Meaning Representation of Numeric Fused-Heads in UCCA

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1 Meaning Representations
Despite the usefulness and popularity of syntactic representation frameworks such as Universal Dependencies (Nivre et al., 2020), researchers have pointed out their sole focus on surface-syntactic information (Hershcovich et al., 2019; Žabokrtský et al., 2020) and proposed to design linguistic schemes on a deep-syntactic or semantic level. Meaning representation (MR) frameworks aim at capturing shared semantic principles in one or more languages and representing sentences in a structured way (Žabokrtský et al., 2020). Frameworks including as Elementary Dependency Structures (EDS; Oepen et al., 2016), Prague Tectogrammatical Graphs (PTG; Hajic et al., 2020), Universal Conceptual Cognitive Annotation (UCCA; Abend and Rappoport, 2013) and Abstract Meaning Representation (AMR; Banarescu et al., 2013) are designed to represent semantics directly and (to varying degrees) comprehensively. Whereas these frameworks model explicit linguistic constructions, only few address implicit phenomena, where predicates, arguments and modifiers are omitted and need to be inferred from the context. One of them is UCCA, which annotates implicit units as part of the meaning representation graph. Furthermore, Cui and Hershcovich (2020) proposed refining this annotation with a layer representing fine-grained distinctions between implicit arguments that correspond to participants.

2 Numeric Fused-Heads
The linguistic construction of fused heads (FHs; Elazar and Goldberg, 2019) corresponds to a noun phrase where the head noun is “fused” with the dependent modifier. Numeric fused-heads (NFHs), where the phrase is a number, are an interesting subset. For example, in the sentence ‘I’m 42’ (Figure 1), the phrase ‘42’ refers to the age of the person in years, though years is implicit in this context. We investigate whether the semantics of this construction is represented in meaning representation frameworks in English, empirically with UCCA.

3 NFHs in UCCA
For UCCA, the annotation guidelines (Abend et al., 2020) give only a very partial account of NFHs, and it is not clear how implicit NFHs should be annotated, for example. However, our interpretation of the guidelines would assign this construction the UCCA annotation of a Quantifier (Q) with an implicit or remote Center (C), as in Figure 1. We inspect the UCCA English Web Treebank Corpus (UCCA EWT)1 and the UCCA Wikipedia Corpus (UCCA Wiki)2, which are both annotated with implicit units, and find 54 and 124 instances according to this rule, respectively. There may be other instances of this linguistic phenomenon in the corpora, which we are in the progress of manually identifying.

4 Parsing Experiments
Subsequently, we train a recently proposed transition-based neural parser, which is able to

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1 github.com/UniversalConceptualCognitiveAnnotation/UCCA_English-EWT
2 github.com/UniversalConceptualCognitiveAnnotation/UCCA_English-Wiki
handle implicit arguments (Cui and Hershcovich, 2021), on the UCCA EWT dataset, and use its predictions on the NFH Identification test set introduced by Elazar and Goldberg (2019), to extract NFH instances in a zero-shot prediction experiment, without training on the associated training set. We find that the parser failed to predict any implicit or remote unit for any of the 206 NFH test instances in this setting. Table 1 shows the results. The low performance is likely to result from the small number of examples for this phenomenon in the training set, and possibly the fact that NFHs, in fact, appear in several distinct constructions, idiosyncratically annotated in different ways in UCCA.

5 Conclusion

We conclude that the implicit UCCA parser does not address NFHs consistently, which could result either from inconsistent annotation, insufficient training data or a modelling limitation. We are investigating which factors are involved. We consider this phenomenon important, as it is pervasive in text and critical for correct inference. Careful design and fine-grained annotation of NFHs in MRs would benefit downstream tasks such as machine translation, natural language inference and question answering, particularly when they require numeric reasoning (e.g., Dua et al., 2019), as recovering and categorizing them. We are investigating the treatment of this phenomenon by other meaning representations, such as AMR. We encourage researchers in meaning representations, and computational linguistics in general, to address this phenomenon in future research.

Table 1: Parser predictions for the NFH test set. The upper row represents instances supposed to have numeric fused-heads. The lower row are instances without numeric fused-heads. The parser predicted Quantifier (Q) for 33% of the NFH examples in the test set, and 81% of the non-NFH examples in the test set. Empty sets are failed predictions that cannot be converted from MRP format to XML for measurements.

|     | A | C | D | E | H | L | P | Q | R | S | T | S/A | ⌀ | Total |
|-----|---|---|---|---|---|---|---|---|---|---|---|-----|---|-------|
| w/ NFH | 24 | 80 | 2 | 6 | 1 | 0 | 4 | 68 | 5 | 8 | 3 | 1 | 2 | 206 |
| w/o NFH | 5 | 22 | 6 | 6 | 0 | 1 | 4 | 240 | 3 | 3 | 0 | 0 | 3 | 294 |

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