Event in Compositional Dynamic Semantics

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Outline

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?

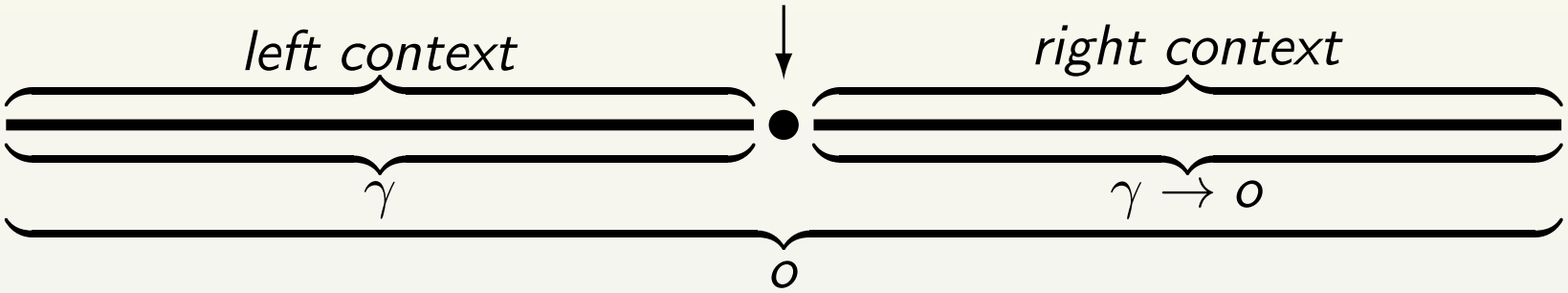
- Montague Grammar (MG)
  - Thesis: no important theoretical difference between natural language and formal language
  - Foundation: type theory, λ-calculus, first-order logic (FOL), Frege's principle/compositionality
- Dynamic Semantics
  - Motivation: MG's inability in modeling discourse semantics (e.g., anaphoric links across multiple sentences)
  - Concept of Meaning:

    $$\text{Satisfactory Models} \rightarrow \text{Context Change Potential (CCP)}$$

  - 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



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

New Approach - Typing & Composition

Typing Rules

$[\![s]\!]$	$\gamma \to (\gamma \to o) \to o$	o
$[\![n]\!]$	$\iota \to [\![s]\!]$	$\iota \to o$
$[\![np]\!]$	$(\iota \to [\![s]\!]) \to [\![s]\!]$	$(\iota \to o) \to o$

Discourse Composition

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

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.*

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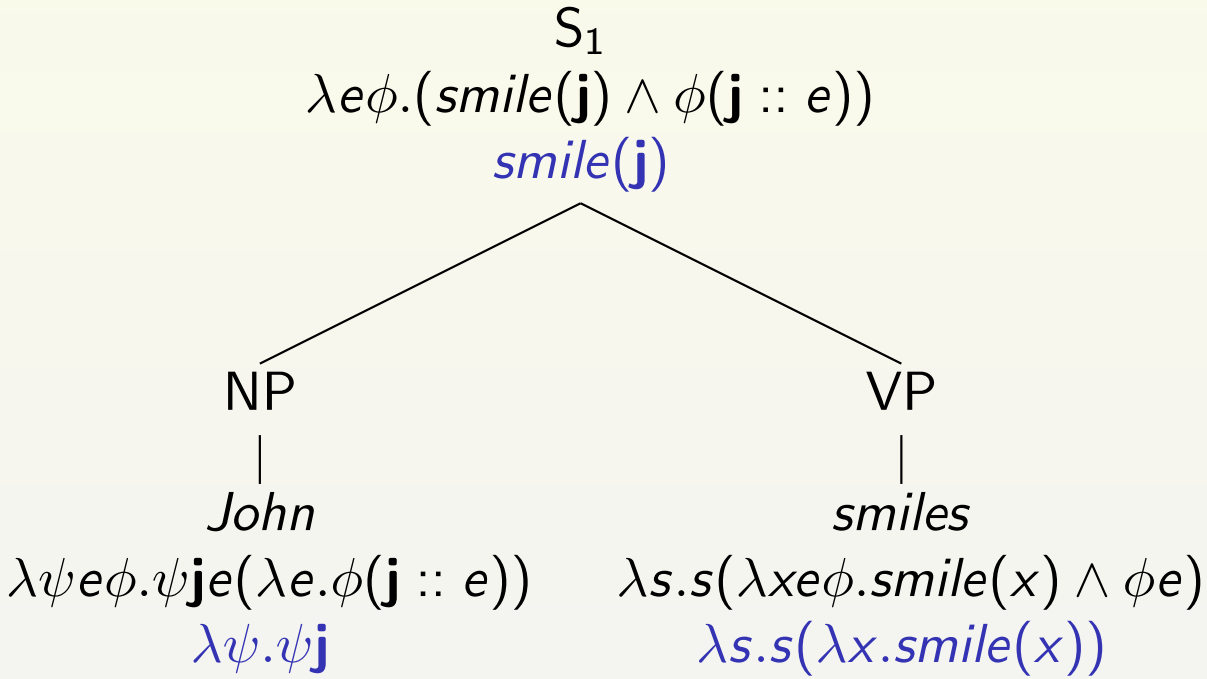

