Ling 566
Oct 14, 2009

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.

Examples?

- 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

- Pragmatics
- Fine-grained lexical semantics:

The meaning of *life* is *life'*, or, in our case,

$$\begin{bmatrix} \text{RELN} & \text{life} \\ \text{INST} & i \end{bmatrix}$$

Our Slice of a World of Meanings

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

"... 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." (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

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

$$
\begin{bmatrix}
\text{SYN} & \begin{bmatrix} \text{HEAD} & \textit{pos} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \textit{list}(\textit{expression}) \\ \text{COMPS} & \textit{list}(\textit{expression}) \end{bmatrix} \end{bmatrix} \\
\text{SEM} & \begin{bmatrix} \text{MODE} & \{\, \text{prop} , \text{ques} , \text{dir} , \text{ref}, \text{none} \,\} \\ \text{INDEX} & \{\, i , j , k , \ldots s_1 , s_2 , \ldots \,\} \\ \text{RESTR} & \textit{list}(\textit{pred}) \end{bmatrix}
\end{bmatrix}
$$

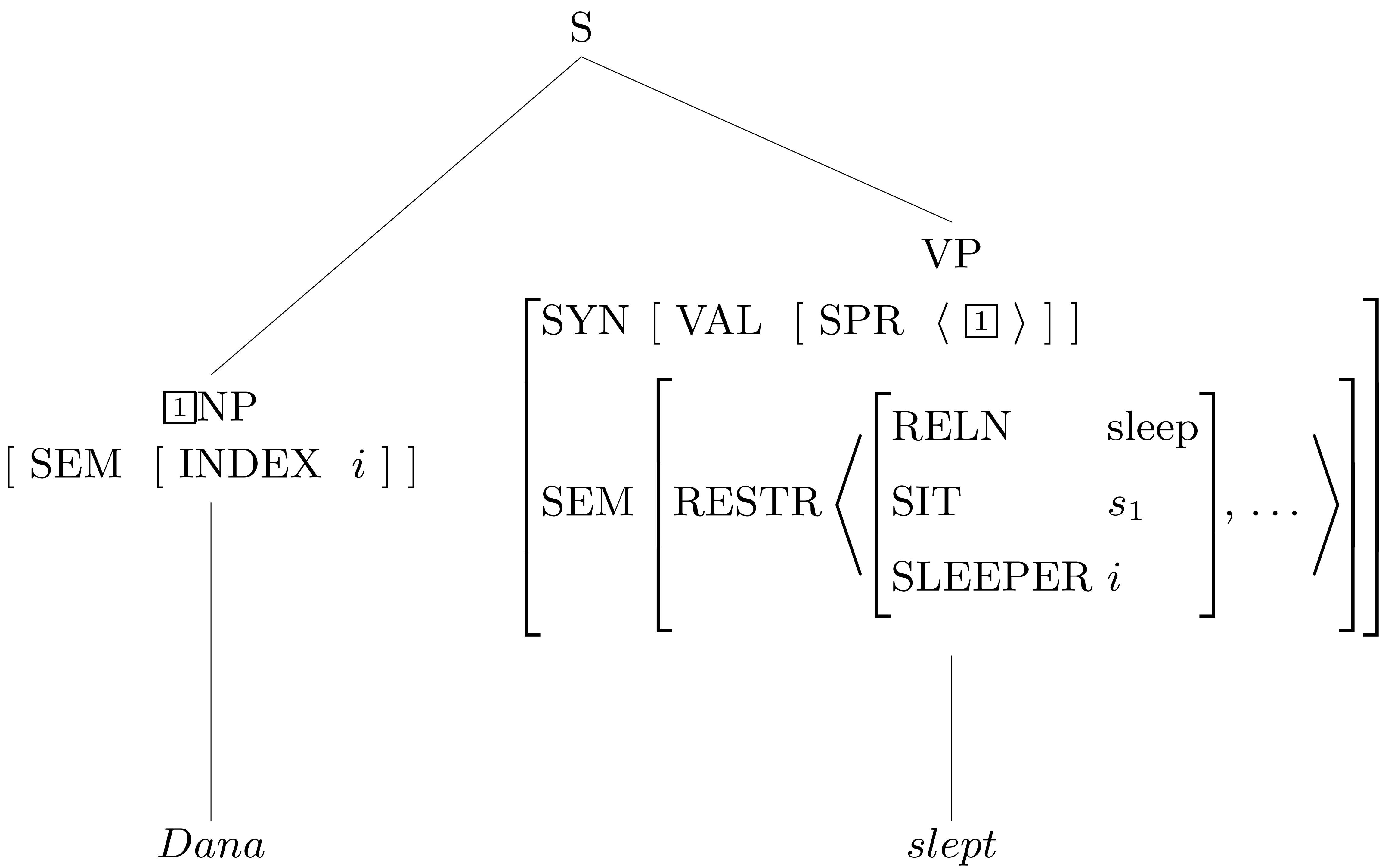
How the Pieces Fit Together

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

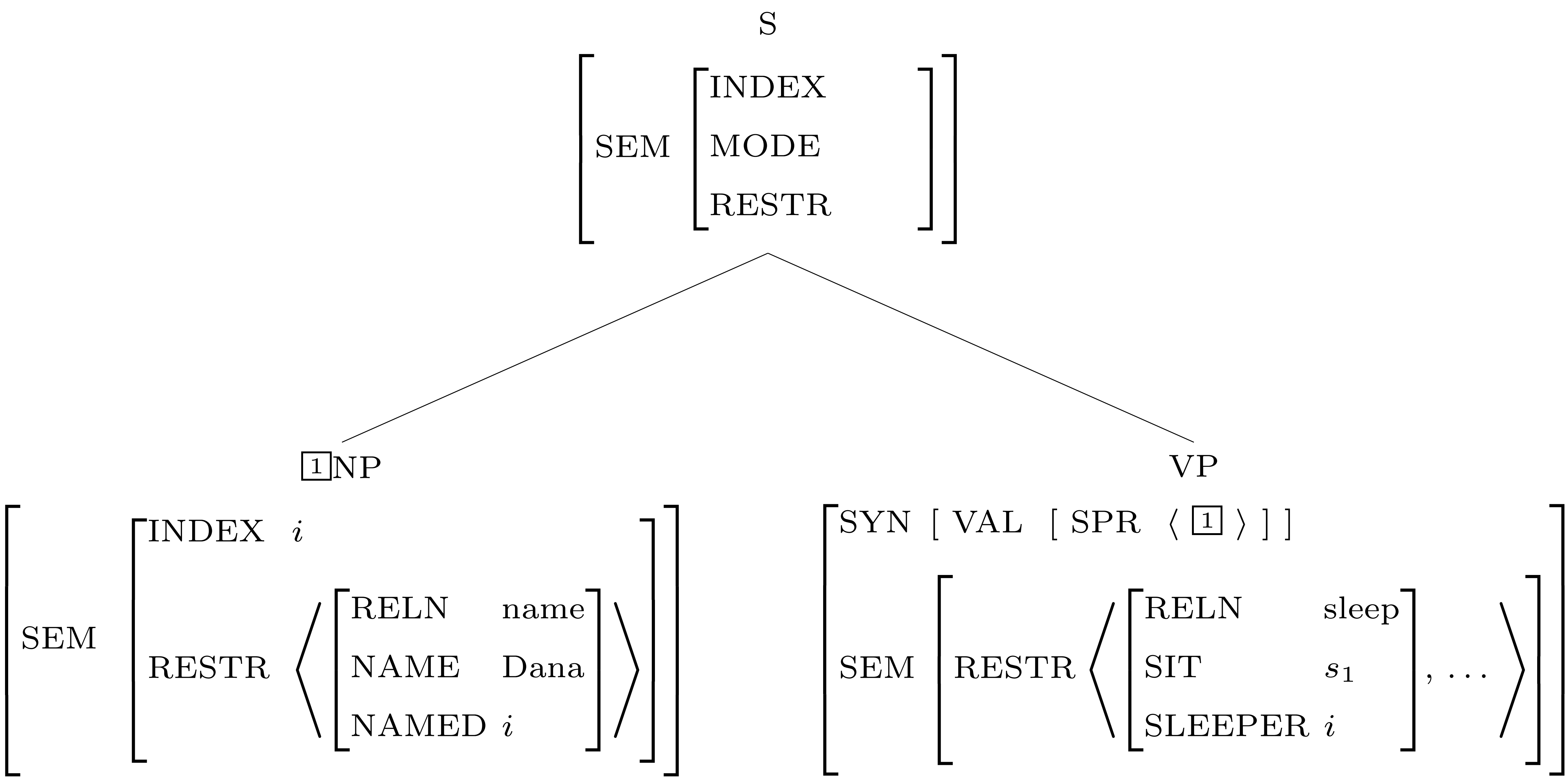
How the Pieces Fit Together

$$\left\langle \text{slept}, \begin{bmatrix} \textit{word} & \\ \text{SYN} & \begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle \text{NP}_j \rangle \\ \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{INDEX} & s_1 \\ \text{MODE} & \text{prop} \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \text{sleep} \\ \text{SIT} & s_1 \\ \text{SLEEPER} & j \end{bmatrix}, \ldots \right\rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

