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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, $\lambda$-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
  - $o(t)$, propositions/truth values
  - $\gamma$, left context

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

Typing Rules

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

Discourse Composition

$$\llbracket D.S \rrbracket = \lambda e.\llbracket D \rrbracket e(\lambda e'.\llbracket S \rrbracket e'\phi)$$
“::” adjoins accessible variables in the selection list, with type $\iota \rightarrow \gamma \rightarrow \gamma$

“$\text{sel}_he$” selects the correct variable from the list, with type $\gamma \rightarrow \iota$
New Approach - Example

(1) *John smiles. He is happy.*

\[
S_1 = \lambda e.((\text{smile}(j) \land \phi(j :: e))
\]

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

\[
\begin{align*}
\text{NP} & \quad \text{VP} \\
\lambda \psi e \phi. & \psi j e(\lambda e. \phi(j :: e)) & \lambda s. s(\lambda x e \phi. \text{smile}(x) \land \phi e) \\
\lambda \psi. & \psi j & \lambda s. s(\lambda x. \text{smile}(x))
\end{align*}
\]
New Approach - Example Continued

\[ S_2 \]
\[ \lambda e \phi. (is\_happy(sel\_he\ e) \land \phi e) \]
\[ \exists x. (is\_happy(x) \land x = ?) \]

NP
\[ he \]
\[ \lambda \psi \ e \phi. \psi (sel\_he\ e) e \phi \]
\[ \lambda P \exists x. (P(x) \land x = ?) \]

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

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

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

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

- Discourse is a coherent sequence of propositional elements

(2) 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 RRs

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.²

²Example 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) \textit{John kissed Mary in the plaza.}

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

\(^3\text{Ag stands for Agent, Pat for Patient and Loc for Location}\)
Interpretation Construction

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

Lexicon

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

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

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

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

\[ \text{John} \]
\[ john \]
\[ \text{VP} \]
\[ \text{NP} \]
\[ \text{V} \]
\[ \text{NP} \]
\[ \text{Mary} \]
\[ mary \]
Interpretation Construction Step 2

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

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

\[ \text{PP} \]
\[ \text{in_the_plaza} \]
\[ \lambda Pe. (P(e) \land \text{Loc}(e, \text{plaza})) \]
Interpretation Construction Step 3

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

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

\[ \text{EOS} \]
\[ \lambda P. \exists e. P(e) \]
Making Things Dynamic

Inserting the left and right context!

Dynamic Lexicon

\[
\text{\texttt{\texttt{kiss}}} = \lambda \text{oseab}. (\text{Kiss}(e) \land \text{Ag}(e, s) \land \text{Th}(e, o) \land b(e :: a))^4 \\
\text{\texttt{\texttt{smile}}} = \lambda \text{seab}. (\text{Smile}(e) \land \text{Ag}(e, s) \land b(e :: a)) \\
\text{\texttt{\texttt{in\_the\_plaza}}} = \lambda \text{Peab}. (\text{Peab} \land \text{Loc}(e, \text{plaza})) \\
\text{\texttt{\texttt{she}}} = \lambda \text{Peab}. P(\text{Sel}(a))eab
\]

\footnote{\textit{\texttt{\texttt{a}}} denotes the left context, \textit{\texttt{\texttt{b}}} the right context.}
Dynamic Interpretations

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

b. *She smiles.*

a. $\llbracket \text{in\_the\_plaza} \rrbracket \left( \left( \llbracket \text{kiss} \rrbracket \llbracket \text{Mary} \rrbracket \right) \llbracket \text{John} \rrbracket \right)$

$\Rightarrow_\beta \lambda e a b. (\text{Kiss}(e) \land \text{Ag}(e, \text{john}) \land \text{Th}(e, \text{mary}) \land \text{Loc}(e, \text{plaza}) \land b(e :: a))$

b. $\llbracket \text{she} \rrbracket \llbracket \text{smile} \rrbracket$

$\Rightarrow_\beta \lambda e a b. (\text{Smile}(e) \land \text{Ag}(e, \text{Sel}(a)) \land b(e :: a))$
Sentence & Discourse

Proposal

Sentence and Discourse are distinct semantic entities!

\[ [S] = \lambda eab.(\text{Pred}(e) \land \ldots \land ba) \]

\[ [D] = \lambda ab.\exists e_1 e_2 \ldots (\text{Pred}_1(e_1) \land \text{Pred}_2(e_2) \land \ldots \land \text{Rel}_1(e_i, e_j) \land \text{Rel}_2(e_m, e_n) \land \ldots \land ba') \]

\[ ^{5}\text{"}a\text{" is a complicated structure containing the event accessibility relation.} \]
Subordinating Composition Functions

\[
\begin{align*}
\text{Sub}_\text{Bas} & = \lambda DSab. Da(\lambda a'. \exists e. (Sea' b)) \\
\text{Sub}_\text{Adv} & = \lambda DSab. Da(\lambda a'. \exists e. ((Sea' b) \land Rel(Sel(a'), e))) \\
\text{Empty} & = \lambda ab. ba
\end{align*}
\]
Subordinating Examples

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

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

\[ \text{\text{\text{Coor}_{Bas}}} = \lambda DSab. Da(\lambda a'. \exists e. (Sea' b)) \]

\[ \text{\text{\text{Coor}_{Adv}}} = \lambda DSab. \exists e_c. Da(\lambda a'. \exists e. (Se(e_c :: (Del(a'))) b) \land Rel(Sel(a'), e, e_c)) \]
Event in Compositional Dynamic Semantics

Event in Dynamic Semantics

Event in Discourse Semantics

Coordinating Examples

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

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


