

# Robust Sub-Graph Generation for Abstract Meaning Representation Parsing

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## Abstract

The Abstract Meaning Representation (AMR) is a promising representation for open-domain rich semantics. Generating semantic sub-graphs from contiguous tokens is a crucial part of AMR parsing. The state-of-the-art AMR parsing approach memorizes a dictionary of legal AMR sub-graphs which can be generated from training data. We instead propose a small set of actions to *construct* a sub-graph at test time from a span of tokens, which allow us to greatly expand our generalization from training data. We show that our mapping is a good approximation which we can learn with a simple classifier. This reduces the need for sparse dictionary lookups, which improves generalization on unknown words and allows us to exploit statistical efficiency on a small training set. We demonstrate that our approach improves on published state-of-the-art AMR parsing, from 0.58 smatch to 0.64 smatch on the LDC2013E117 dataset.

## 1 Introduction

The Abstract Meaning Representation (AMR) is a semantic formalism that represents meaning as a directed graph, where nodes represent concepts and arcs are relationships between concepts. It makes no effort to have a one-to-one correspondence between nodes in a graph and tokens in the source sentence. In fact, AMR will often either expand single tokens into large sub-graph elements, or ignore tokens completely. The AMR graph corresponding to a sentence need not be projective when AMR nodes are aligned back to their source tokens. The graph doesn't even need to be a DAG, as cycles are possible. However, as a result

of these nasty computational properties, a tremendous amount of expressive power is available in AMR.

To introduce AMR and its notation, we'll unpack the parse of "He ran to his house".

(r / run-01 :ARG0 (h / he) :destination (h2 / house :poss-of h))

AMR parses in text form can be read as the result of a breadth first traversal of the underlying directed graph. First, we introduce a node "run-01", and give it a coreference tag "r", which is written as "r / run-01". Then we observe an arc from "r / run-01" to a new node, "he", with coreference tag "h", and arc name "ARG0". This is written as "(r / run-01 :ARG0 (h / he))". We observe another arc, "destination", to "h2 / house". So far our tree is

(r / run-01 :ARG0 (h / he) :destination (h2 / house))

Now we find ourselves with a problem, because we would like to write (h / he :poss (h2 / house)). However, that would no longer be a tree, and it's not clear how to render that directly in text. Instead, AMR allows a writer to invert the direction of an arc by appending "-of". So we can write (h2 / house :poss-of (h / he)). Writing (h / he) is a bit redundant though, since we've already introduced the concept (h / he) higher up in the tree. Instead, we'll just use the coreference tag we associated with (h / he), and we'll write (h2 / house :poss-of h). The "h" all by itself represents a link back to the original node represented by (h / he) in the written representation.

There are three different sources that AMR gets its arc-labels from. The first is PropBank, where it also gets the frames for its action nodes, from which AMR pulls ARG[0-N], and time, location, manner, and a few others. The second is Vivek Srikumar's thesis, where AMR gets its special purpose arc labels, which are lifted directly from his "Preposition Sense Tagging" experiments, like destination, purpose, beneficiary, medium, and

several others. The third is from dependency parsing.

To take a more complex example that highlights more challenges with parsing AMR, we'll parse "Jason talked to the U.S. Olympic Sailing Team coach on June 2nd."

```
(talk-01 :ARG0 (p / person :name (n / name :op1 "Jason"))) :ARG1 (p / person :ARG1-of (c / coach-01 :ARG2 (t / team :mod (c2 / country :name (n2 / name :op1 "United" :op2 "States"))) :mod (g / games :mod (o / olympic))) :ARG1-of (s / sail-01)))) :time (temporal-entity :month 2 :day 2))
```

## 2 Overview

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 ??). **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 ?. Do not number the pages.

### 2.1 Electronically-available resources

We strongly prefer that you prepare your PDF files using L<sup>A</sup>T<sub>E</sub>X with the official ACL 2015 style file (acl2015.sty) and bibliography style (acl.bst). These files are available at <http://acl2015.org>. You will also find the document you are currently reading (acl2015.pdf) and its L<sup>A</sup>T<sub>E</sub>X source code (acl2015.tex) on this website.

You can alternatively use Microsoft Word to produce your PDF file. In this case, we strongly recommend the use of the Word template file (acl2015.dot) on the ACL 2015 website (<http://acl2015.org>). If you have an option, we recommend that you use the L<sup>A</sup>T<sub>E</sub>X2e version. If you will be using the Microsoft Word template, we suggest that you anonymize your source file so that the pdf produced does not retain your identity. This can be done by removing any personal information from your source document properties.

### 2.2 Format of Electronic Manuscript

For the production of the electronic manuscript you must use Adobe's Portable Document Format

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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.

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

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## 2.4 Fonts

For reasons of uniformity, Adobe's **Times Roman** font should be used. In  $\text{\LaTeX}2\text{e}$  this is accomplished by putting

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

in the preamble. If Times Roman is unavailable, use **Computer Modern Roman** ( $\text{\LaTeX}2\text{e}$ '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.

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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 ??) 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 "Schlangen" not "SCHLANGEN"). Do not format title and section headings in all capitals

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**Citations:** Citations within the text appear in parentheses as (?) or, if the author's name appears in the text itself, as Gusfield (?). Append lowercase letters to the year in cases of ambiguity. Treat double authors as in (?), but write as in (?) when more than two authors are involved. Collapse multiple citations as in (?: ?). Also refrain from using full citations as sentence constituents. We suggest that instead of

"(?) showed that ..."

you use

“Gusfield (?) showed that ...”

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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 (?) ...”

should be avoided. Instead, use citations such as

“Gusfield (?) previously showed ... ”

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The  $\text{\LaTeX}$  and  $\text{\BibTeX}$  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**.

## 2.7 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>

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

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

## 2.8 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.

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## **Acknowledgments**

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## **References**

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