HG4041 Theories of Grammar

Semantics

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Lecture 4
Location: LHN-TR+36

Overview

- Last week: HC, HS, VP, SHAC
- Some notes on the linguist's stance
- Which aspects of semantics we'll tackle
- Our formalization; Semantics Principles
- Building semantics of phrases
- Modification, coordination
- Structural ambiguity

Overview

- Complex Feature Structures allow us to
  - Write more general rules
  - Constrain them lexically

Head-Complement Rule

$$\begin{bmatrix} \textit{phrase} & \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\rangle \end{bmatrix} \end{bmatrix} \rightarrow \boldsymbol{H} \begin{bmatrix} \textit{word} & \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \left\langle \boxed{1}, \ldots, \boxed{n} \right\rangle \end{bmatrix} \end{bmatrix} \boxed{1}, \ldots, \boxed{n}$$

- ➢ The possible complements are specified lexically

$$\left\langle \text{devour}, \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \textit{verb} \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle \text{NP} \rangle \end{bmatrix} \end{bmatrix} \right\rangle \quad \left\langle \text{put}, \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \textit{verb} \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle \text{NP PP} \rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

Head-Specifier Rule

$$\begin{bmatrix} \textit{phrase} & \\ \textit{VAL} & \begin{bmatrix} \textit{COMPS} & \langle\rangle \\ \textit{SPR} & \langle\rangle \end{bmatrix} \end{bmatrix} \rightarrow \boxed{2} \quad \textbf{\textit{H}} \begin{bmatrix} \textit{VAL} & \begin{bmatrix} \textit{COMPS} & \langle\rangle \\ \textit{SPR} & \langle \boxed{2} \rangle \end{bmatrix} \end{bmatrix}$$

- Combines the rules expanding S and NP (and other, ...).
- Again, restrictions on specifiers come from the lexicon.

$$\left\langle \text{dog}, \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \textit{noun} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle \text{D} \rangle \\ \text{COMPS} & \langle\rangle \end{bmatrix} \end{bmatrix} \right\rangle \quad \left\langle \text{eat}, \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \textit{verb} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle \text{NP} \rangle \\ \text{COMPS} & \langle (\text{NP}) \rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

Two Principles

➢ **The Valence Principle**

Unless the rule says otherwise, the mother's values for the VAL features (SPR and COMPS) are identical to those of the head daughter.

➢ **The Specifier-Head Agreement Constraint (SHAC)**

Verbs and nouns must be specified as:

$$\begin{bmatrix} \text{HEAD} & \begin{bmatrix} \text{AGR} \; \boxed{1} \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} \left\langle \text{AGR} \; \boxed{1} \right\rangle \end{bmatrix} \end{bmatrix}$$

Actually inherited from a lexical super-type

Semantics

Overview

- Some notes on the linguist's stance
- Which aspects of semantics we'll tackle
- Our formalization; Semantics Principles
- Building semantics of phrases
- Modification, coordination
- Structural ambiguity

The Linguist's Stance: Building a precise model

- Some of our statements are statements about how the model works:

  "[*prep*] and [AGR *3sing*] can't be combined because AGR is not a feature of the type prep."

- Some of our statements are statements about how (we think) English or language in general works.

  "The determiners *a* and *many* only occur with count nouns, the determiner *much* only occurs with mass nouns, and the determiner *the* occurs with either."

- Some are statements about how we code a particular linguistic fact within the model.

  "All count nouns are [SPR < [COUNT +]>]."

The Linguist's Stance:

A Vista on the Set of Possible English Sentences

- ...as a background against which linguistic elements (words, phrases) have a distribution
- ...as an arena in which linguistic elements "behave" in certain ways

Semantics: Where's the Beef?

So far, our grammar has no semantic representations. We have, however, been relying on semantic intuitions in our argumentation, and discussing semantic contrasts where they line up (or don't) with syntactic ones.

- structural ambiguity
- S/NP parallelism
- count/mass distinction
- complements vs. modifiers

Our Slice of a World of Meanings

Aspects of meaning we won't account for (in this course)

- Pragmatics
- Fine-grained lexical semantics
  The meaning of *life* is
  - `life` (or life′)
  - $\begin{bmatrix} \text{RELN} & \textit{life} \\ \text{INST} & i \end{bmatrix}$
  - Not like wordnet: $\texttt{life}_1 \subset \texttt{being}_1 \subset \texttt{state}_1$ ...

Our Slice of a World of Meanings

$$
\begin{bmatrix}
\text{MODE} & \textit{prop} \\
\text{INDEX} & s \\
\text{RESTR} & \left\langle
\begin{bmatrix}
\text{RELN} & \textbf{save} \\
\text{SIT} & s \\
\text{SAVER} & i \\
\text{SAVED} & j
\end{bmatrix},
\begin{bmatrix}
\text{RELN} & \textbf{name} \\
\text{NAME} & \textit{Chris} \\
\text{NAMED} & i
\end{bmatrix},
\begin{bmatrix}
\text{RELN} & \textbf{name} \\
\text{NAME} & \textit{Pat} \\
\text{NAMED} & j
\end{bmatrix}
\right\rangle
\end{bmatrix}
$$

"...the linguistic meaning of *Chris saved Pat* is a proposition that will be true just in case there is an actual situation that involves the saving of someone named Pat by someone named Chris."

(Sag *et al*, 2003, p. 140)

Our Slice of a World of Meanings

What we are accounting for is the **compositionality** of sentence meaning.

- How the pieces fit together

  Semantic arguments and **indices**

- How the meanings of the parts add up to the meaning of the whole.

  Appending RESTR lists up the tree

The value of **restriction** is the set of conditions that must hold (in some possible world) for the expression to be applicable.

