

Minimum Viable Tuning for Intent and Emotion Classification with DistilBERT

Kieffer Thomas

UC Berkeley School of Information

kieffert@berkeley.edu

Abstract

Inferring the underlying intents and emotions in small snippets of text is central to many applications of machine learning. These classifications can provide a high-level motivational map for search queries, give a deeper understanding of posts on social media, and are crucial for developing accurate question-answering and dialog systems. Focusing on contexts where resources may be limited in terms of the scale of data, the length of text to be classified, and compute resources available, utilizing the DistilBERT model to fine-tune a classifier on small amounts of data is found to be effective at building accurate text classifiers with relatively few data points.

1 Introduction

Intent detection plays a critical role in many real-world applications for machine learning. For instance, when choosing what ad to show when serving advertisements on a search engine, being able to differentiate the nuanced motivations behind similar queries like "best deal on new hiking boots" (shop for deals), "buy new hiking boots" (high intent to purchase), and "best hiking boots for high altitudes" (research) would enable an advertiser to tailor specific messaging that matches a high-level contextual understanding of what that short snippet of text truly *means* for the searcher. More directly, there are often scenarios such as dialog systems on websites or automated phone systems that rely on specifically answering questions from a user, and correctly classifying the type of question being posed allows for efficient retrieval of answers and relevant information.

Similarly, emotion detection from text can play an important role in developing better automated solutions. In *SemEval-2019 Task 3: EmoContext*,

Contextual Emotion Detection in Text (Chatterjee et al., 2019), the researchers note that in addition to deep informational knowledge, if digital assistants like Siri and Alexa can possess a degree of emotional intelligence they can achieve more human-like interaction with users, and highlight the challenge of inferring emotion strictly from text without additional information such as facial expressions. On a social media site like Twitter, the ability to accurately gauge a user's emotion from a short tweet can enable more efficient moderation, content recommendation algorithms, or even identify when users are struggling with mental health (Hasan et al., 2019).

However, the ability to create a robust text classifier for intents and emotions will often be difficult due to resource constraints. This could be the case when adapting to a new environment, like working to tailor advertisements for a small company where little data exists for queries of their niche products, attempting to build an automated question-answering system from the ground up, or when a user or community has little textual information to build a statistical model from. The highly adaptable pre-trained language model BERT has proven very effective in such environments, leveraging fine-tuning of the base model on a wide range of NLP tasks to achieve state of the art performance, often with small datasets used for fine-tuning (Devlin et al., 2018).

The analysis looks at low-resource data scenarios, and using DistilBERT – a pared down version of the larger BERT model that is "40% smaller, 60% faster, [and] retains 97% of the language understanding capabilities" (Sanh et al., 2019) – finds classification models fine-tuned using just 2000 data points are generally sufficient to produce models that perform within 5 percentage points of the best accuracy scores of the larger BERT models and best performers overall.

2 Background

- BERT is a highly adaptable model etc. etc. (BERT Paper)
- DistilBERT Improves upon this and provides a somewhat less compute-intensive representation. (DistilBERT Paper)
- Proven low-resource successes.
- Progress on intent detection and emotion classification

3 Data

Fine-tuning and performance is evaluated for four datasets:

ATIS: Airline Travel Information Systems. Consists of transcripts of requests for flight information and the intent of the request. n=4274 training examples, 512 test. 17 intent classes.

SNIPS: Benchmark dataset created at snips.ai. Consists of text of requests to automated assistants. Split to n=262 training examples, 66 test. 10 intent classes.

emotion: Dataset collected by Elvis Saravia et al. (Saravia et al., 2018). Consists of English language twitter messages. n=16000 training examples, 2000 test. 6 emotion classes.

emo: Dataset created by Chatterjee et al. (Chatterjee et al., 2019). Each example has three “turns” of a text exchange, the third of which is classified with an emotion. n=30160 training examples, 5509 test. 4 emotion classes.

ACL provides this description and accompanying style files at

<http://acl2020.org/downloads/acl2020-templates.zip>

We strongly recommend the use of these style files, which have been appropriately tailored for the ACL 2020 proceedings.

