Semantic Representation of Modal Subordination Using Type Theory

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Outline

Modal Subordination: Some Examples

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1. A wolf might walk in. It would growl.

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References: DRT and Dynamic Frameworks

- Accommodation of DRSs [Roberts(1989)]
- Modals presuppose their domain [Geurts(1999)]
- Anaphoric context references and graded modality [Frank and Kamp(1997)]
- Compositional DRT extension [Stone and Hardt(1997)]
- Two-dimensionsal approach, accessibility relation and world ordering [van Rooij(2005)]
- DPL and sets of epistemic possibilities [Asher and McCready(2007)]

DRT Based Account

Example

A wolf might walk in.

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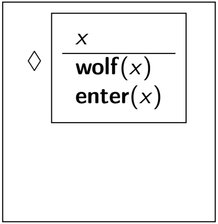

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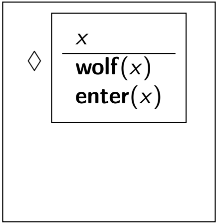

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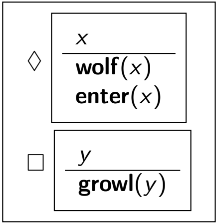

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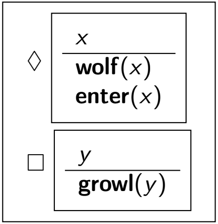

Note:

- Accessibility conditions

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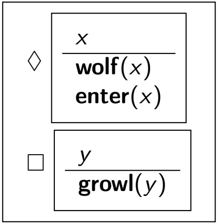

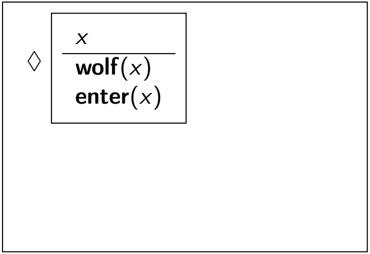

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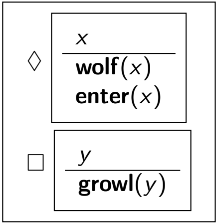

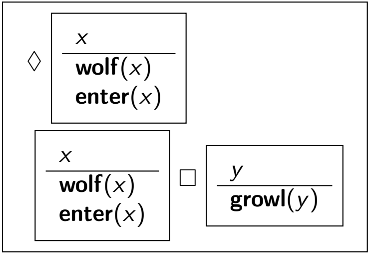

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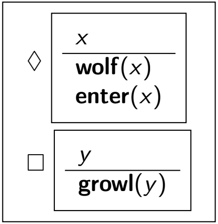

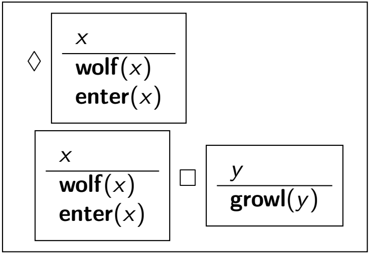

Note:

- Accessibility conditions
- Modal base and accommodation

A Montagovian Treatment

Our Aim

To consider modal subordination in [de Groote(2006)]'s framework:

- Taking advantages of this framework
- Implementing MS principles in lexical entries
- Without any change to the formal framwork

The Steps

- Intepretation of (the syntactic type of) the sentences
- Combination rules
- The lexical semantics of MS

Interpretation of the Sentences

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- A modal environment and a factual environment

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Note on pairs: (t, t) as $(t \rightarrow t \rightarrow t) \rightarrow t$

- A pair (a, b) is interpreted as $\lambda f.f\ a\ b$ (selecting two-place functions and applying them to the 1st and the 2nd component)
- An additional parameter:
  - How should the modal and the factual part be combined? Typically $\lambda b_1 b_2 . b_1 \wedge b_2$
  - When should they be combined? Possibility of a `Reset` operator that close the modal contribution.