New Approach - Example Continued

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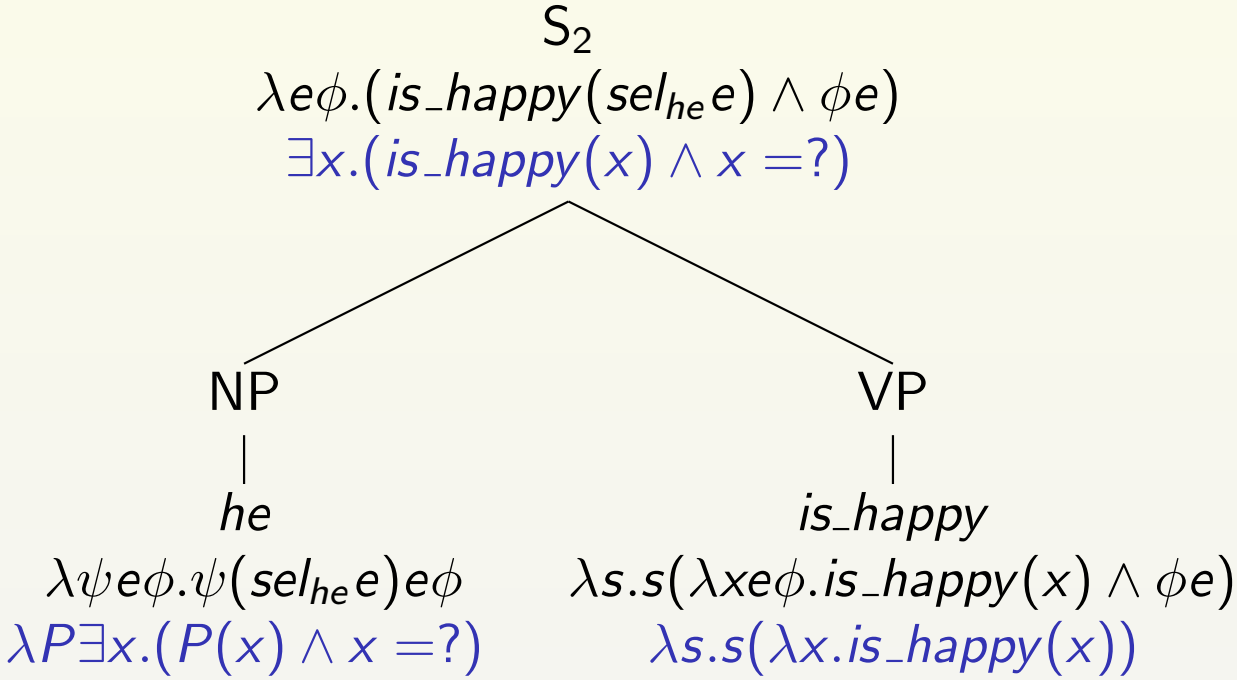