Semantics in Constraint-Based Grammar

- Constraints as (generalized) truth conditions
  - **proposition**: what must be the case for a proposition to be true
  - **directive**: what must happen for a directive to be fulfilled
  - **question**: the kind of situation the asker is asking about
  - **reference**: the kind of entity the speaker is referring to

- **Syntax/semantics interface**:

  Constraints on how syntactic arguments are related to semantic ones, and on how semantic information is compiled from different parts of the sentence.

Feature Geometry

$$\begin{bmatrix} \textit{expression} & \\ \text{SYN} & \begin{bmatrix} \textit{syn-cat} & \\ \text{HEAD} & \begin{bmatrix}\textit{pos}\\ \ldots\end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle \ldots \rangle \\ \text{COMPS} & \langle \ldots \rangle \end{bmatrix}\end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \textit{sem-cat} & \\ \text{MODE} & \{\ \textit{prop},\ \textit{ques},\ \textit{dir},\ \textit{ref},\ \textit{none}\ \} \\ \text{INDEX} & \{\ i,\ j,\ k,\ \ldots,\ s_1,\ s_2,\ \ldots\} \\ \text{RESTR} & \langle \ldots \rangle \end{bmatrix}\end{bmatrix}$$

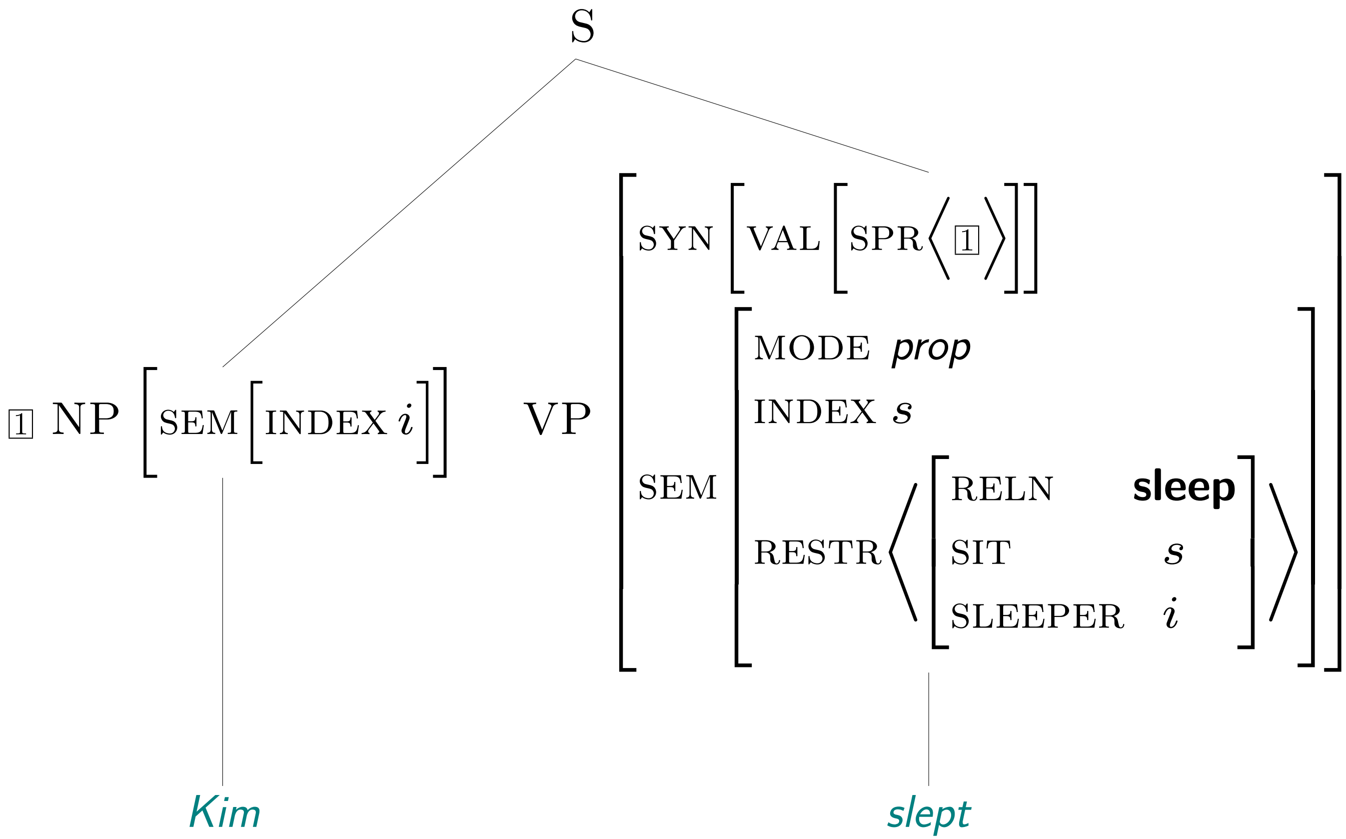
How the Pieces Fit Together

$$\left\langle \textit{Kim}, \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{noun} & \\ \text{AGR} & \textit{3sing} \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle\rangle \\ \text{COMPS} & \langle\rangle \end{bmatrix} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{MODE} & \textit{ref} \\ \text{INDEX} & i \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \textbf{name} \\ \text{NAME} & \textit{Kim} \\ \text{NAMED} & i \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

