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Event in Compositional Dynamic Semantics

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Outline

1 Background
   - Dynamic Semantics
   - Discourse Structure

2 Event in Dynamic Semantics
   - Event in Sentential Semantics
   - Event in Discourse Semantics

3 Conclusion & Future Work
Overview

Key Words
Event, Dynamics, Montague Semantics, DRT, Discourse Structure, Accessibility, λ-calculus

Questions to be tackled:

1. Combining event semantics with dynamic discourse semantics compositionally

2. Embedding rhetorical relation in the above framework, thus obtaining the desired variable accessibility constraint
Why Dynamics?

- Montague Grammar (MG)
  - Thesis: no important theoretical difference between natural language and formal language
  - Foundation: type theory, $\lambda$-calculus, first-order logic (FOL), Frege’s principle/compositionality

- Dynamic Semantics
  - Motivation: MG’s inability in modeling discourse semantics (e.g., anaphoric links across multiple sentences)
  - Concept of Meaning:
    - Satisfactory Models $\rightarrow$ Context Change Potential (CCP)
  - Representatives: Discourse Representation Theory (DRT), Dynamic Predicate Logic (DPL), File Change Semantics, and etc.
A New Approach to Dynamics [de Groote, 2006]

- A pure Montagovian framework for discourse dynamics
- Basic Types
  - $\iota (e)$, individuals/entities
  - $\sigma (t)$, propositions/truth values
  - $\gamma$, left context

1 Diagram illustration cited from [de Groote, 2006].
New Approach - Typing & Composition

Typing Rules

\[
\begin{align*}
[s] & \quad \gamma \rightarrow (\gamma \rightarrow o) \rightarrow o & 0 \\
[n] & \quad \iota \rightarrow [s] & \iota \rightarrow o \\
[np] & \quad (\iota \rightarrow [s]) \rightarrow [s] & (\iota \rightarrow o) \rightarrow o
\end{align*}
\]

Discourse Composition

\[
[D.S] = \lambda e\varphi. [D]e(\lambda e'. [S]e'\varphi)
\]
New Approach - Technical Remarks

- "::" adjoins accessible variables in the selection list, with type $\iota \rightarrow \gamma \rightarrow \gamma$

- "sel_{he}" selects the correct variable from the list, with type $\gamma \rightarrow \iota$
New Approach - Example

(1) John smiles. He is happy.

\[ \lambda e. (\text{smile}(j) \land \phi(j::e)) \]

\[ \text{smile}(j) \]

\[ \text{NP} \quad \text{VP} \]

\[ \lambda \psi.e.\psi.j.e(\lambda e.\phi(j::e)) \quad \lambda s.s(\lambda x.e.\phi.\text{smile}(x) \land \phi e) \]

\[ \lambda \psi.\psi.j \quad \lambda s.s(\lambda x.\text{smile}(x)) \]
New Approach - Example Continued

\[ S_2 \]
\[ \lambda e \phi. (\text{is\_happy}(sel_{he} e) \land \phi e) \]
\[ \exists x. (\text{is\_happy}(x) \land x = ?) \]

\[ NP \]
\[ he \]
\[ \lambda \psi e \phi. \psi (sel_{he} e) e \phi \]
\[ \lambda \psi e \phi. \psi (sel_{he} e) e \phi \]
\[ \lambda P \exists x. (P(x) \land x = ?) \]

\[ VP \]
\[ is\_happy \]
\[ \lambda s. s(\lambda x e \phi. \text{is\_happy}(x) \land \phi e) \]
\[ \lambda s. s(\lambda x e \phi. \text{is\_happy}(x)) \]
New Approach - Example Continued

\[ S = \lambda e \phi. (\text{smile}(j) \land is\_happy(sel_{he}(j :: e)) \land \phi(j :: e)) \]

\[ [D.S] = \lambda e \phi. [D]e(\lambda e' [S]e' \phi) \]

\[ S_1 = \lambda e \phi. (\text{smile}(j) \land \phi(j :: e)) \]
\[ S_2 = \lambda e \phi. (is\_happy(sel_{he}e) \land \phi e) \]
What is the Structure in Discourse?

- Discourse is a coherent sequence of propositional elements

\[(2)\quad \text{People are attending LACL Conference in Montpellier. All presentations are interesting. John loves Mary.}\]

- Rhetorical Relation (RR)/Discourse Relation: various coherences within the discourse
- Discourse Structure: an internal hierarchy shaped by RRs, representing different levels in the discourse

- Linguistic Motivation
  - Anaphora Resolution
  - Temporal structure resolution
  - Word sense disambiguation
  - .......
Types of RR.s

1. Subordinating Relation (↓)
   - Complete or further develop an ongoing topic
   - E.g., Elaboration, Explanation

(3) People come into the hall. LACL 2011 is held there.