New Approach - Example Continued

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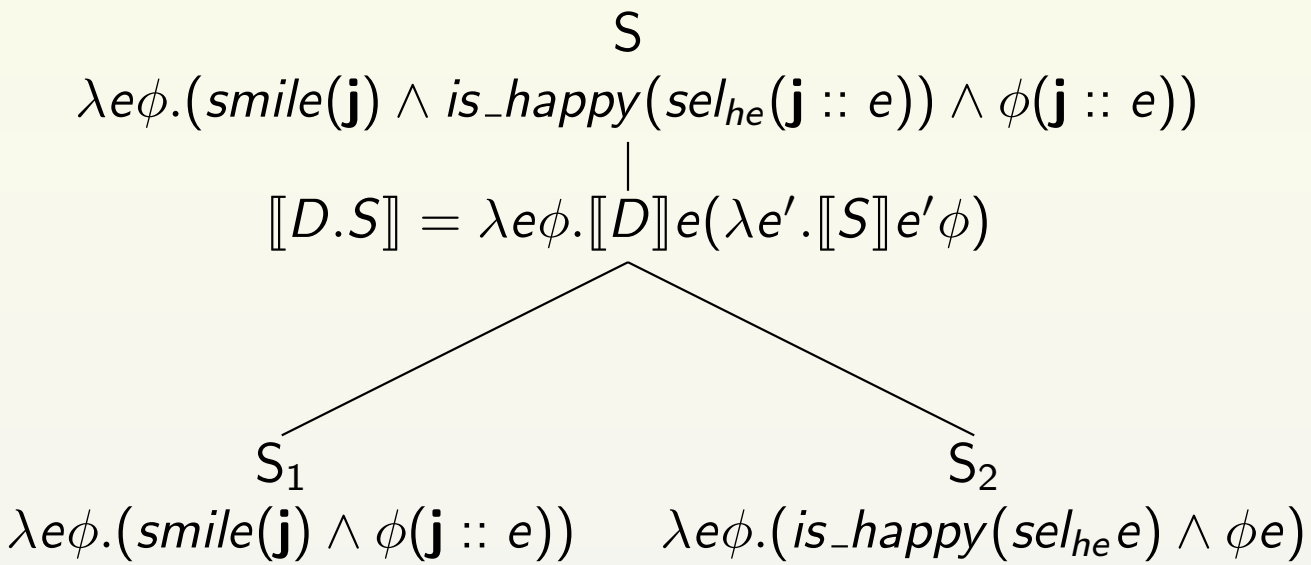


What is the Structure in Discourse?

- 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

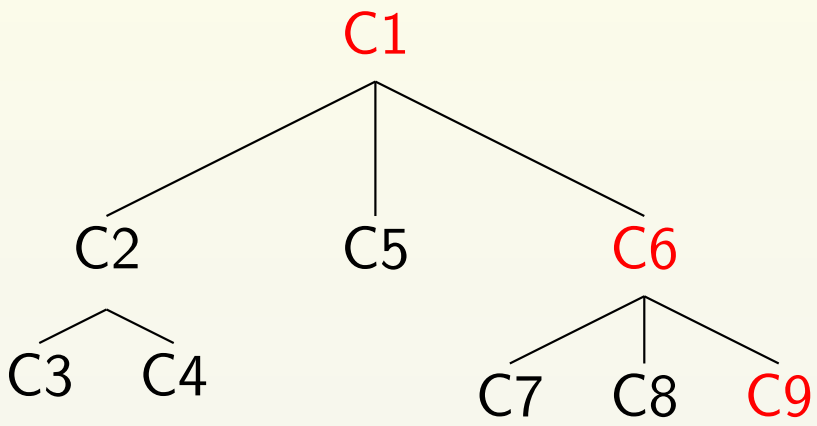
1. Subordinating Relation ($\downarrow$)
   - Complete or further develop an ongoing topic
   - E.g., Elaboration, Explanation