L^AT_EX-specific details: The templates include the L^AT_EX2e source (`acl2020.tex`), the L^AT_EX2e style file used to format it (`acl2020.sty`), an ACL bibliography style (`aclnatbib.bst`), an example bibliography (`acl2020.bib`), and the bibliography for the ACL Anthology (`anthology.bib`).

4 Length of Submission

The 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. Papers that do not conform to the specified length and formatting requirements are subject to be rejected without review.

The conference encourages the submission of additional material that is relevant to the reviewers but not an integral part of the paper. There are two such types of material: appendices, which can be read, and non-readable supplementary materials, often data or code. Additional material must be submitted as separate files, and must adhere to the same anonymity guidelines as the main paper. The paper must be self-contained: it is optional for reviewers to look at the supplementary material. Papers should not refer, for further detail, to documents, code or data resources that are not available to the reviewers. Refer to Appendices A and B for further information.

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.

5 Anonymity

As reviewing will be double-blind, papers submitted for review should not include any author information (such as names or affiliations). Furthermore, self-references that reveal the author’s identity, *e.g.*,

We previously showed (?) ...

should be avoided. Instead, use citations such as

? previously showed...

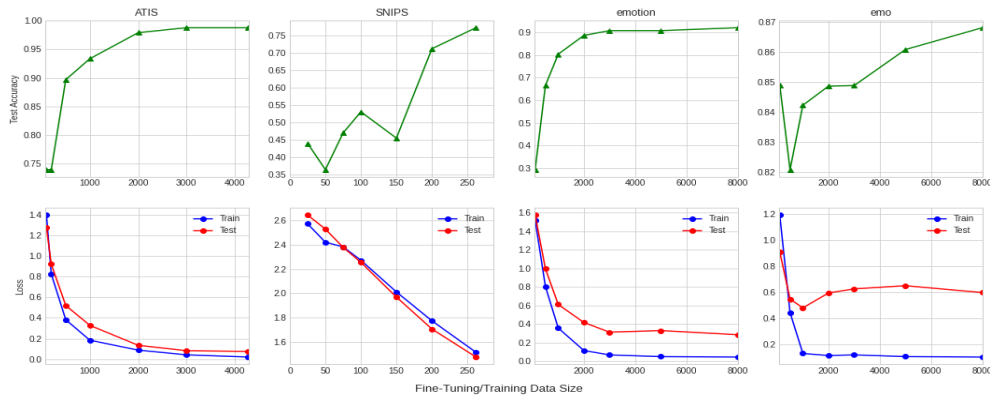


Figure 1: This is an image.



Figure 2: description of figure here

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

Any preliminary non-archival versions of submitted papers should be listed in the submission form but not in the review version of the paper. Reviewers are generally aware that authors may present preliminary versions of their work in other venues, but will not be provided the list of previous presentations from the submission form.

Once a paper has been accepted to the conference, the camera-ready version of the paper should include the author's names and affiliations, and is allowed to use self-references.

L^AT_EX-specific details: For an anonymized submission, ensure that `\aclfinalcopy` at the top of this document is commented out, and that you have filled in the paper ID number (assigned during the submission process on softconf) where `***` appears in the `\def\aclpaperid{***}` definition at the top of this document. For a camera-ready submission, ensure that `\aclfinalcopy` at the top of this document is not commented out.

6 Multiple Submission Policy

Papers that have been or will be submitted to other meetings or publications must indicate this at submission time in the START submission form, and must be withdrawn from the other venues if accepted by ACL 2020. Authors of papers accepted for presentation at ACL 2020 must notify the program chairs by the camera-ready deadline as to whether the paper will be presented. We will not accept for publication or presentation the papers that overlap significantly in content or results with papers that will be (or have been) published elsewhere.

Authors submitting more than one paper to ACL 2020 must ensure that submissions do not overlap significantly ($\geq 25\%$) with each other in content or results.