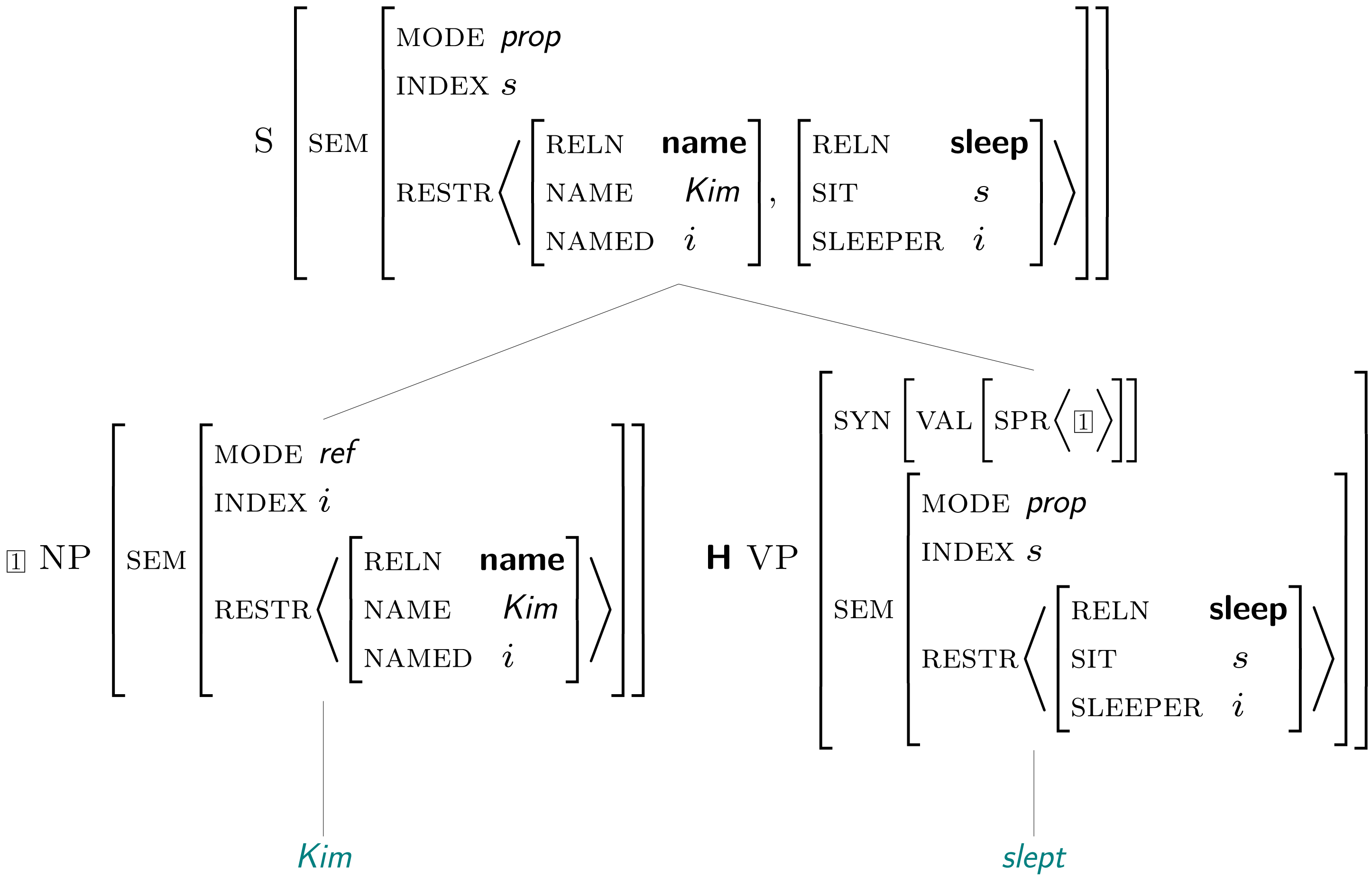
How the Pieces Fit Together

$$
\left\langle \textit{sleep}\ ,\ \begin{bmatrix}
\text{SYN} & \begin{bmatrix}
\text{HEAD} & \textit{verb} \\
\text{VAL} & \begin{bmatrix}
\text{SPR} & \langle\ \textit{NP}_i\ \rangle \\
\text{COMPS} & \langle\ \rangle
\end{bmatrix}
\end{bmatrix} \\
\text{SEM} & \begin{bmatrix}
\text{MODE} & \textit{prop} \\
\text{INDEX} & s \\
\text{RESTR} & \left\langle \begin{bmatrix}
\text{RELN} & \textbf{sleep} \\
\text{SIT} & s \\
\text{SLEEPER} & i
\end{bmatrix} \right\rangle
\end{bmatrix}
\end{bmatrix} \right\rangle
$$

The Pieces Together



Another View of the Same Tree



How to Share Semantic Information

We need the Semantics Principles

- **The Semantic Inheritance Principle**

  In any headed phrase, the mother's MODE and INDEX are identical to those of the head daughter.