(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]

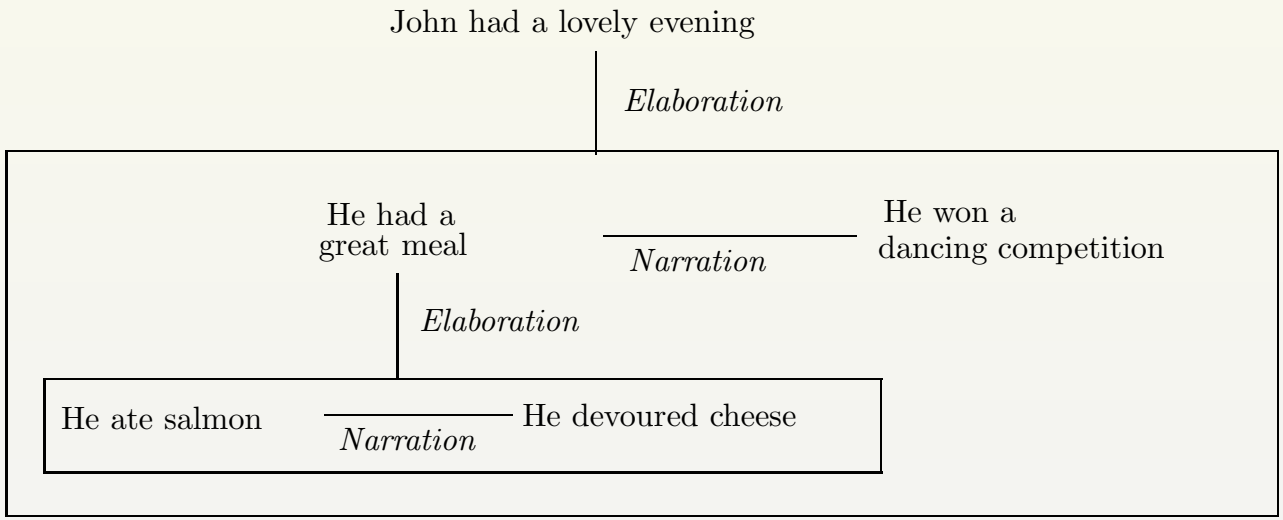


The Constraint

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]