7 Formatting 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 Section 7.5). **Type single-spaced.** Start all pages directly under the top margin. The manuscript should be printed single-sided and its length should not exceed the maximum page limit described in Section 4. Pages should be numbered in the version submitted for review, but **pages should not be numbered in the camera-ready version.**

L^AT_EX-specific details: The style files will generate page numbers when `\acfinalcopy` is commented out, and remove them otherwise.

7.1 File Format

For the production of the electronic manuscript you must use Adobe’s Portable Document Format (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. 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.

L^AT_EX-specific details: PDF files are usually produced from L^AT_EX using the `pdflatex` command. If your version of L^AT_EX produces Postscript files, `ps2pdf` or `dvipdf` can convert these to PDF. To ensure A4 format in L^AT_EX, use the command `\special{papersize=210mm,297mm}` in the L^AT_EX preamble (below the `\usepackage` commands) and use `dvipdf` and/or `pdflatex`; or specify `-t a4` when working with `dvips`.

7.2 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

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
subsection titles	11 pt	bold
document text	11 pt	
captions	10 pt	
abstract text	10 pt	
bibliography	10 pt	
footnotes	9 pt	

Table 1: Font guide.

- 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.

7.3 Fonts

For reasons of uniformity, Adobe’s **Times Roman** font should be used. If Times Roman is unavailable, you may use Times New Roman or **Computer Modern Roman**.

Table 1 specifies what font sizes and styles must be used for each type of text in the manuscript.

L^AT_EX-specific details: To use Times Roman in L^AT_EX2_ε, put the following in the preamble:

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

7.4 Ruler

A printed ruler (line numbers in the left and right margins of the article) should be presented in the version submitted for review, so that reviewers may comment on particular lines in the paper without circumlocution. 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.

Reviewers: note that the ruler measurements may 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.*, this line ends at mark 295.5).

L^AT_EX-specific details: The style files will generate the ruler when `\aclfinalcopy` is commented out, and remove it otherwise.

7.5 Title and Authors

Center the title, author’s name(s) and affiliation(s) across both columns. Do not use footnotes for affiliations. Place the title centered at the top of the first page, in a 15-point bold font. Long titles should be typed on two lines without a blank line intervening. Put the title 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 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.

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

Start the body of the first page 7.5 cm from the top of the page. **Even in the anonymous version of the paper, you should maintain space for names and addresses so that they will fit in the final (accepted) version.**

7.6 Abstract

Use two-column format when you begin the 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 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.

7.7 Text

Begin typing the main body of the text immediately after the abstract, observing the two-column format as shown in the present document.

Indent 0.4 cm when starting a new paragraph.

7.8 Sections

Format section and subsection headings in the style shown on the present document. Use numbered sections (Arabic numerals) to facilitate cross references. Number subsections with the section number and the subsection number separated by a dot, in Arabic numerals.

7.9 Footnotes

Put footnotes at the bottom of the page and use 9 point font. They may be numbered or referred to by asterisks or other symbols.¹ Footnotes should be separated from the text by a line.²

7.10 Graphics

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 is allowed, but adhere to Section 8’s guidelines on accessibility.

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 10 point text. Captions should be placed below illustrations. Captions that are one line are centered (see Table 1). Captions longer than one line are left-aligned (see Table 2).

¹This is how a footnote should appear.

²Note the line separating the footnotes from the text.

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>	î	<code>\l</code>	ł
<code>\.I</code>	İ	<code>\~n</code>	ñ
<code>\o</code>	ø	<code>\H o</code>	ő
<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., BibTeX names.

L^AT_EX-specific details: The style files are compatible with the caption and subcaption packages; do not add optional arguments. **Do not override the default caption sizes.**

7.11 Hyperlinks

Within-document and external hyperlinks are indicated with Dark Blue text, Color Hex #000099.

7.12 Citations

Citations within the text appear in parentheses as (?) or, if the author’s name appears in the text itself, as ?. Append lowercase letters to the year in cases of ambiguities. Treat double authors as in (?), but write as in (?) when more than two authors are involved. Collapse multiple citations as in (??).

Refrain from using full citations as sentence constituents. Instead of

“(?) showed that ...”

write

“? showed that ...”