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- A modal environment and a factual environment
- A modal continuation and a factual continuation (or a modal contribution and a factual contribution of the continuation)
- a modal part and a factual part
- $[\![np]\!] = (e \to [\![s]\!]) \to [\![s]\!]$, $[\![n]\!] = e \to [\![s]\!]$, etc.

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Combinations

$S_1.S_2$ when S_2 has a factual mood

$$[\![S_1.S_2]\!] = \lambda i_1 i_2 k_1 k_2 f.[\![S_1]\!]\ i_1\ i_2\ k_1\ (\lambda i'_1 i'_2.[\![S_2]\!] i'_1 i'_2 k_1 k_2 \Pi_2)\ f$$

(with $\Pi_2 = \lambda ab.b$ the second projection)

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$S_1.S_2$ when S_2 has a nonfactual mood

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(with $\Pi_1 = \lambda ab.a$ the first projection)

Example

$$[\![S_1.S_2]\!] = \lambda i_1 i_2 k_1 k_2 f.[\![S_1]\!]\ i_1\ i_2\ k_1\ (\lambda i_1' i_2'.[\![S_2]\!] i_1' i_2' k_1 k_2 \Pi_2)\ f$$

Example

$$[\![\textit{A wolf might walk in}]\!] = \lambda i_1 i_2 k_1 k_2 f.f \quad (\Diamond(\exists x.(\mathbf{wolf}\ x) \wedge ((\mathbf{enter}\ x) \wedge (k_1\ (x :: i_1)\ i_2))))\ (k_2\ i_1\ i_2)$$

Example

$$[\![S_1 . S_2]\!] = \lambda i_1 i_2 k_1 k_2 f . [\![S_1]\!]\; i_1\; i_2\; k_1\; (\lambda i'_1 i'_2 . [\![S_2]\!] i'_1 i'_2 k_1 k_2 \Pi_2)\; f$$

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Let:

- `Nil` be the empty environment (`sel Nil` always fails)
- $\mathbb{T}$ be the trivial continuation ($\lambda i_1 i_2.\top$)
- `Conj` be the conjunction ($\lambda b_1 b_2.b_1 \land b_2$)

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We can then evaluate (Nil Nil $\mathbb{T}\,\mathbb{T}$ Conj parameters are omitted):

Example (*A wolf might walk in. It would growl*)

$$[\![S]\!] = (\Diamond(\exists x.(\mathbf{wolf}\ x) \wedge ((\mathbf{enter}\ x) \wedge (\Box((\mathbf{growl}\ (\mathtt{sel}(x :: \mathtt{Nil}) \cup \mathtt{Nil})) \wedge \top))))) \wedge \top$$

Example (cont'd)

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Lexical Semantics

$$[\![might]\!] = \lambda vs.\lambda i_1 i_2 k_1 k_2 f.f\ (\Diamond(v\ s\ i_1\ i_2\ k_1\ k_2 \Pi_1))(k_2\ i_1\ i_2))$$

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$$[\![a_{nf}]\!] = \lambda PQ.\lambda i_1 i_2 k_1 k_2 f.\exists x.P\, x\,(x :: i_1)\, i_2\,(\lambda ij.Q\, x\, i\, j\, k_1\, k_2\, \Pi_1)\, k_2\, f$$

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$$\mathtt{Reset} \triangleq \lambda S.\lambda e_1 e_2 k_1 k_2 f.f\,(k_1\,e_1\,e_2) \qquad (S\,e_1\,e_2\,\mathbb{T}\,k_2\,\mathtt{Conj})$$

Discussion

Example (*A wolf might walk in. It would growl*)

$$[\![S]\!] = (\Diamond(\exists x.(\textbf{wolf}\,x) \land ((\textbf{enter}\,x) \land (\Box((\textbf{growl}\,(\texttt{sel}(x :: \texttt{Nil}) \cup \texttt{Nil})) \land \top))))) \land \top$$

- $\Box$ under the scope of $\Diamond$
- But what if in the accessed worlds, **wolf** x is false?

