

Formalization of AMR Inference via Hybrid Logic Tableaux

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May 7, 2021

Abstract

AMR and its extensions have become popular in semantic representation due to their ease of annotation by non-experts and attention to the predicative core of sentences, abstracting away from syntactic differences. An area where AMR and its extensions warrant improvement is formalization and suitability for inference, where it is lacking compared to other semantic/knowledge representations such as description logics, episodic logic, and discourse representation theory. This thesis presents a formalization of inference over AMR variants annotated for tense and aspect along with quantification and scope, via Blackburn and Marx's tableaux method for quantified hybrid logic, and Blackburn and Jørgensen's tableaux method for indexical hybrid tense logic. Hybrid logic's nominals are used to handle tense (and non-habitual aspect) in AMR via Blackburn's treatment of Reichenbach tenses for hybrid logic. Quantification, negation, and modality are handled natively in quantified hybrid logic. We motivate the merging of these AMR variants, present their interpretation and inference in the combined quantified hybrid logic and indexical hybrid tense logic, and demonstrate the soundness, completeness, and decidability of the combined logics.

1 Introduction

2 Related Work

3 Merging AMR Annotations

4 Merging Quantified Hybrid Logic and Indexical Hybrid Tense Logic

4.1 Soundness and Completeness

(Sketch)

4.2 Decidability

(Sketch)

5 AMR Interpretation in Hybrid Logic

5.1 Examples

- (1) a. Carl submitted the forms and everyone will sign up again tomorrow.
b.

```
(a / and
  :op1 (s / scope
    :pred (f / fill-out-03 :ongoing - :complete + :time (b / before :op1 (n / now)))
      :ARG0 (p / person
        :name (n2 / name
          :op "Carl"))
      :ARG1 (f2 / form))
    :ARG0 p
    :ARG1 f2)
  :op2 (s2 / scope
```

```

:pred (m / submit-01 :ongoing - :complete + :time (a2 / after :op1 n)
      :ARG0 (p2 / person
              :mod (a3 / all))
      :ARG1 f2)
      :ARG0 p2
      :ARG1 f2))

c. It was impossible not to notice the license plate.
d.

(s / scope
  :pred (p / possible-01
        :ARG0 (n / notice-01 :ongoing - :complete + :time (b / before :op1 (n2 / now))
              :polarity (n3 / not)
              :ARG1 (c / car)
              :polarity (n4 / not))
        :ARG0 n4
        :ARG1 p))

```

6 AMR with Scope, Tense and Aspect, to Hybrid Logic

6.1 Design Decisions

Since to my knowledge there's no precedent in either of the adopted AMR annotations, UMR, or in the hybrid logic literature for the ways quantification optimally interacts with time, one option is to take quantification to be eternalist, i.e. all quantification will be over entities in the entire domain of discourse as opposed to different entities which exist at particular times throughout the discourse. The other option is to use presentist quantification, which indexes the domain of discourse over times/nominals, so quantification is done over entities which exist at that time. One motivator to use eternalist quantification is that given the root node will either be `scope` or a logical connective, there is no way within the combination of AMR annotations (or UMR) to ensure the

6.2 Extraction Steps

With the chosen annotation the root node can consist of either a logical connective (`and`, `or`, or `cond`) linking two AMR graphs, or a `scope` node with its following predicate and arguments.