L^AT_EX-specific details: Table 3 shows the syntax supported by the style files. We encourage you to use the natbib styles. You can use the command `\citet` (cite in text) to get “author (year)” citations as in ?. You can use the command `\citep` (cite in parentheses) to get “(author, year)” citations as in (?). You can use the command `\citealp` (alternative cite without parentheses) to get “author year” citations (which is useful for using citations within parentheses, as in ?).

7.13 References

Gather the full set of references together under the heading **References**; place the section before any Appendices. 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* (?). Use full names for authors, not just initials.

Submissions should accurately reference prior and related work, including code and data. If a piece of prior work appeared in multiple venues, the version that appeared in a refereed, archival venue should be referenced. If multiple versions of a piece of prior work exist, the one used by the authors should be referenced. Authors should not rely on automated citation indices to provide accurate references for prior and related work.

The following text cites various types of articles so that the references section of the present document will include them.

- Example article in journal: (?).
- Example article in proceedings, with location: (Börschinger and Johnson, 2011).
- Example article in proceedings, without location: (?).
- Example arxiv paper: (?).

L^AT_EX-specific details: The L^AT_EX and BibTeX style files provided roughly follow the American Psychological Association format. If your own bib file is named `acl2020.bib`, then placing the following before any appendices in your L^AT_EX file will generate the references section for you:

```
\bibliographystyle{acl_natbib}
\bibliography{acl2020}
```

You can obtain the complete ACL Anthology as a BibTeX file from <https://aclweb.org/anthology/anthology.bib.gz>. To include both the anthology and your own bib file, use the following instead of the above.

```
\bibliographystyle{acl_natbib}
\bibliography{anthology, acl2020}
```

Comparison of Classification Accuracy					
Dataset	Baseline (MCC)	DistilBERT (up to 2K)	DistilBERT (up to 8K)	BERT _{base} (up to 8K)	SOTA
ATIS	74.2	97.5	98.8	98.8	99.0
SNIPS	19.8	77.3	77.3	62.1	99.0
emotion	33.5	88.6	92.0	92.2	94.1
emo	49.6	84.5	86.8	87.0	89.7

Table 3: Fine-tuning DistilBERT on 2000 training examples achieves performance close to BERT_{base} and state of the art approaches. In table, "up to 2K" and "up to 8K" indicate model was fine-tuned on 2000 and 8000 training examples if data available; if dataset is not large enough, full training was used to fine-tune and results reported. Baseline is most common classifier (MCC). State of the art (SOTA) results for ATIS were achieved by (Wu et al., 2020), SNIPS by (Wang et al., 2018), emotion by (Silveira et al., 2014), emo by (Chatterjee et al., 2019).

7.14 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.

All camera-ready references are required to contain the appropriate DOIs (or as a second resort, the hyperlinked ACL Anthology Identifier) to all cited works. 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.

L^AT_EX-specific details: Please ensure that you use Bib_TE_X records that contain DOI or URLs for any of the ACL materials that you reference. If the Bib_TE_X file contains DOI fields, the paper title in the references section will appear as a hyperlink to the DOI, using the hyperref L^AT_EX package.

7.15 Appendices

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

8 Accessibility

In an effort to accommodate people who are color-blind (as well as those printing to paper), grayscale readability is strongly encouraged. Color is not forbidden, but authors should ensure that tables and figures do not rely solely on color to convey critical distinctions. A simple criterion: All curves and points in your figures should be clearly distinguishable without color.

9 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"

10 L^AT_EX Compilation Issues

You may encounter the following error during compilation:

`\pdfendlink ended up in different
nesting level than \pdfstartlink.`

This happens when pdf_lat_ex is used and a citation splits across a page boundary. To fix this, the style file contains a patch consisting of two lines: (1) `\RequirePackage{etoolbox}` (line 455 in

acl2020.sty), and (2) A long line below (line 456 in acl2020.sty).

