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Event in Compositional Dynamic Semantics

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Logical Aspects of Computational Linguistics, LACL 2011

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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:

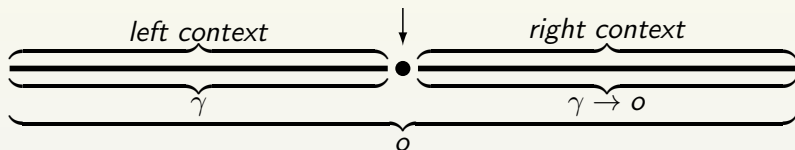
- 1** Combining event semantics with dynamic discourse semantics compositionally
- 2** Embedding rhetorical relation in the above framework, thus obtaining the desired variable accessibility constraint

Why Dynamics?

- Montague Grammar (MG)
 - Thesis: no important theoretical difference between natural language and formal language
 - Foundation: type theory, λ -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
 - ι (e), individuals/entities
 - o (t), propositions/truth values
 - γ , left context



1

¹Diagram illustration cited from [de Groote, 2006].

New Approach - Typing & Composition

Typing Rules

$$\begin{array}{lll}
 \llbracket s \rrbracket & \gamma \rightarrow (\gamma \rightarrow o) \rightarrow o & o \\
 \llbracket n \rrbracket & \iota \rightarrow \llbracket s \rrbracket & \iota \rightarrow o \\
 \llbracket np \rrbracket & (\iota \rightarrow \llbracket s \rrbracket) \rightarrow \llbracket s \rrbracket & (\iota \rightarrow o) \rightarrow o
 \end{array}$$

Discourse Composition

$$\llbracket D.S \rrbracket = \lambda e \phi. \llbracket D \rrbracket e (\lambda e'. \llbracket S \rrbracket e' \phi)$$

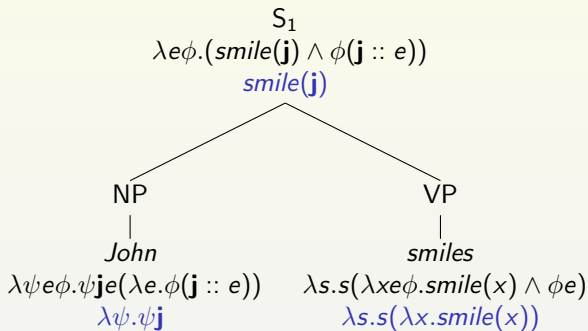
New Approach - Technical Remarks

- “ $::$ ” 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

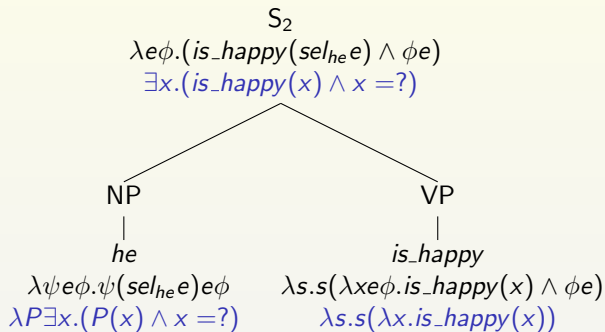
(1) *John smiles. He is happy.*

1



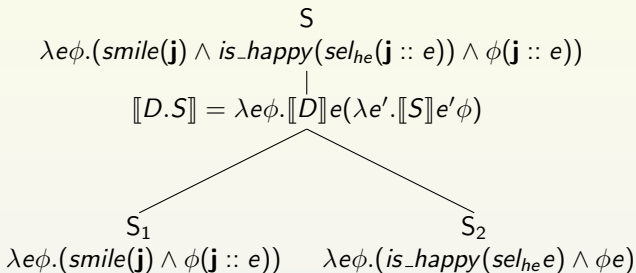
New Approach - Example Continued

2



New Approach - Example Continued

3



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 (\downarrow)