[2]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.*

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

[3] *Ag* stands for Agent, *Pat* for Patient and *Loc* for Location

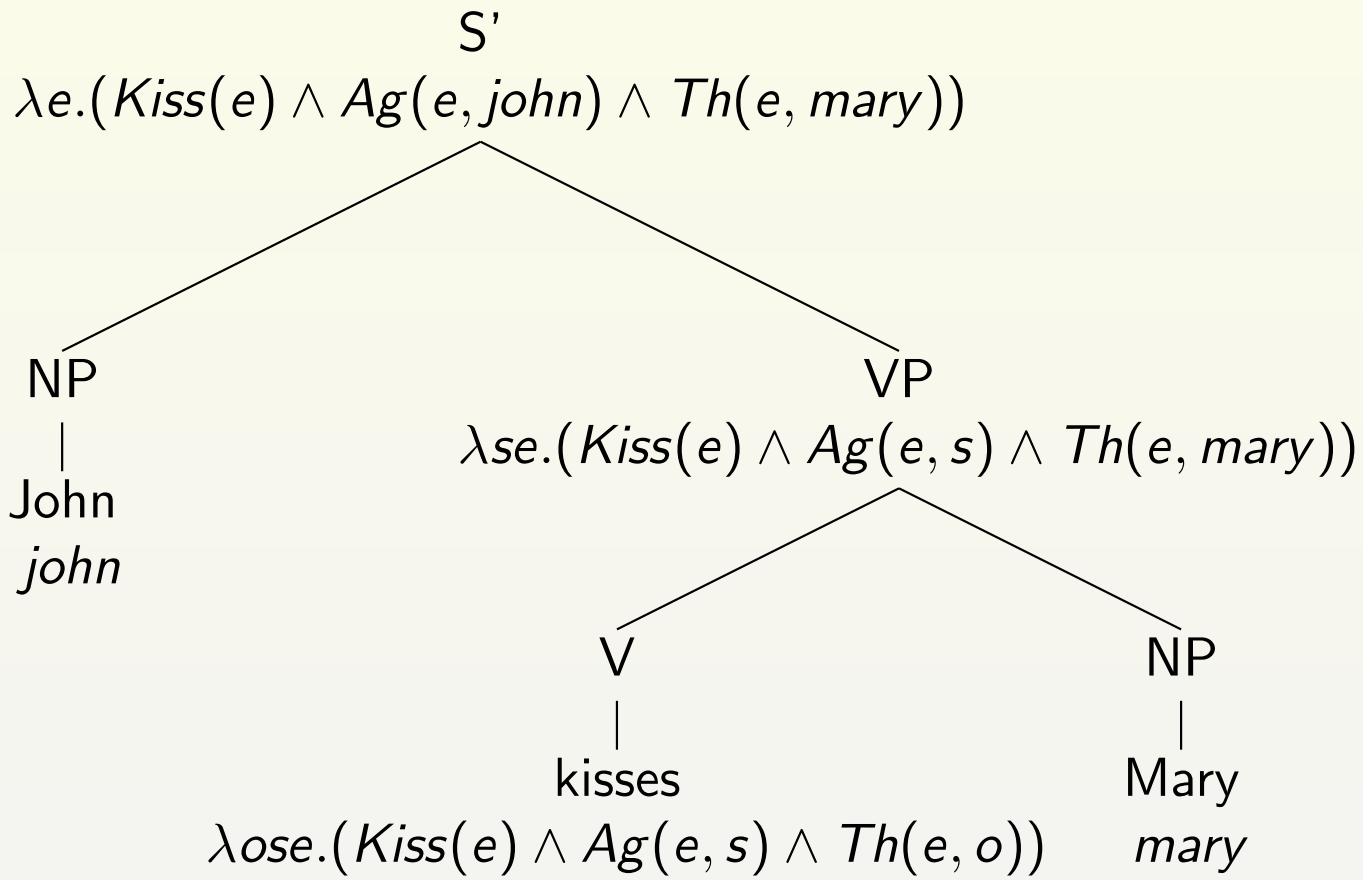
Interpretation Construction

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