- **The Semantic Compositionality Principle**

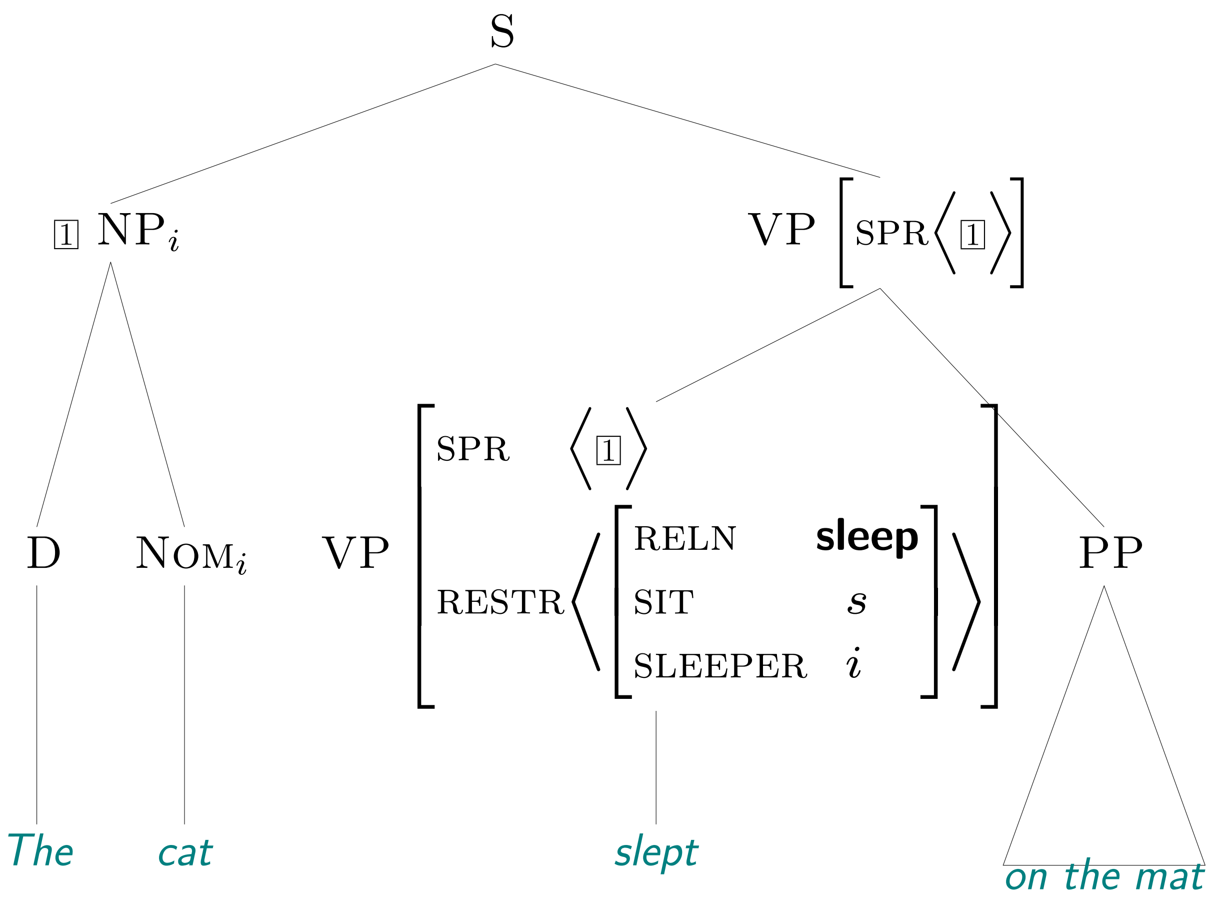
  In any well-formed phrase structure, the mother's RESTR value is the sum of the RESTR values of the daughter.

List summation: $\oplus$ (technically concatenation) $\langle A \rangle \oplus \langle B \rangle \neq \langle B \rangle \oplus \langle A \rangle$

$\langle a_1, a_2, \ldots, a_n \rangle \oplus \langle b_1, b_2, \ldots, b_m \rangle = \langle a_1, a_2, \ldots, a_n, b_1, b_2, \ldots, b_m \rangle$

$\langle b_1, b_2, \ldots, b_m \rangle \oplus \langle a_1, a_2, \ldots, a_n \rangle = \langle b_1, b_2, \ldots, b_m, a_1, a_2, \ldots, a_n \rangle$

What Identifies Indices?



Summary: Words ...

- contribute predications
- 'expose' one index in those predications, for use by words or phrases
- relate syntactic arguments to semantic arguments

$$\left\langle \textit{sleep} \; , \; \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle \; \textit{NP}_i \; \rangle \\ \text{COMPS} & \langle \; \rangle \end{bmatrix} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{MODE} & \textit{prop} \\ \text{INDEX} & s \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \textbf{sleep} \\ \text{SIT} & s \\ \text{SLEEPER} & i \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

Summary: Grammar Rules ...

- Identify feature structures (including the INDEX value) across daughters
  - Head Specifier Rule

$$\begin{bmatrix} \textit{phrase} & \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle\rangle \end{bmatrix} \end{bmatrix} \rightarrow \boxed{1} \quad \boldsymbol{H} \begin{bmatrix} \text{VAL} & \begin{bmatrix} \text{SPR} & \langle \boxed{1} \rangle \\ \text{COMPS} & \langle\rangle \end{bmatrix} \end{bmatrix}$$

  - Head Complement Rule

$$\begin{bmatrix} \textit{phrase} & \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\rangle \end{bmatrix} \end{bmatrix} \rightarrow \boldsymbol{H} \begin{bmatrix} \textit{word} & \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \left\langle \boxed{1}, \ldots, \boxed{n} \right\rangle \end{bmatrix} \end{bmatrix} \boxed{1}, \ldots, \boxed{n}$$

  - Head Modifier Rule

$$\begin{bmatrix} \textit{phrase} \end{bmatrix} \rightarrow \boldsymbol{H}\,\boxed{1} \begin{bmatrix} \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\rangle \end{bmatrix} \end{bmatrix} \begin{bmatrix} \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\rangle \\ \text{MOD} & \left\langle \boxed{1} \right\rangle \end{bmatrix} \end{bmatrix}$$

Summary: Grammar Rules ...