2. Coordinating Relation (→)
   - Opening a new page, starting a new topic in discourse
   - E.g., Narration, Background

(4) People come into the hall. They find their seats and sit down.
The Right Frontier Constraint [Polanyi, 1985]

A clause must be attached on the right frontier of the ongoing discourse structure.
Anaphoric Link with Rhetorical Relations

(5)  
   a.  *John had a great evening last night.
   b.  He had a great meal.
   c.  He ate salmon.
   d.  He devoured lots of cheese.
   e.  He won a dancing competition.
   f.  *It was a beautiful pink.  

\[\text{John had a lovely evening}\]
\[\text{Elaboration}\]
\[\text{He had a great meal}\]
\[\text{Narration}\]
\[\text{He won a dancing competition}\]
\[\text{Elaboration}\]
\[\text{He ate salmon}\]
\[\text{Narration}\]
\[\text{He devoured cheese}\]

\[^2\text{Example cited from [Asher and Lascarides, 2003].}\]
Why Event Semantics?

- Adverbial Modification
  - Permutation
  - Drop

(6)  *Brutus stabbed Caesar in the back with a knife.*

- Multiple events in single proposition

(7)  *John said he killed Bill. Mary did not believe it.*

- Other evidence
  - Perceptual verbs: *see, hear,* and etc.
  - Interaction with thematic roles
Constructing Event Interpretation

Aim
Compositionally compute event-style semantic representations!

Example

(8) John kissed Mary in the plaza.

$\exists e. (\text{Kiss}(e) \land \text{Ag}(e, john) \land \text{Pat}(e, mary) \land \text{Loc}(e, plaza))^3$

$^3$Ag stands for Agent, Pat for Patient and Loc for Location
Interpretation Construction

- Two Approximations:
  - Basic Thematic Roles: Agent, Theme
  - Event variable "e" introduced in verb
- Proposed Lexical Entries

**Lexicon**

\[
\begin{align*}
[\text{John}] &= \text{john} \\
[\text{Mary}] &= \text{mary} \\
[\text{kiss}] &= \lambda\text{ose.}(\text{Kiss}(e) \land \text{Ag}(e, s) \land \text{Th}(e, o)) \\
[\text{in\_the\_plaza}] &= \lambda\text{Pe.}(P(e) \land \text{Loc}(e, \text{plaza})) \\
[\text{EOS}] &= \lambda P. \exists e. P(e)
\end{align*}
\]
Interpretation Construction Step 1

\[ \lambda e. (\text{Kiss}(e) \land \text{Ag}(e, \text{john}) \land \text{Th}(e, \text{mary})) \]

\[ S' \]

\[ \text{NP} \]
\[ \text{VP} \]
\[ \lambda e. (\text{Kiss}(e) \land \text{Ag}(e, s) \land \text{Th}(e, \text{mary})) \]

\[ \text{NP} \]
\[ \text{VP} \]
\[ \lambda e. (\text{Kiss}(e) \land \text{Ag}(e, s) \land \text{Th}(e, o)) \]

<table>
<thead>
<tr>
<th>John</th>
<th>kisses</th>
<th>Mary</th>
</tr>
</thead>
<tbody>
<tr>
<td>\text{john}</td>
<td>\text{kisses}</td>
<td>\text{mary}</td>
</tr>
</tbody>
</table>
Interpretation Construction Step 2

\[ S'' = \lambda e. (Kiss(e) \land Ag(e, john) \land Th(e, mary) \land Loc(e, plaza)) \]

\[ S' = \lambda e. (Kiss(e) \land Ag(e, john) \land Th(e, mary)) \]

\[ PP = \lambda Pe. (P(e) \land Loc(e, plaza)) \]
Interpretation Construction Step 3

$$\exists e. (\text{Kiss}(e) \land \text{Ag}(e, \text{john}) \land \text{Pat}(e, \text{mary}) \land \text{Loc}(e, \text{plaza}))$$

$$\lambda e. (\text{Kiss}(e) \land \text{Ag}(e, \text{john}) \land \text{Th}(e, \text{mary}) \land \text{Loc}(e, \text{plaza}))$$

$$\lambda P. \exists e. P(e)$$
Making Things Dynamic

Inserting the left and right context!

Dynamic Lexicon

\[
\begin{align*}
\llbracket \text{kiss} \rrbracket &= \lambda e . a b . (\text{Kiss}(e) \land \text{Ag}(e, s) \land \text{Th}(e, o) \land b(e :: a)) \\
\llbracket \text{smile} \rrbracket &= \lambda e . a b . (\text{Smile}(e) \land \text{Ag}(e, s) \land b(e :: a)) \\
\llbracket \text{in\_the\_plaza} \rrbracket &= \lambda e . a b . (\text{Peab} \land \text{Loc}(e, \text{plaza})) \\
\llbracket \text{she} \rrbracket &= \lambda e . a b . (\text{Sel}(a))
\end{align*}
\]

\(^4\) “a” denotes the left context, “b” the right context.
Dynamic Interpretations

(9)   a.  *John kisses Mary in the plaza.*
   b.  *She smiles.*

a.  \[
\left[ in\_the\_plaza \right] \left( \left[ \text{kiss} \left[ \text{Mary} \right] \right) \left[ \text{John} \right] \right)
\Rightarrow_\beta \lambda eab. (\text{Kiss}(e) \land \text{Ag}(e, \text{john}) \land \text{Th}(e, \text{mary}) \land \text{Loc}(e, \text{plaza}) \land b(e :: a))
\]

b.  \[
\left[ \text{she} \right] \left[ \text{smile} \right]
\Rightarrow_\beta \lambda eab. (\text{Smile}(e) \land \text{Ag}(e, \text{Sel}(a)) \land b(e :: a))
\]
Sentence & Discourse

