identity, *e.g.*,

“We previously showed (Gusfield, 1997) ...”

should be avoided. Instead, use citations such as

“Gusfield (1997) previously showed ...”

**Please do not use anonymous citations** and do not include acknowledgements when submitting your papers. Papers that do not conform to these requirements may be rejected without review.

**References:** Gather the full set of references together under the heading **References**; place the section before any Appendices, unless they contain references. Arrange the references alphabetically by first author, rather than by order of occurrence in the text. Provide as complete a citation as possible, using a consistent format, such as the one for *Computational Linguistics* or the one in the *Publication Manual of the American Psychological Association* (American Psychological Association, 1983). Use of full names for authors rather than initials is preferred. A list of abbreviations for common computer science journals can be found in the *ACM Computing Reviews* (for *Computing Machinery*, 1983).

The L<sup>A</sup>T<sub>E</sub>X and BibT<sub>E</sub>X style files provided roughly fit the American Psychological Association format, allowing regular citations, short citations and multiple citations as described above.

**Appendices:** Appendices, if any, directly follow the text and the references (but see above). Letter them in sequence and provide an informative title: **Appendix A. Title of Appendix**.

## 2.8 Footnotes

**Footnotes:** Put footnotes at the bottom of the page and use 9 points text. They may be numbered or

referred to by asterisks or other symbols.<sup>1</sup> Footnotes should be separated from the text by a line.<sup>2</sup>

## 2.9 Graphics

**Illustrations:** Place figures, tables, and photographs in the paper near where they are first discussed, rather than at the end, if possible. Wide illustrations may run across both columns. Color illustrations are discouraged, unless you have verified that they will be understandable when printed in black ink.

**Captions:** Provide a caption for every illustration; number each one sequentially in the form: “Figure 1. Caption of the Figure.” “Table 1. Caption of the Table.” Type the captions of the figures and tables below the body, using 11 point text.

## 2.10 Accessibility

In an effort to accommodate the color-blind (as well as those printing to paper), grayscale readability for all accepted papers will be encouraged. Color is not forbidden, but authors should ensure that tables and figures do not rely solely on color to convey critical distinctions. Here we give a simple criterion on your colored figures, if your paper has to be printed in black and white, then you must assure that every curves or points in your figures can be still clearly distinguished.

## 3 Translation of non-English Terms

It is also advised to supplement non-English characters and terms with appropriate transliterations and/or translations since not all readers understand all such characters and terms. Inline transliteration or translation can be represented in the order of: original-form transliteration “translation”.

## 4 Length of Submission

The ACL 2017 main conference accepts submissions of long papers and short papers. Long papers may consist of up to eight (8) pages of content plus unlimited pages for references. Upon acceptance, final versions of long papers will be given one additional page – up to nine (9) pages of content plus unlimited pages for references – so that reviewers’ comments can be taken into account. Short papers may consist of up to four (4) pages of content, plus unlimited pages for references. Upon acceptance,

short papers will be given five (5) pages in the proceedings and unlimited pages for references.

For both long and short papers, all illustrations and tables that are part of the main text must be accommodated within these page limits, observing the formatting instructions given in the present document. Supplementary material in the form of appendices does not count towards the page limit.

However, note that supplementary material should be supplementary (rather than central) to the paper, and that reviewers may ignore supplementary material when reviewing the paper (see Appendix A). Papers that do not conform to the specified length and formatting requirements are subject to be rejected without review.

Workshop chairs may have different rules for allowed length and whether supplemental material is welcome. As always, the respective call for papers is the authoritative source.

## Acknowledgments

The acknowledgments should go immediately before the references. Do not number the acknowledgments section. Do not include this section when submitting your paper for review.

## References

- Alfred V. Aho and Jeffrey D. Ullman. 1972. *The Theory of Parsing, Translation and Compiling*, volume 1. Prentice-Hall, Englewood Cliffs, NJ.
- American Psychological Association. 1983. *Publications Manual*. American Psychological Association, Washington, DC.
- Ashok K. Chandra, Dexter C. Kozen, and Larry J. Stockmeyer. 1981. [Alternation](https://doi.org/10.1145/322234.322243). *Journal of the Association for Computing Machinery* 28(1):114–133. <https://doi.org/10.1145/322234.322243>.
- Association for Computing Machinery. 1983. *Computing Reviews* 24(11):503–512.
- James Goodman, Andreas Vlachos, and Jason Naradowsky. 2016. [Noise reduction and targeted exploration in imitation learning for abstract meaning representation parsing](https://doi.org/10.18653/v1/P16-1001). In *Proceedings of the 54th Annual Meeting of the Association for Computational Linguistics (Volume 1: Long Papers)*. Association for Computational Linguistics, pages 1–11. <https://doi.org/10.18653/v1/P16-1001>.
- Dan Gusfield. 1997. *Algorithms on Strings, Trees and Sequences*. Cambridge University Press, Cambridge, UK.

<sup>1</sup>This is how a footnote should appear.

<sup>2</sup>Note the line separating the footnotes from the text.

Mary Harper. 2014. [Learning from 26 languages: Program management and science in the babel program](http://aclweb.org/anthology/C14-1001). In *Proceedings of COLING 2014, the 25th International Conference on Computational Linguistics: Technical Papers*. Dublin City University and Association for Computational Linguistics, page 1. <http://aclweb.org/anthology/C14-1001>.

## A Supplemental Material

ACL 2017 also encourages the submission of supplementary material to report preprocessing decisions, model parameters, and other details necessary for the replication of the experiments reported in the paper. Seemingly small preprocessing decisions can sometimes make a large difference in performance, so it is crucial to record such decisions to precisely characterize state-of-the-art methods.

Nonetheless, supplementary material should be supplementary (rather than central) to the paper. **Submissions that misuse the supplementary material may be rejected without review.** Essentially, supplementary material may include explanations or details of proofs or derivations that do not fit into the paper, lists of features or feature templates, sample inputs and outputs for a system, pseudo-code or source code, and data. (Source code and data should be separate uploads, rather than part of the paper).

The paper should not rely on the supplementary material: while the paper may refer to and cite the supplementary material and the supplementary material will be available to the reviewers, they will not be asked to review the supplementary material.

Appendices (*i.e.* supplementary material in the form of proofs, tables, or pseudo-code) should come after the references, as shown here. Use `\appendix` before any appendix section to switch the section numbering over to letters.

## B Multiple Appendices

... can be gotten by using more than one section. We hope you won't need that.