- Identify feature structures (including the INDEX value) across daughters
- License trees which are subject to the semantic principles
  - SIP: 'passes up' MODE and INDEX from head daughter
  - SCP: 'gathers up' predications (RESTR list) from all daughters
- The semantics is strictly compositional — all of the meaning comes from the words, rules and principles.
  - We then enrich this with pragmatic inference — but we need a base to infer from

Other Aspects of Semantics

- Tense, Quantification (only touched on here)
- Modification
- Coordination
- Structural Ambiguity

Evolution of a Phrase Structure Rule

C2 NOM $\rightarrow$ NOM PP; VP $\rightarrow$ VP PP

C3 $$\begin{bmatrix} \textit{phrase} & \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \text{-} \\ \text{COMPS} & \textit{itr} \end{bmatrix} \end{bmatrix} \rightarrow \boldsymbol{H} \begin{bmatrix} \textit{phrase} & \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \text{-} \end{bmatrix} \end{bmatrix} \; \textit{PP}$$

C4 $$\begin{bmatrix} \textit{phrase} \end{bmatrix} \rightarrow \boldsymbol{H} \begin{bmatrix} \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\rangle \end{bmatrix} \end{bmatrix} \; \textit{PP}$$

C5 $$\begin{bmatrix} \textit{phrase} \end{bmatrix} \rightarrow \boldsymbol{H}\,\boxed{1} \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\rangle \end{bmatrix} \end{bmatrix} \end{bmatrix} \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\rangle \\ \text{MOD} & \left\langle \boxed{1} \right\rangle \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

$$= \begin{bmatrix} \textit{phrase} \end{bmatrix} \rightarrow \boldsymbol{H}\,\boxed{1} \begin{bmatrix} \text{COMPS} & \langle\rangle \end{bmatrix} \begin{bmatrix} \text{COMPS} & \langle\rangle \\ \text{MOD} & \left\langle \boxed{1} \right\rangle \end{bmatrix}$$

Evolution of Another Phrase Structure Rule

C2 X $\rightarrow$ X+ CONJ X;

C3 $$\boxed{1} \rightarrow \boxed{1}+ \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \textit{conj} \end{bmatrix} \boxed{1}$$

C4 $$\begin{bmatrix} \text{VAL} & \boxed{1} \end{bmatrix} \rightarrow \begin{bmatrix} \text{VAL} & \boxed{1} \end{bmatrix}+ \begin{bmatrix} \textit{word} & \\ \text{HEAD} & \textit{conj} \end{bmatrix} \begin{bmatrix} \text{VAL} & \boxed{1} \end{bmatrix}$$

C5 $$\begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{VAL} & \boxed{0} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{IND} & s_0 \end{bmatrix} \end{bmatrix} \rightarrow$$

$$\begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{VAL} & \boxed{0} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{IND} & s_1 \end{bmatrix} \end{bmatrix} \ldots \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{VAL} & \boxed{0} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{IND} & s_{n-1} \end{bmatrix} \end{bmatrix} \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{HEAD} & \textit{conj} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{IND} & s_0 \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{ARGS} & \langle s_1, \ldots, s_{n-1}, s_n \rangle \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{VAL} & \boxed{0} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{IND} & s_n \end{bmatrix} \end{bmatrix}$$

$$= \begin{bmatrix} \text{VAL} & \boxed{0} \\ \text{IND} & s_0 \end{bmatrix} \rightarrow \begin{bmatrix} \text{VAL} & \boxed{0} \\ \text{IND} & s_1 \end{bmatrix} \ldots \begin{bmatrix} \text{VAL} & \boxed{0} \\ \text{IND} & s_{n-1} \end{bmatrix} \begin{bmatrix} \text{HEAD} & \textit{conj} \\ \text{IND} & s_0 \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{ARGS} & \langle s_1, \ldots, s_{n-1}, s_n \rangle \end{bmatrix} \right\rangle \end{bmatrix} \begin{bmatrix} \text{VAL} & \boxed{0} \\ \text{IND} & s_n \end{bmatrix}$$