Proposal

Sentence and Discourse are distinct semantic entities!

\[
\begin{align*}
\lfloor S \rfloor &= \lambda eab.(\text{Pred}(e) \land ... \land ba) \\
\lfloor D \rfloor &= \lambda ab. \exists e_1 e_2 ...(\text{Pred}_1(e_1) \land \text{Pred}_2(e_2) \land ... \land \text{Rel}_1(e_i, e_j) \land \\
& \quad \text{Rel}_2(e_m, e_n) \land ... \land ba')^5
\end{align*}
\]

---

^5 "a’" is a complicated structure containing the event accessibility relation.
Subordinating Composition Functions

\[ [Sub_{Bas}] = \lambda DSab.Da(\lambda a'.\exists e.(Sea'b)) \]
\[ [Sub_{Adv}] = \lambda DSab.Da(\lambda a'.\exists e.((Sea'b) \land Rel(Sel(a'), e))) \]
\[ [Empty] = \lambda ab.ba \]
Subordinating Examples

1  \[ \downarrow Sub_{Bas} \downarrow \downarrow Empty \downarrow \downarrow (9-a) \]\n\[ \Rightarrow \beta \lambda a_1 b_1 . (\lambda a_3 b_3 . b_3 a_3) a_1 (\lambda a_2 . \exists e. (\lambda e' a_4 b_4 . (Kiss(e') \land ... \land b_4(e' :: a_4)) ea_2 b_1)) \]
\[ \Rightarrow \beta \lambda a_1 b_1 . \exists e. (Kiss(e) \land ... \land b_1(e :: a_1)) \]

2  \[ \downarrow Sub_{Adv} \downarrow \downarrow \downarrow Sub_{Bas} \downarrow \downarrow Empty \downarrow \downarrow (9-a) \downarrow \downarrow (9-b) \]\n\[ \Rightarrow \beta \lambda a_1 b_1 . (\lambda a_3 b_3 . \exists e_1 . (Kiss(e_1) \land ... \land b_3(e_1 :: a_3))) a_1 (\lambda a_2 . \exists e. (((\lambda e_2 a_4 b_4 . (Smile(e_2) \land ... \land b_4(e_2 :: a_4))) ea_2 b_1) \land Rel(Sel(a_2), e))) \]
\[ = \lambda a_1 b_1 . \exists e_1 e_2 . (Kiss(e_1) \land ... \land Smile(e_2) \land ... \land b_1(e_2 :: e_1 :: a_1) \land Rel(Sel(e_1 :: a_1), e_2)) \]
Coordinating Composition Functions

\[
\begin{align*}
\llbracket \text{Coor}_{\text{Bas}} \rrbracket &= \lambda DSa. Da(\lambda a'. \exists e. (Se a' b)) \\
\llbracket \text{Coor}_{\text{Adv}} \rrbracket &= \lambda DSa. \exists e_c. Da(\lambda a'. \exists e. (Se (e_c :: (Del a')) b) \wedge \text{Rel}(Sel a', e, e_c))
\end{align*}
\]
Coordinating Examples

1. \[ [\text{Coor}_{\text{Bas}}][\text{Empty}]][((9-a))] = [\text{Sub}_{\text{Bas}}][\text{Empty}][((9-a))] \Rightarrow \beta \lambda a_1 b_1. \exists e. (\text{Kiss}(e) \land \ldots \land b_1(e :: a_1))

2. \[ [\text{Coor}_{\text{Adv}}]([\text{Coor}_{\text{Bas}}][\text{Empty}]][(9-a)])[(9-b)] \Rightarrow \beta \lambda Sa_1 b_1. \exists e_c. (\lambda a_3 b_3. \exists e_1. (\text{Kiss}(e_1) \land \ldots \land b_3(e_1 :: a_3)))a_1(\lambda a_2. \exists e. ((\lambda e_2 a_4 b_4. (\text{Smile}(e_2) \land \ldots \land b_4(e_2 :: a_4)))e(e_c :: (\text{Del}(a_2)))b_1) \land \text{Rel} (\text{Sel}(a_2), e, e_c)) \Rightarrow \beta \lambda Sa_1 b_1. \exists e_c e_1 e_2. (\text{Kiss}(e_1) \land \ldots \land \text{Smile}(e_2) \land \ldots \land b_1(e_2 :: e_c :: (\text{Del}(e_1 :: a_1))) \land \text{Rel}(\text{Sel}(e_1 :: a_1), e_2, e_c))
Summary

- **Conclusion**
  - Event structure implemented compositionally
  - Discourse dynamics expressed via left & right context
  - Rhetorical relation concerned and embedded
  - $[\text{Discourse}] \neq [\text{Sentence}]$

- **Future Work**
  - Linguistic coverage extension for event semantics
  - Rhetorical relation determination
  - Other constraints besides the RFC
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