- Complete or further develop an ongoing topic
- E.g., Elaboration, Explanation

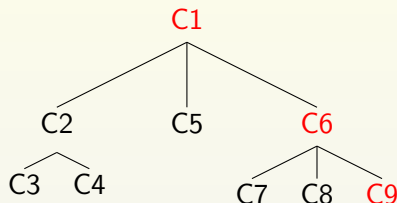
(3) *People come into the hall. LACL 2011 is held there.*

2 Coordinating Relation (\rightarrow)

- 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]

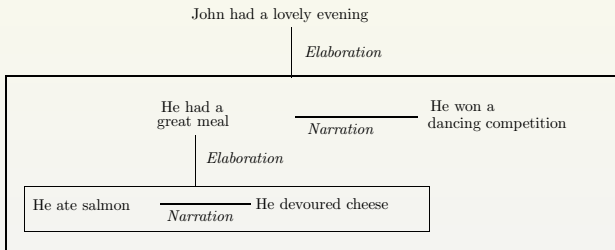


The Constraint

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) *John kissed Mary in the plaza.*

$$\exists e.(Kiss(e) \wedge Ag(e, john) \wedge Pat(e, mary) \wedge Loc(e, plaza))^3$$

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

$\llbracket \textit{John} \rrbracket = \textit{john}$

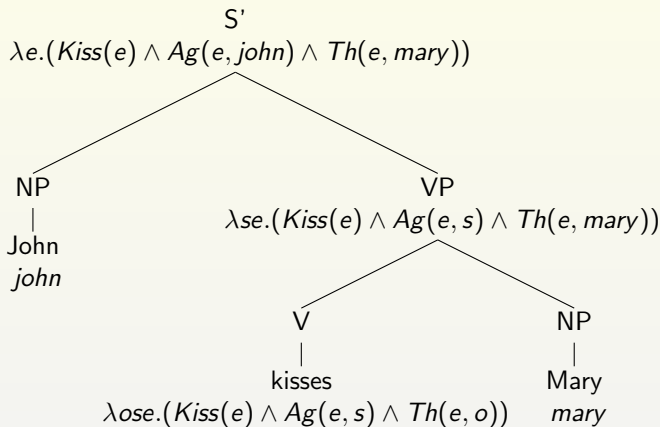
$\llbracket \textit{Mary} \rrbracket = \textit{mary}$

$\llbracket \textit{kiss} \rrbracket = \lambda o s e. (Kiss(e) \wedge Ag(e, s) \wedge Th(e, o))$

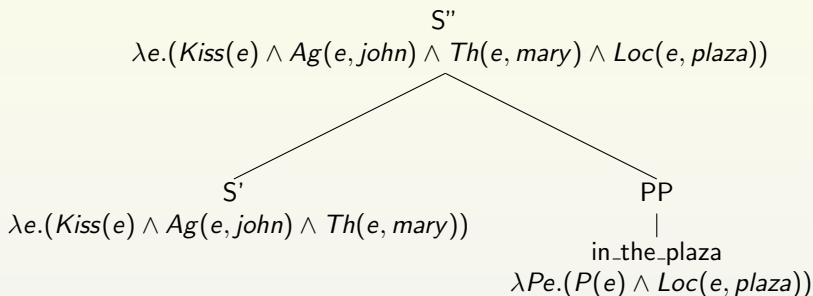
$\llbracket \textit{in_the_plaza} \rrbracket = \lambda P e. (P(e) \wedge Loc(e, plaza))$

$\llbracket \textit{EOS} \rrbracket = \lambda P. \exists e. P(e)$

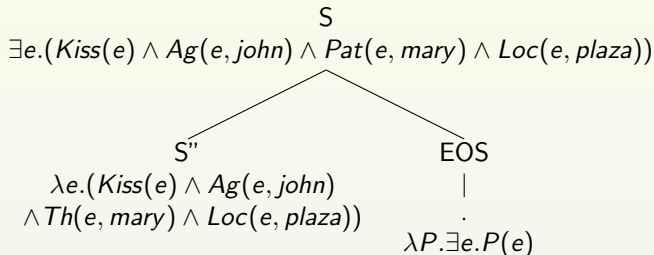
Interpretation Construction Step 1



Interpretation Construction Step 2



Interpretation Construction Step 3



Making Things Dynamic

Inserting the left and right context!