Combining Constraints and Coordination

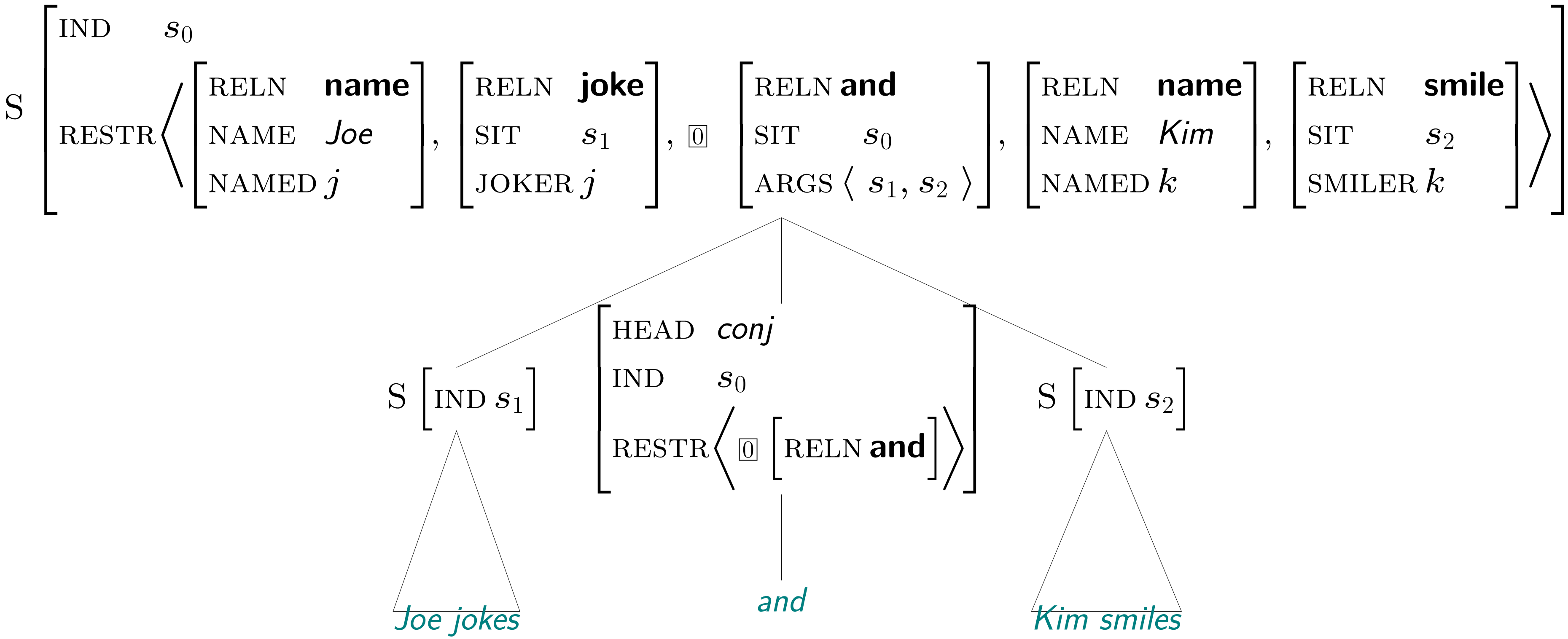
- Coordination Rule

$$\begin{bmatrix} \text{VAL} & \boxed{0} \\ \text{IND} & s_0 \end{bmatrix} \rightarrow \begin{bmatrix} \text{VAL} & \boxed{0} \\ \text{IND} & s_1 \end{bmatrix} \dots \begin{bmatrix} \text{VAL} & \boxed{0} \\ \text{IND} & s_{n-1} \end{bmatrix} \begin{bmatrix} \text{HEAD} & \textit{conj} \\ \text{IND} & s_0 \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{ARGS} & \langle s_1, \dots, s_{n-1}, s_n \rangle \end{bmatrix} \right\rangle \end{bmatrix} \begin{bmatrix} \text{VAL} & \boxed{0} \\ \text{IND} & s_n \end{bmatrix}$$

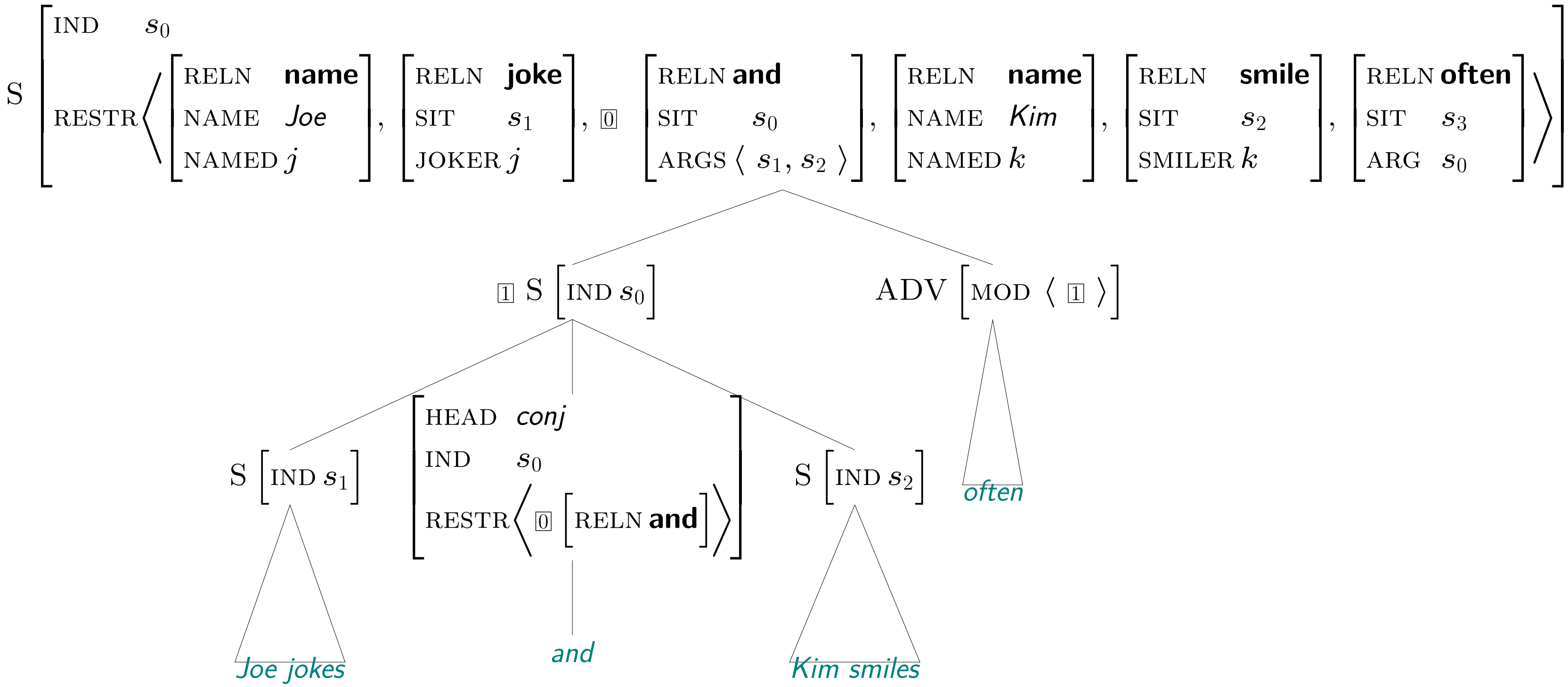
- Lexical Entry for ***and***

$$\left\langle \textit{and} \; , \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{HEAD} & \textit{conj} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{MODE} & \textit{none} \\ \text{IND} & s \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \textbf{and} \\ \text{SIT} & s \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