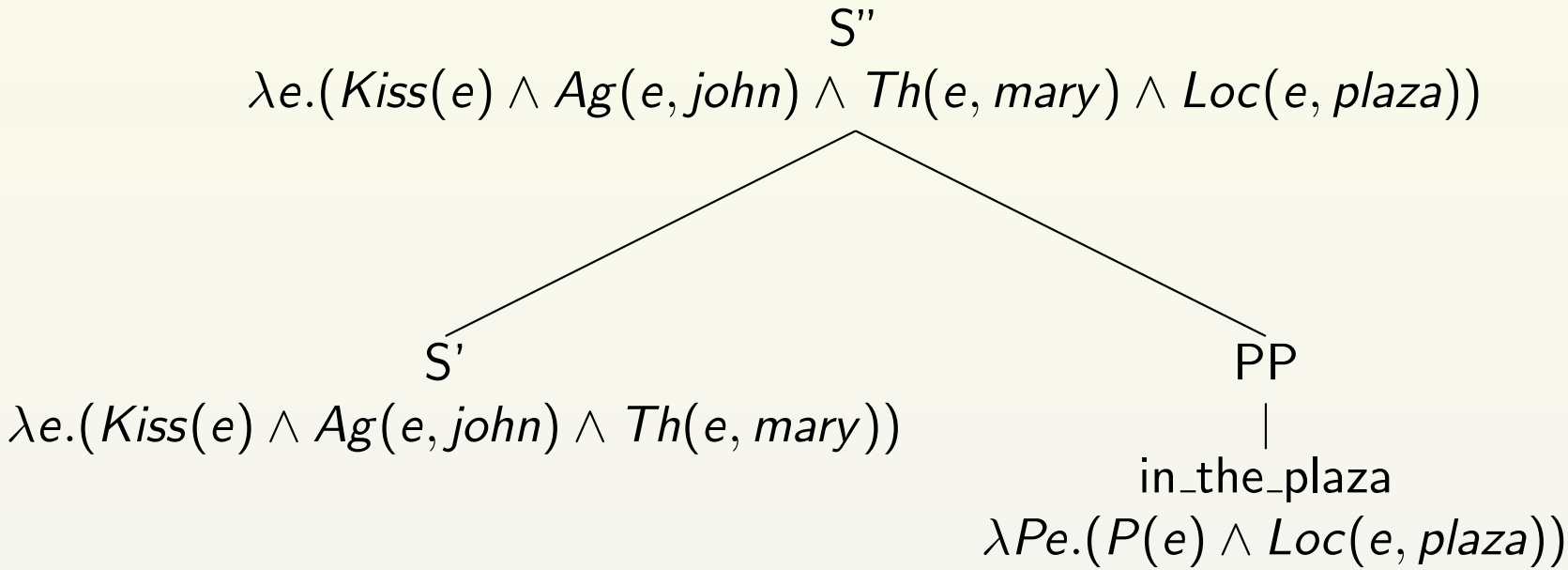
Lexicon

$[\![John]\!] = john$
$[\![Mary]\!] = mary$
$[\![kiss]\!] = \lambda ose.(Kiss(e) \wedge Ag(e, s) \wedge Th(e, o))$
$[\![in\_the\_plaza]\!] = \lambda Pe.(P(e) \wedge Loc(e, plaza))$
$[\![EOS]\!] = \lambda P.\exists e.P(e)$