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$\Rightarrow$ Modal base and local accommodation: we would like to have

$$\begin{aligned}[\![S]\!] \quad &= (\Diamond(\exists x.(\mathbf{wolf}\ x) \wedge ((\mathbf{enter}\ x) \wedge \\ &(\Box(((\mathbf{wolf}\ x) \wedge (\mathbf{enter}\ x)) \Rightarrow (\mathbf{growl}\ (\mathtt{sel}(x :: \mathtt{Nil}) \cup \mathtt{Nil})) \wedge \top))))) \wedge \top\end{aligned}$$

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Alternative Proposal

$$[\![s]\!] = \gamma \rightarrow \gamma \rightarrow (\gamma \rightarrow \gamma \rightarrow t \rightarrow \kappa \rightarrow t) \rightarrow (\gamma \rightarrow \gamma \rightarrow t \rightarrow \kappa \rightarrow t) \rightarrow (t \rightarrow t \rightarrow t \rightarrow t) \rightarrow t$$

with $\kappa \triangleq t \rightarrow t \rightarrow t$ (typically $\lambda b_1 b_2.b_1 \wedge \Diamond(b_1 \Rightarrow b_2)$)

Accommodation: Example

Example (*A wolf might enter. It would growl. It would eat you first*)

$$\Diamond\exists x.((\mathbf{wolf}\ x) \wedge (\mathbf{enter}\ x) \wedge$$
$$\Box(((\mathbf{wolf}\ x) \wedge (\mathbf{enter}\ x)) \Rightarrow ((\mathbf{growl}\ (sel((x :: \mathtt{Nil}) + \mathtt{Nil}))) \wedge$$
$$\Box(((\mathbf{wolf}\ x) \wedge (\mathbf{enter}\ x)) \Rightarrow ((\mathbf{eat\ you}\ (sel((x :: \mathtt{Nil}) + \mathtt{Nil})))))))))$$

γ as a Macro Definition

- We used γ as a list of entities
- But we could introduce s the type of worlds and move to TY2
  - `Sel` function on worlds and explicit reference to worlds (context referents)

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$$\lambda e_1\, e_2\, k\, w.\exists w'.(R\, w\, w') \wedge (\exists x.(\mathbf{wolf}\, x\, w') \wedge ((\mathbf{enter}\, x\, w') \wedge (k\, ((w', x) + e_1)(w' :: e_2)\, w)))$$

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Example

John might buy a house$_x$. He earns enough to get a mortage. He could rent it$_x$ out for the festival.

γ as a Macro Definition

- We used γ as a list of entities
- But we could introduce s the type of worlds and move to TY2
  - `Sel` function on worlds and explicit reference to worlds (context referents)

Example (*a wolf might walk in*)

$$\lambda e_1\, e_2\, k\, w.\exists w'.(R\, w\, w') \wedge (\exists x.(\mathbf{wolf}\, x\, w') \wedge ((\mathbf{enter}\, x\, w') \wedge (k\, ((w', x) + e_1)(w' :: e_2)\, w)))$$

  - Flexibility on factual and nonfactual world interaction

Example

John might buy a house$_x$. He earns enough to get a mortage. He could rent it$_x$ out for the festival.

Example

If John's at home he'll be reading a book$_x$. Actually he's still at the office. *It$_x$'ll be *War and Peace*.

Conclusion

Wrapping Up

- Modal subordination in [de Groote(2006)]'s framework
- Flexibility of the approach
- Role of the lexical semantics
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Future Work

- Dynamic modal logic?
- Negation and counterfactuals
- [Veltman(1996)]'s testing and filtering
- Interaction with discourse structure (factual explanations of nonfactual possibilities)
- Hob and Nob sentences

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