If you still encounter compilation issues even with the patch enabled, disable the patch by commenting the two lines, and then disable the hyperref package by loading the style file with the nohyperref option:

```
\usepackage[nohyperref]{acl2020}
```

Then recompile, find the problematic citation, and rewrite the sentence containing the citation. (See, e.g., <http://tug.org/errors.html>)

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

Benjamin Börschinger and Mark Johnson. 2011. [A particle filter algorithm for Bayesian wordsegmentation](#). In *Proceedings of the Australasian Language Technology Association Workshop 2011*, pages 10–18, Canberra, Australia.

Ankush Chatterjee, Kedhar Nath Narahari, Meghana Joshi, and Puneet Agrawal. 2019. Semeval-2019 task 3: Emocontext contextual emotion detection in text. In *Proceedings of the 13th international workshop on semantic evaluation*, pages 39–48.

Jacob Devlin, Ming-Wei Chang, Kenton Lee, and Kristina Toutanova. 2018. Bert: Pre-training of deep bidirectional transformers for language understanding. *arXiv preprint arXiv:1810.04805*.

James Goodman, Andreas Vlachos, and Jason Naradowsky. 2016. [Noise reduction and targeted exploration in imitation learning for abstract meaning representation parsing](#). In *Proceedings of the 54th Annual Meeting of the Association for Computational Linguistics (Volume 1: Long Papers)*, pages 1–11, Berlin, Germany. Association for Computational Linguistics.

Mary Harper. 2014. [Learning from 26 languages: Program management and science in the babel program](#). In *Proceedings of COLING 2014, the 25th International Conference on Computational*

Linguistics: Technical Papers, page 1, Dublin, Ireland. Dublin City University and Association for Computational Linguistics.

Maryam Hasan, Elke Rundensteiner, and Emmanuel Agu. 2019. Automatic emotion detection in text streams by analyzing twitter data. *International Journal of Data Science and Analytics*, 7(1):35–51.

Victor Sanh, Lysandre Debut, Julien Chaumond, and Thomas Wolf. 2019. Distilbert, a distilled version of bert: smaller, faster, cheaper and lighter. *arXiv preprint arXiv:1910.01108*.

Elvis Saravia, Hsien-Chi Toby Liu, Yen-Hao Huang, Junlin Wu, and Yi-Shin Chen. 2018. Carer: Contextualized affect representations for emotion recognition. In *Proceedings of the 2018 Conference on Empirical Methods in Natural Language Processing*, pages 3687–3697.

Natalia Silveira, Timothy Dozat, Marie-Catherine De Marneffe, Samuel R Bowman, Miriam Connor, John Bauer, and Christopher D Manning. 2014. A gold standard dependency corpus for english. In *LREC*, pages 2897–2904. Citeseer.

Yu Wang, Yilin Shen, and Hongxia Jin. 2018. A bi-model based rnn semantic frame parsing model for intent detection and slot filling. *arXiv preprint arXiv:1812.10235*.

Di Wu, Liang Ding, Fan Lu, and Jian Xie. 2020. Slotrefine: A fast non-autoregressive model for joint intent detection and slot filling. *arXiv preprint arXiv:2010.02693*.

A Appendices

Appendices are material that can be read, and include lemmas, formulas, proofs, and tables that are not critical to the reading and understanding of the paper. Appendices should be **uploaded as supplementary material** when submitting the paper for review. Upon acceptance, the appendices come after the references, as shown here.

L^AT_EX-specific details: Use `\appendix` before any appendix section to switch the section numbering over to letters.

B Supplemental Material

Submissions may include non-readable supplementary material used in the work and described in the paper. Any accompanying software and/or data should include licenses and documentation of research review as appropriate. Supplementary material may 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.** 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.

References

- Benjamin Börschinger and Mark Johnson. 2011. [A particle filter algorithm for Bayesian wordsegmentation](#). In *Proceedings of the Australasian Language Technology Association Workshop 2011*, pages 10–18, Canberra, Australia.
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- Di Wu, Liang Ding, Fan Lu, and Jian Xie. 2020. Slotrefine: A fast non-autoregressive model for joint intent detection and slot filling. *arXiv preprint arXiv:2010.02693*.