

# Formalizing AMR Inference via Hybrid Logic Tableaux

## CL Masters Thesis Defense

Eli Goldner

July 27, 2021

# Introduction

# Motivation

# Approach

# AMR with Tense and Aspect

# AMR with Scope

# Hybrid Logic

# Hybrid Logic Variants

# First-Order Hybrid Tense Logic

## FHTL Tableau Example

- |      |   |
|------|---|
| (1)  |   |
| (2)  | $\textcircled{S}(\exists x)[P((\exists y)[f(x, y) = f(y, x)]) \vee \neg(\exists z)[x = z]]$ |
| (3)  | $\textcircled{S}P((\exists y)[f(s_1, y) = f(y, s_1)]) \vee \neg(\exists z)[s_1 = z]$        |
| (4)  | $\textcircled{S}P((\exists y)[f(s_1, y) = f(y, s_1)])$                                      |
| (5)  | $\textcircled{S}\neg(\exists z)[s_1 = y]$   |
| (6)  | $\textcircled{S}Pt$   |
| (7)  | $\textcircled{S}\neg[s_1 = s_1]$  |
| (8)  | $\textcircled{S}( \exists y)[f(s_1, y) = f(y, s_1)]$  |
| (9)  | $\textcircled{S}[s_1 = s_1]$  |
| (10) | $\dots$   |
| (11) | $\otimes$   |

# Model Checking Example

- ▶ Every computer will be located at a desk.

- ▶ AMR with quantification and tense:

(s / scope

```
:pred (b / be-located-at-91 :ongoing -
      :complete +
      :time (a / after
            :op1 (n / now))

      :ARG0 (c / computer)
      :ARG1 (d / desk
            :quant (e / every)))
```

```
:ARG0 d
```

```
:ARG1 c)
```

- ▶ FHTL translation:

$$@_{now}(\forall y)[\text{desk}(y) \rightarrow (\exists x)[\text{computer}(x) \wedge F(\text{be-located-at-91}(x, y))]]$$

# Model Checking Example

Define a small *FHTL* model  $\mathfrak{M} = (T, \mathcal{R}, (D_t)_{t \in T}, I_{nom}, (I_t)_{t \in T})$  where:

$$T = \{\text{yesterday, now, tomorrow}\}$$

$$\mathcal{R} = \{(\text{yesterday, now}), (\text{now, tomorrow}), (\text{yesterday, tomorrow})\}$$

$$I_{nom} = \{(y, \text{yesterday}), (n, \text{now}), (t, \text{tomorrow})\}$$

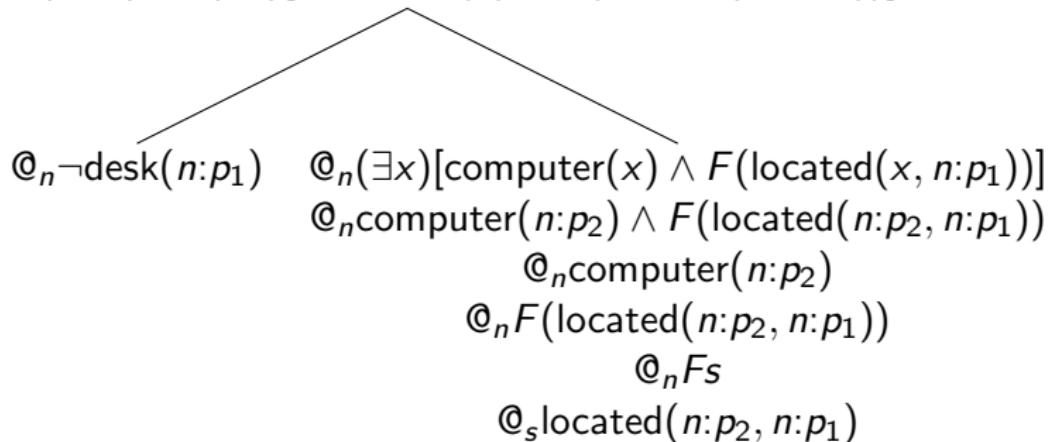
$$D_{\text{yesterday}} = \{\text{computer}_1, \text{desk}_1\}$$

$$D_{\text{now}} = \{\text{computer}_1, \text{computer}_2, \text{desk}_1, \text{desk}_2, \text{desk}_3\}$$

$$D_{\text{tomorrow}} = \{\text{computer}_1, \text{computer}_2, \text{desk}_1, \text{desk}_2\}$$

# Model Checking Example

$$\begin{aligned} @_n(\forall y)[\text{desk}(y) \rightarrow (\exists x)[\text{computer}(x) \wedge F(\text{located}(x, y))]] \\ @_n \text{desk}(n:p_1) \rightarrow (\exists x)[\text{computer}(x) \wedge F(\text{located}(x, n:p_1))] \end{aligned}$$



Where we assign  $s = t = \text{tomorrow}$ ,  $n:p_2 = \text{computer}_1$  and  $n:p_1 = \text{desk}_2$ , or  $n:p_2 = \text{computer}_2$  and  $n:p_1 = \text{desk}_1$  we see that  $\mathfrak{M}$  satisfies the *FHTL* sentence.