Dynamic Lexicon

$$\llbracket \textit{kiss} \rrbracket = \lambda o s e a b. (Kiss(e) \wedge Ag(e, s) \wedge Th(e, o) \wedge b(e :: a))^4$$

$$\llbracket \textit{smile} \rrbracket = \lambda s e a b. (Smile(e) \wedge Ag(e, s) \wedge b(e :: a))$$

$$\llbracket \textit{in_the_plaza} \rrbracket = \lambda P e a b. (Peab \wedge Loc(e, plaza))$$

$$\llbracket \textit{she} \rrbracket = \lambda P e a b. P(Sel(a)) e a b$$

⁴ “a” denotes the left context, “b” the right context.

Dynamic Interpretations

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

a. $\llbracket in_the_plaza \rrbracket ((\llbracket kiss \rrbracket \llbracket Mary \rrbracket) \llbracket John \rrbracket)$
 $\Rightarrow_{\beta} \lambda eab. (Kiss(e) \wedge Ag(e, john) \wedge Th(e, mary) \wedge$
 $Loc(e, plaza) \wedge b(e :: a))$


b. $\llbracket she \rrbracket \llbracket smile \rrbracket$
 $\Rightarrow_{\beta} \lambda eab. (Smile(e) \wedge Ag(e, Sel(a)) \wedge b(e :: a))$

Sentence & Discourse

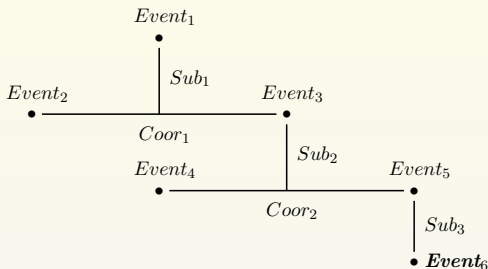
Proposal

Sentence and Discourse are distinct semantic entities!

- $\llbracket S \rrbracket = \lambda eab.(Pred(e) \wedge \dots \wedge ba)$
- $\llbracket D \rrbracket = \lambda ab.\exists e_1 e_2 \dots (Pred_1(e_1) \wedge Pred_2(e_2) \wedge \dots \wedge Rel_1(e_i, e_j) \wedge Rel_2(e_m, e_n) \wedge \dots \wedge ba')^5$

⁵ "a'" is a complicated structure containing the event accessibility relation. 

Subordinating Composition Functions



$$\llbracket Sub_{Bas} \rrbracket = \lambda DSab. Da(\lambda a'. \exists e. (Sea' b))$$

$$\llbracket Sub_{Adv} \rrbracket = \lambda DSab. Da(\lambda a'. \exists e. ((Sea' b) \wedge Rel(Sel(a'), e)))$$

$$\llbracket Empty \rrbracket = \lambda ab. ba$$

Subordinating Examples

$$1 \quad \llbracket Sub_{Bas} \rrbracket \llbracket Empty \rrbracket \llbracket (9-a) \rrbracket$$

$$\Rightarrow_{\beta} \lambda a_1 b_1. (\lambda a_3 b_3. b_3 a_3) a_1 (\lambda a_2. \exists e. (\lambda e' a_4 b_4. (Kiss(e') \wedge \dots \wedge b_4(e' :: a_4)) e a_2 b_1))$$