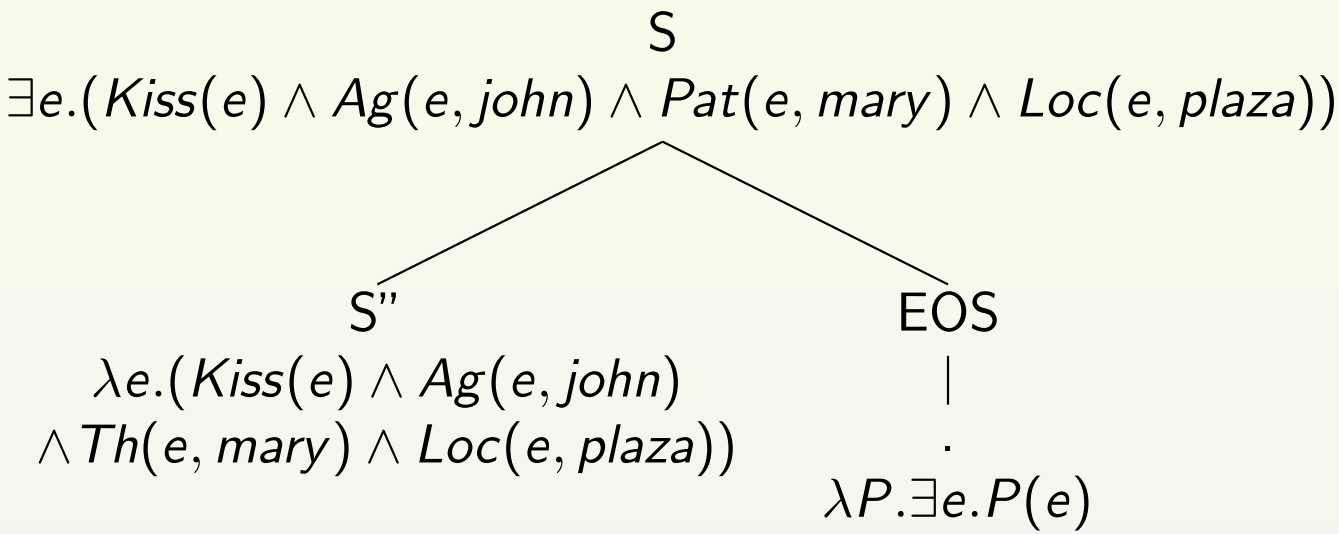
Interpretation Construction Step 1



Interpretation Construction Step 2



Interpretation Construction Step 3



Making Things Dynamic

Inserting the left and right context!

Dynamic Lexicon

$[\![kiss]\!] = \lambda oseab.(Kiss(e) \wedge Ag(e,s) \wedge Th(e,o) \wedge b(e :: a))$[4]
$[\![smile]\!] = \lambda seab.(Smile(e) \wedge Ag(e,s) \wedge b(e :: a))$
$[\![in\_the\_plaza]\!] = \lambda Peab.(Peab \wedge Loc(e, plaza))$
$[\![she]\!] = \lambda Peab.P(Sel(a))eab$

[4] "a" denotes the left context, "b" the right context.

Dynamic Interpretations

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

b. *She smiles.*

a. $[\![in\_the\_plaza]\!]([\![kiss]\!][\![Mary]\!])[\![John]\!])$
$\Rightarrow_\beta \lambda eab.(Kiss(e) \wedge Ag(e, john) \wedge Th(e, mary) \wedge$
$Loc(e, plaza) \wedge b(e :: a))$

b. $[\![she]\!][\![smile]\!]$
$\Rightarrow_\beta \lambda eab.(Smile(e) \wedge Ag(e, Sel(a)) \wedge b(e :: a))$

Sentence & Discourse

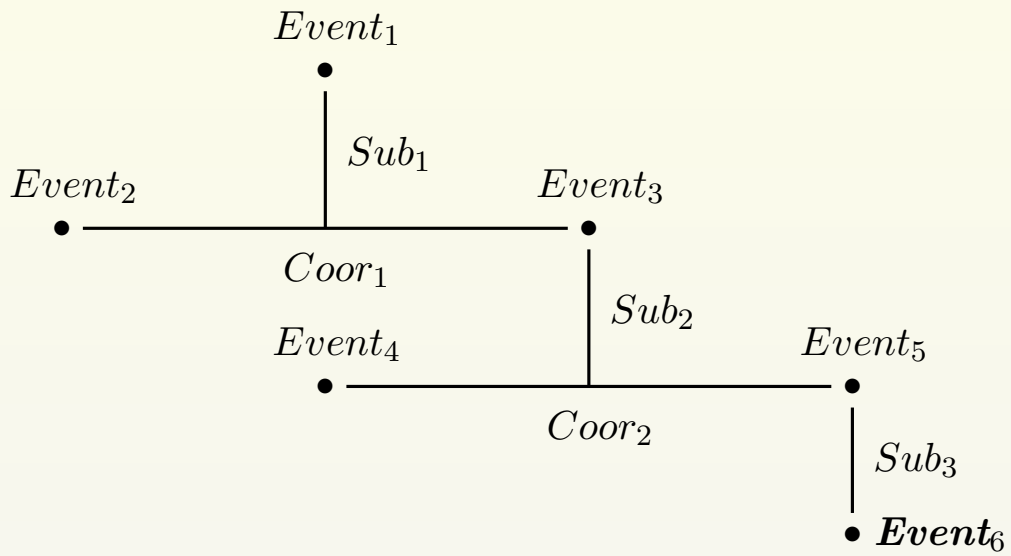
Proposal

Sentence and Discourse are distinct semantic entities!