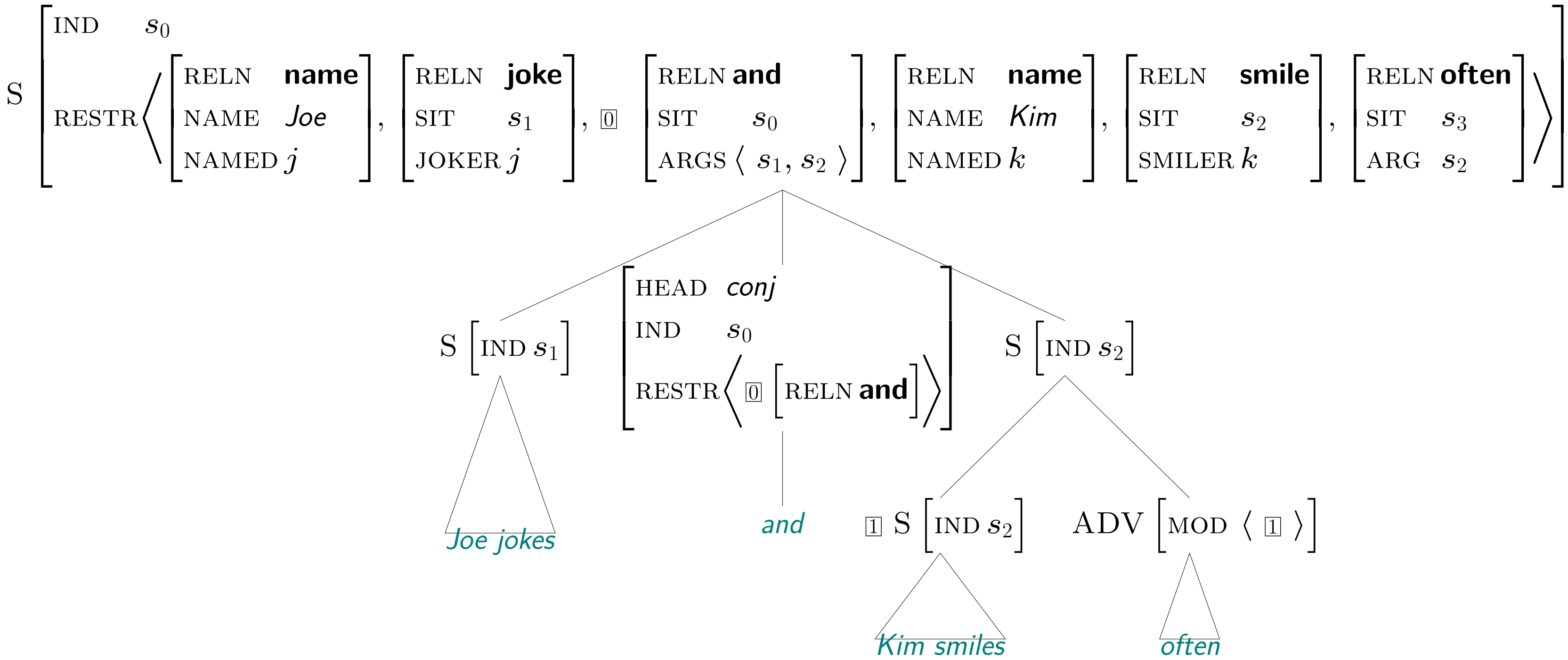
Combining Constraints and Coordination



Ambiguity


S
IND s_0
RESTR
RELN name
NAME Joe
NAMED j
RELN joke
SIT s_1
JOKER j
0
RELN and
SIT s_0
ARGS ⟨ s_1, s_2 ⟩
RELN name
NAME Kim
NAMED k
RELN smile
SIT s_2
SMILER k
RELN often
SIT s_3
ARG s_0
1 S
IND s_0
ADV
MOD ⟨ 1 ⟩
S
IND s_1
HEAD conj
IND s_0
RESTR ⟨ 0 RELN and ⟩
S
IND s_2
often
Joe jokes
and
Kim smiles

Ambiguity


S
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SIT s_1
JOKER j
0
RELN and
SIT s_0
ARGS ⟨ s_1, s_2 ⟩
RELN name
NAME Kim
NAMED k
RELN smile
SIT s_2
SMILER k
RELN often
SIT s_3
ARG s_2
S [IND s_1]
HEAD conj
IND s_0
RESTR ⟨ 0 [RELN and] ⟩
S [IND s_2]
Joe jokes
and
1 S [IND s_2]
ADV [MOD ⟨ 1 ⟩]
Kim smiles
often

Question About Structural Ambiguity

Why isn't this a possible semantic representation for the string *Joe jokes and Kim smiles often*?

$$
\left[\begin{array}{ll}
\text{IND} & s_0 \\
\text{MODE} & \textit{prop} \\
\text{RESTR} & \left\langle
\left[\begin{array}{ll}\text{RELN} & \textbf{name} \\ \text{NAME} & \textit{Joe} \\ \text{NAMED} & j\end{array}\right],
\left[\begin{array}{ll}\text{RELN} & \textbf{joke} \\ \text{SIT} & s_1 \\ \text{JOKER} & j\end{array}\right],
\boxed{0}\left[\begin{array}{ll}\text{RELN} & \textbf{and} \\ \text{SIT} & s_0 \\ \text{ARGS} & \langle\, s_1, s_2 \,\rangle\end{array}\right],
\left[\begin{array}{ll}\text{RELN} & \textbf{name} \\ \text{NAME} & \textit{Kim} \\ \text{NAMED} & k\end{array}\right],
\left[\begin{array}{ll}\text{RELN} & \textbf{smile} \\ \text{SIT} & s_2 \\ \text{SMILER} & k\end{array}\right],
\left[\begin{array}{ll}\text{RELN} & \textbf{often} \\ \text{SIT} & s_3 \\ \text{ARG} & s_1\end{array}\right]
\right\rangle
\end{array}\right]
$$

Some Standard Extensions

- Quantification
  - typically expressed as restrictions on scope
  - Minimal Recursion Semantics goes further
- Pragmatics
  - typically expressed as another feature: CONTEXT
  - contains things like *speaker*, *hearer*, *audience*
  - used for pronominal reference, politeness

Problem: Two Kinds of Modifiers in English

In English, modifiers of nouns can appear either before or after the noun, although any given modifier is usually restricted to one position or the other.

