Last Class: Semantic interpretation

1. logical form
2. representing words
3. functional form / semantic roles

Today: Semantic Interpretation

1. syntax-driven rule-by-rule approach

Features of the Internal Representation

- *words*: word senses
- *noun phrases*:
  - structure representing meaning of whole phrase
  - note the difference between class of objects and particular object; between definite vs. indefinite references
- *clauses and sentences*: denote functional structure — who did what to whom.

Compositional, Rule-by-Rule Approach

Eva loves algorithms. →
(loves1 **l1** (NAME **n1** Eva1) algorithms1)

- Add **SEM** feature to each lexical entry and grammatical rule.
- Use **VAR** feature to store discourse variable.
- Modify chart parser in two ways:
  1. When lexical rule is instantiated, VAR feature set to new discourse variable.
  2. When constituent built, its SEM feature is simplified by performing *lambda reductions*.

Lexicon Additions

- Eva (name **SEM** Eva1)
- loves (v **SEM** loves1 **SUBCAT** _np)
- algorithms (n **SEM** algorithms1)

New Grammar

1. (S **SEM** (?semvp ?semnp)) →
   (NP **SEM** ?semnp) (VP **SEM** ?semvp)
2. (VP **VAR** ?v **SEM** (λ a1 (?semv ?v a1 ?semnp))) →
   (V*[_np]* **SEM** ?semv) (NP **SEM** ?semnp)
3. (NP **VAR** ?v **SEM** (NAME ?v ?semname)) →
   (NAME **SEM** ?semname)
4. (NP **VAR** ?v **SEM** ?semn) → (N **SEM** ?semn)

VAR is a head feature for S, VP, NP.

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The Lambda Calculus

Formalism for defining these functions.
$(\lambda x\ Px)$
$((\lambda x\ Px)\ a) = P\{x/a\}$

loves algorithms ⇒ (λa (loves1 **l1** a algorithms1))
Eva ⇒ (NAME **r1** Eva1)

(S **SEM** (?semvp ?semnp)) →
(NP **SEM** ?semnp) (VP **SEM** ?semvp)

((λa (loves1 **l1** a algorithms1)) (NAME **r1** Eva1))
(loves1 **l1** (NAME **r1** Eva1) algorithms1)

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New Grammar

1. (S **SEM** (?semvp ?semnp)) →
   (NP **SEM** ?semnp) (VP **SEM** ?semvp)
2. (VP **VAR** ?v **SEM** (λ a1 (?semv ?v a1 ?semnp))) →
   (V*[_np]* **SEM** ?semv) (NP **SEM** ?semnp)
3. (NP **VAR** ?v **SEM** (NAME ?v ?semname)) →
   (NAME **SEM** ?semname)
4. (NP **VAR** ?v **SEM** ?semn) → (N **SEM** ?semn)

VAR is a head feature for S, VP, NP.

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Adding Thematic Roles

AGENT *loves* THEME. INSTR *broke* THEME.

(VP **VAR** ?v
  SEM (λ a (?semv ?v [AGENT a] [THEME ?semnp])))
    → (V *[_np* **ROLES** AG-THEME*]* **SEM** ?semv)
      (NP **SEM** ?semnp)
(VP **VAR** ?v
  SEM (λ a (?semv ?v [INSTR a] [THEME ?semnp])))
    → (V *[_np* **ROLES** INSTR-THEME*]* **SEM** ?semv)
      (NP **SEM** ?semnp)

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Lexicalized Semantic Rules

loves:
(V **VAR** ?v
SEM (λ o (λ a (loves1 ?v [AGENT a] [THEME o]))))
broke:
(V **VAR** ?v
SEM (λ o (λ a (breaks1 ?v [INSTR a] [THEME o]))))

Single grammar rule,

(VP **SEM** (?semv ?semnp)) $\rightarrow$
(V **SEM** ?semv) (NP **SEM** ?semnp)

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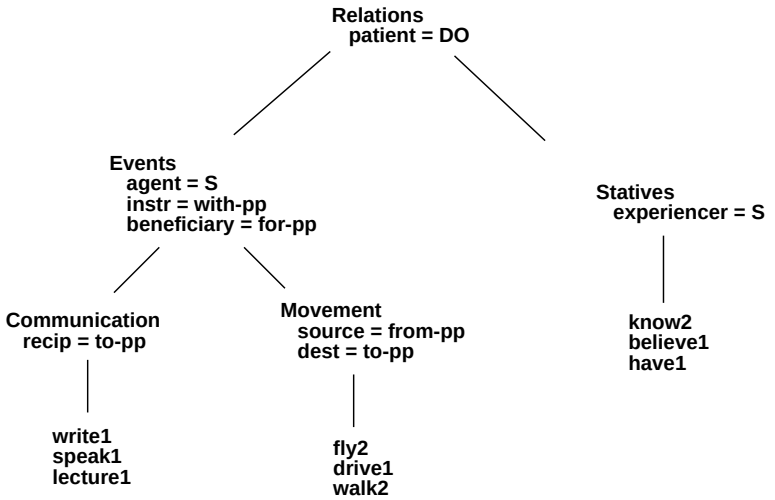
Hierarchical Lexicon



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Caveats

1. Haven't addressed general problems with compositional approach.
   - *a former congressman*
   - *a toy elephant*
   - idioms: *kicked the bucket*
2. Don't have to use lambda forms explicitly.
3. Ignored issues of word sense ambiguity entirely.
4. Ignored thematic role ambiguities entirely, e.g., *ate with fork* vs. *ate with John*.

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