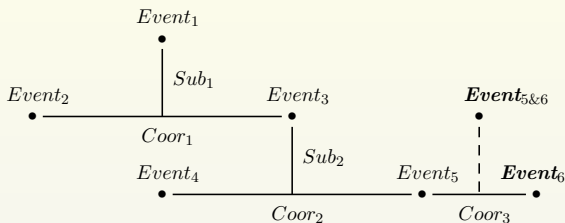
$$\Rightarrow_{\beta} \lambda a_1 b_1. \exists e. (Kiss(e) \wedge \dots \wedge b_1(e :: a_1))$$

$$2 \quad \llbracket Sub_{Adv} \rrbracket (\llbracket Sub_{Bas} \rrbracket \llbracket Empty \rrbracket \llbracket (9-a) \rrbracket) \llbracket (9-b) \rrbracket$$

$$\Rightarrow_{\beta} \lambda a_1 b_1. (\lambda a_3 b_3. \exists e_1. (Kiss(e_1) \wedge \dots \wedge b_3(e_1 :: a_3))) a_1 (\lambda a_2. \exists e. (((\lambda e_2 a_4 b_4. (Smile(e_2) \wedge \dots \wedge b_4(e_2 :: a_4))) e a_2 b_1) \wedge Rel(Sel(a_2), e)))$$

$$= \lambda a_1 b_1. \exists e_1 e_2. (Kiss(e_1) \wedge \dots \wedge Smile(e_2) \wedge \dots \wedge b_1(e_2 :: e_1 :: a_1) \wedge Rel(Sel(e_1 :: a_1), e_2))$$

Coordinating Composition Functions



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

$$\llbracket \text{Coor}_{Adv} \rrbracket = \lambda DSab. \exists e_c. Da(\lambda a'. \exists e. (Se(e_c :: (Del(a')))) b) \wedge Rel(Sel(a'), e, e_c)$$

Coordinating Examples

- 1 $\llbracket \text{Coor}_{Bas} \rrbracket \llbracket \text{Empty} \rrbracket \llbracket (9-a) \rrbracket = \llbracket \text{Sub}_{Bas} \rrbracket \llbracket \text{Empty} \rrbracket \llbracket (9-a) \rrbracket$
 $\Rightarrow_{\beta} \lambda a_1 b_1. \exists e. (\text{Kiss}(e) \wedge \dots \wedge b_1(e :: a_1))$
- 2 $\llbracket \text{Coor}_{Adv} \rrbracket (\llbracket \text{Coor}_{Bas} \rrbracket \llbracket \text{Empty} \rrbracket \llbracket (9-a) \rrbracket) \llbracket (9-b) \rrbracket$
 $\Rightarrow_{\beta} \lambda S a_1 b_1. \exists e_c. (\lambda a_3 b_3. \exists e_1. (\text{Kiss}(e_1) \wedge \dots \wedge b_3(e_1 :: a_3))) a_1 (\lambda a_2. \exists e. ((\lambda e_2 a_4 b_4. (\text{Smile}(e_2) \wedge \dots \wedge b_4(e_2 :: a_4))) e (e_c :: (\text{Del}(a_2)))) b_1) \wedge \text{Rel}(\text{Sel}(a_2), e, e_c))$
 $\Rightarrow_{\beta} \lambda S a_1 b_1. \exists e_c e_1 e_2. (\text{Kiss}(e_1) \wedge \dots \wedge \text{Smile}(e_2) \wedge \dots \wedge b_1(e_2 :: e_c :: (\text{Del}(e_1 :: a_1)))) \wedge \text{Rel}(\text{Sel}(e_1 :: a_1), e_2, e_c))$

Summary

- Conclusion
 - Event structure implemented compositionally
 - Discourse dynamics expressed via left & right context
 - Rhetorical relation concerned and embedded
 - $[[Discourse]] \neq [[Sentence]]$
- Future Work
 - Linguistic coverage extension for event semantics
 - Rhetorical relation determination
 - Other constraints besides the RFC

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