(i) *The red dog on the roof*

(ii) **The on the roof dog*

(iii) **The dog red*

Our current Head-Modifier Rule only licenses post-head modifiers (like *on the roof* in (i)).

A. Write a second Head-Modifier Rule that licenses pre-head modifiers (e.g., *red* in (i)).

B. Modify the Head-Modifier 1 and Head-Modifier 2 Rules so that they are sensitive to which kind of modifier is present and don't generate (ii) or (iii). [*Hint: Use a feature* [*POST-HEAD* $\{+,-\}$] *to distinguish red and on the roof.*]

C. Is POST-HEAD a HEAD feature? Why or why not?

D. Give lexical entries for *red* and *on* that show the value of POST-HEAD. (You may omit the SEM features in these entries.)

E. Is (i) ambiguous according to your grammar (i.e. the Chapter 5 grammar modified to include the two Head-Modifier Rules, instead of just one)? Explain your answer.

This problem assumed that we don't want to make the two Head-Modifier Rules sensitive to the part of speech of the modifier. One reason for this is that modifiers of the same part of speech can occur before and after the head, even though individual modifiers might be restricted to one position or the other.

F. Provide three examples of English NPs with adjectives or APs after the noun.

G. Provide three examples of adverbs that can come before the verbs they modify.

H. Provide three examples of adverbs that can come after the verbs they modify.

Problem: Semantics of Number Names

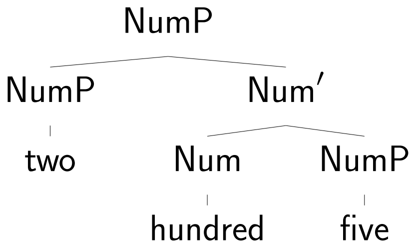
In Chapter 3, we considered the syntax of English number names, and in particular how to find the head of a number name expression. Based on the results of that problem, the lexical entry for *hundred* in a number name like *two hundred five* should include the constraints in (i): (Here we are assuming a new subtype of *pos*, *number*, which is appropriate for number name words.)

(i)

$$\left\langle \textit{hundred}\ ,\ \begin{bmatrix} \textit{SYN} \begin{bmatrix} \textit{HEAD} & \textit{number} \\ \textit{VAL} & \begin{bmatrix} \textit{SPR} & \langle \begin{bmatrix} \textit{HEAD} & \textit{number} \end{bmatrix} \rangle \\ \textit{COMPS} & \langle \begin{bmatrix} \textit{HEAD} & \textit{number} \end{bmatrix} \rangle \end{bmatrix} \end{bmatrix} \end{bmatrix} \right\rangle$$

This lexical entry interacts with our ordinary Head-Complement and Head-Specifier Rules to give us the phrase structure shown in (ii):

(ii)



Smith (1999) provides a compositional semantics of number names. The semantics of this NP should be (iii):

(iii)

$$\begin{bmatrix} \textit{INDEX} & i \\ \textit{MODE} & \textit{ref} \\ \textit{RESTR} & \left\langle \begin{bmatrix} \textit{RELN} & \textbf{constant} \\ \textit{INST} & l \\ \textit{VALUE} & \textit{2} \end{bmatrix}, \begin{bmatrix} \textit{RELN} & \textbf{times} \\ \textit{RESULT} & k \\ \textit{FACTOR1} & l \\ \textit{FACTOR2} & m \end{bmatrix}, \begin{bmatrix} \textit{RELN} & \textbf{constant} \\ \textit{INST} & m \\ \textit{VALUE} & \textit{100} \end{bmatrix}, \begin{bmatrix} \textit{RELN} & \textbf{plus} \\ \textit{RESULT} & i \\ \textit{TERM1} & j \\ \textit{TERM2} & k \end{bmatrix}, \begin{bmatrix} \textit{RELN} & \textbf{constant} \\ \textit{INST} & j \\ \textit{VALUE} & \textit{5} \end{bmatrix} \right\rangle \end{bmatrix}$$

This expresses "(two times one hundred) plus five" (i.e. 205) as a FS.

A. Assume that the two constant predications with the values 2 and 5 are contributed by the lexical entries for *two* and *five*. What predications must be on the RESTR list of the lexical entry for *hundred* in order to build (iii) as the SEM value of *two hundred five*?

B. The lexical entry for *hundred* will identify the indices of its specifier and complement with the value of some feature of a predication on its RESTR list. Which feature of which predication is the index of the specifier identified with? What about the index of the complement?

C. The lexical entry for *hundred* will identify its own INDEX with the value of some feature of some predication on its RESTR list. Which feature of which predication must this be, in order for the grammar to build (iii) as the SEM value of *two hundred five*?

D. Based on your answers in parts (A)–(C), give a lexical entry for *hundred* that includes the constraints in (i) and a fully specified SEM value. [*Note: Your lexical entry need only account for hundred as it is used in two hundred five. Don't worry about other valence possibilities, such as two hundred, two hundred and five, or a hundred.*]

E. The syntax and semantics of number names do not line up neatly: In the syntax, *hundred* forms a constituent with *five*, and *two* combines with *hundred five* to give a larger constituent. In the semantics, the constant predications with the values 2 and 100 are related via the times predication. The result of that is related to the constant predication with the value 5, via the plus predication Why is this mismatch not a problem for the grammar?

Overview

- Some notes on the linguist's stance
- Which aspects of semantics we'll tackle
- Our formalization; Semantics Principles
- Building semantics of phrases
- Modification, coordination
- Structural ambiguity

Acknowledgments and References

- Course design and slides borrow heavily from Emily Bender's course: *Linguistics 566: Introduction to Syntax for Computational Linguistics*
  `http://courses.washington.edu/ling566`