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

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

Subordinating Composition Functions



$$[\![Sub_{Bas}]\!] = \lambda DSab.Da(\lambda a'.\exists e.(Sea'b))$$

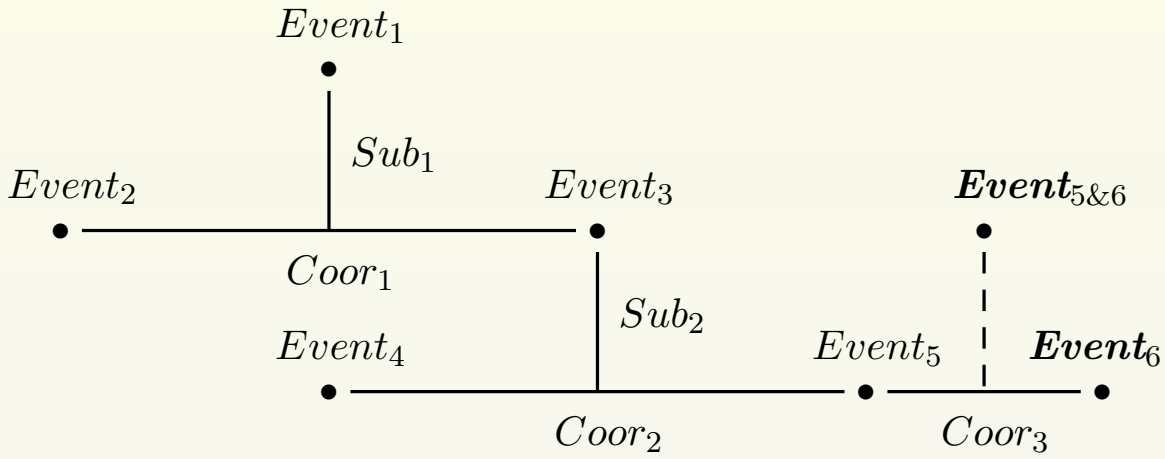
$$[\![Sub_{Adv}]\!] = \lambda DSab.Da(\lambda a'.\exists e.((Sea'b) \wedge Rel(Sel(a'), e))$$

$$[\![Empty]\!] = \lambda ab.ba$$

Subordinating Examples

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

Coordinating Composition Functions



$$[\![Coor_{Bas}]\!] = \lambda DSab.Da(\lambda a'.\exists e.(Sea'b))$$

$$[\![Coor_{Adv}]\!] = \lambda DSab.\exists e_c.Da(\lambda a'.\exists e.(Se(e_c :: (Del(a')))b) \wedge Rel(Sel(a'), e, e_c))$$

Coordinating Examples

1. $[\![Coor_{Bas}]\!][\![Empty]\!][\![(9\text{-a})]\!] = [\![Sub_{Bas}]\!][\![Empty]\!][\![(9\text{-a})]\!]$
   $\Rightarrow_\beta \lambda a_1 b_1.\exists e.(Kiss(e) \wedge ... \wedge b_1(e :: a_1))$
2. $[\![Coor_{Adv}]\!]([\![Coor_{Bas}]\!][\![Empty]\!][\![(9\text{-a})]\!])[\![(9\text{-b})]\!]$
   $\Rightarrow_\beta \lambda S a_1 b_1.\exists e_c.(\lambda a_3 b_3.\exists e_1.(Kiss(e_1) \wedge ... \wedge b_3(e_1 ::$
   $a_3)))a_1(\lambda a_2.\exists e.((\lambda e_2 a_4 b_4.(Smile(e_2) \wedge ... \wedge b_4(e_2 ::$
   $a_4)))e(e_c :: (Del(a_2)))b_1) \wedge Rel(Sel(a_2), e, e_c))$
   $\Rightarrow_\beta \lambda S a_1 b_1.\exists e_c e_1 e_2.(Kiss(e_1) \wedge ... \wedge Smile(e_2) \wedge ... \wedge b_1(e_2 ::$
   $e_c :: (Del(e_1 :: a_1))) \wedge Rel(Sel(e_1 :: a_1), e_2, e_c))$

Summary

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

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