The Pieces Together



A More Detailed View of the Same Tree



To Fill in Semantics for the S-node

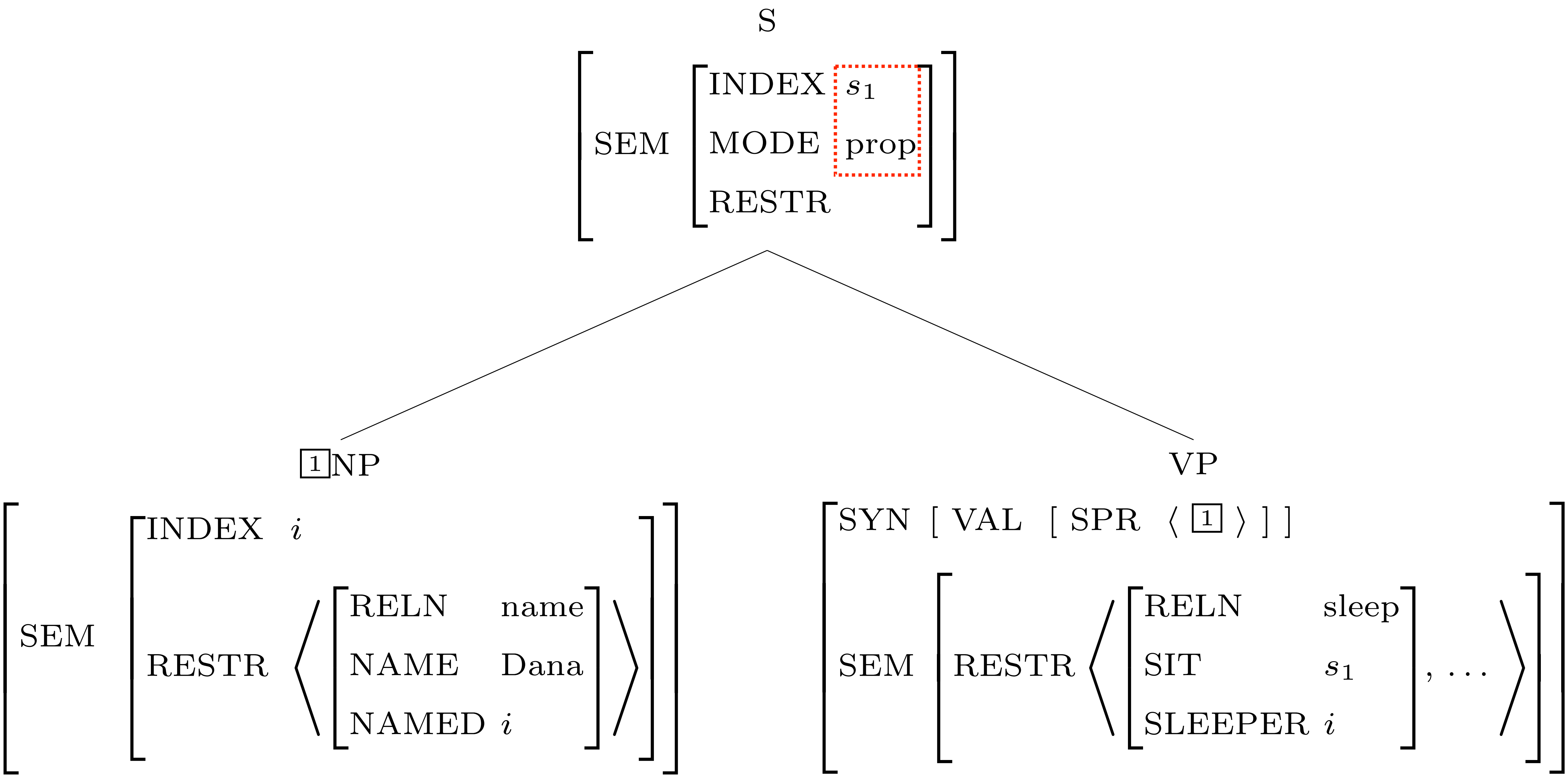
We need the Semantics Principles

- 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:

Semantic Inheritance Illustrated



To Fill in Semantics for the S-node

We need the Semantics Principles

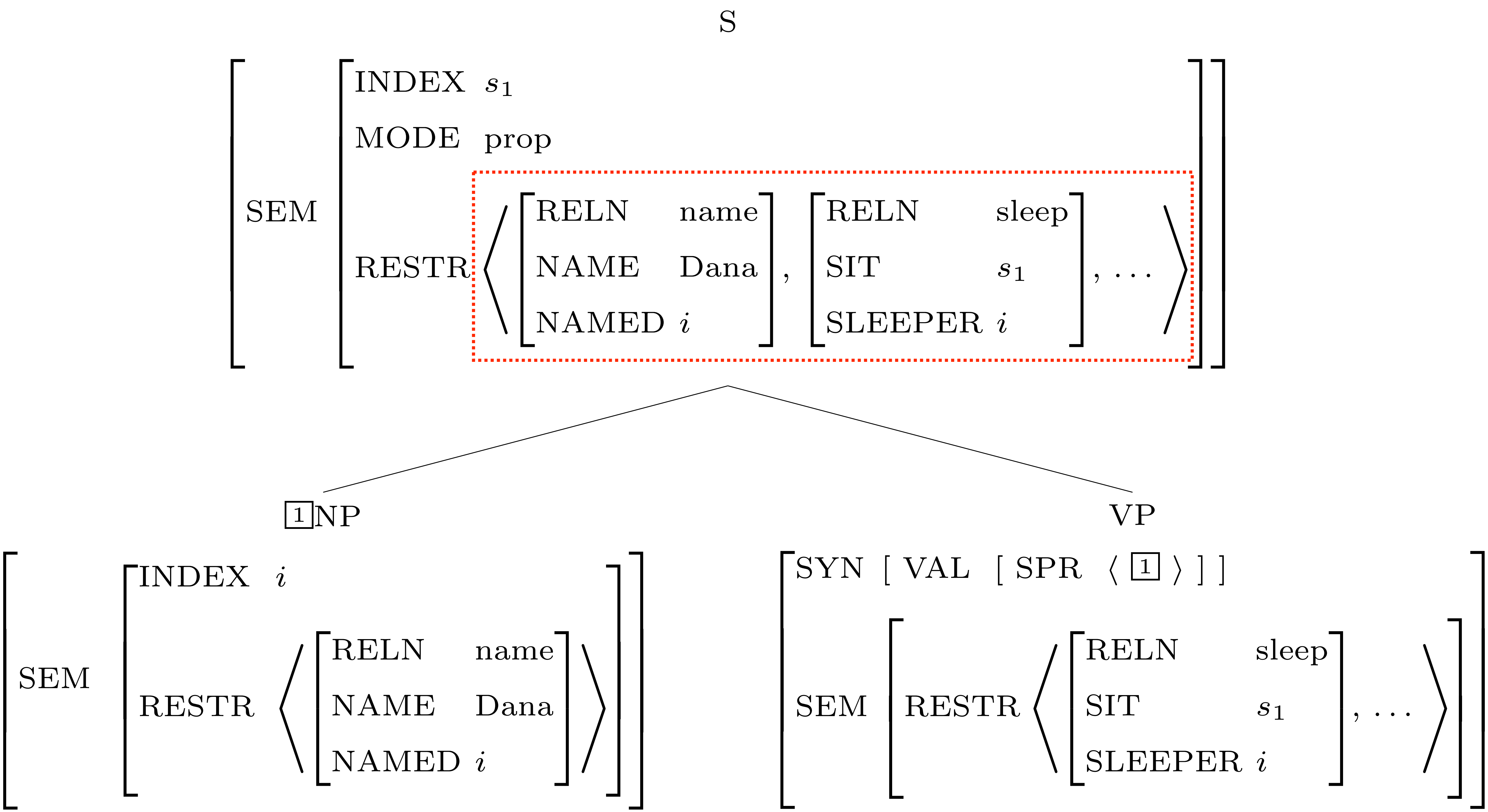
- The Semantic Inheritance Principle:

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

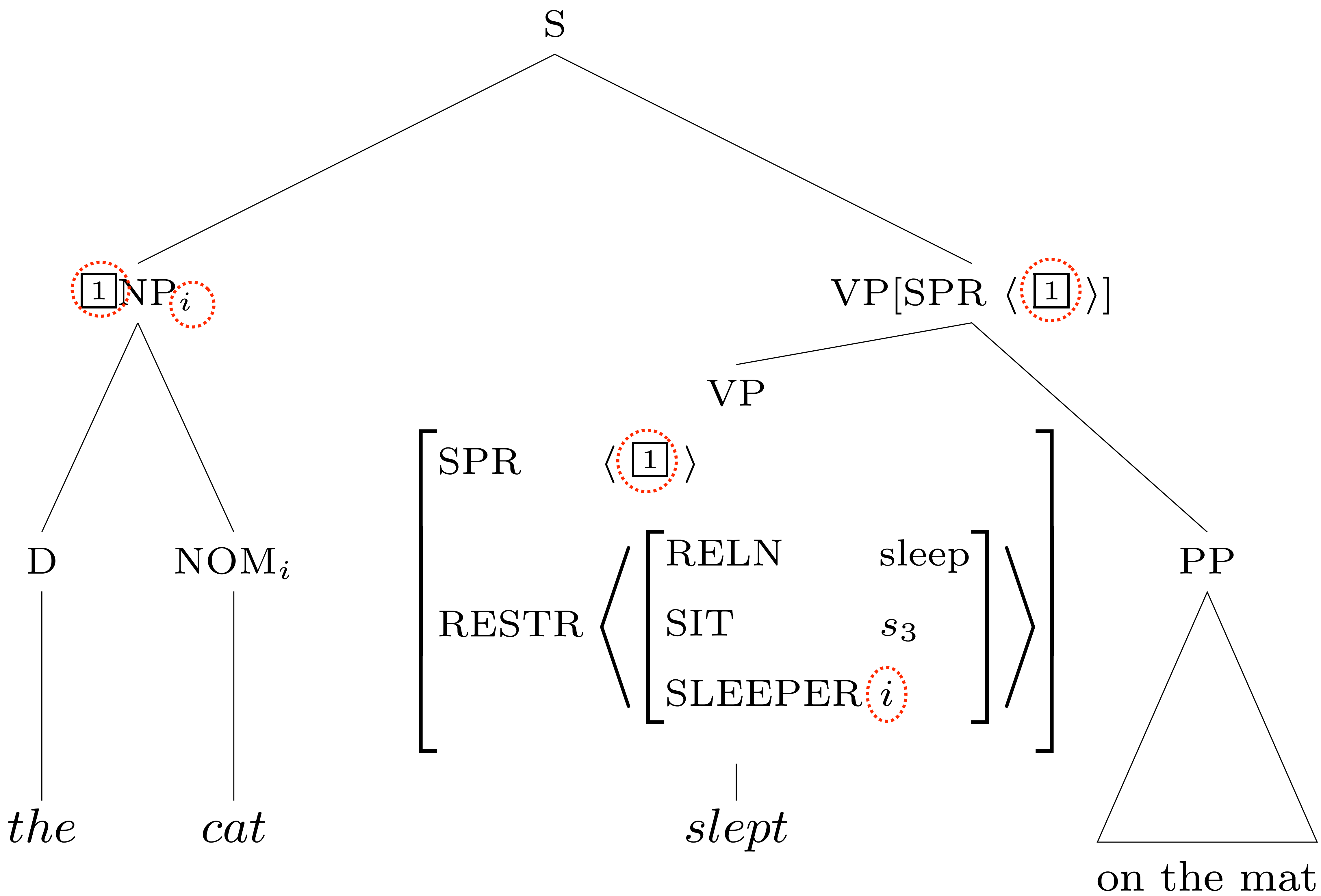
- The Semantic Compositionality Principle:

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

Semantic Compositionality Illustrated



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

$$\left\langle \text{slept}, \begin{bmatrix} \textit{word} & \\ \text{SYN} & \begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle \text{NP}_j \rangle \\ \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{INDEX} & s_1 \\ \text{MODE} & \text{prop} \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \text{sleep} \\ \text{SIT} & s_1 \\ \text{SLEEPER} & j \end{bmatrix}, \ldots \right\rangle \end{bmatrix} \end{bmatrix} \right\rangle$$

Summary: Grammar Rules ...

- identify feature structures (including the INDEX value) across daughters

Head Specifier Rule

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

Head Complement Rule

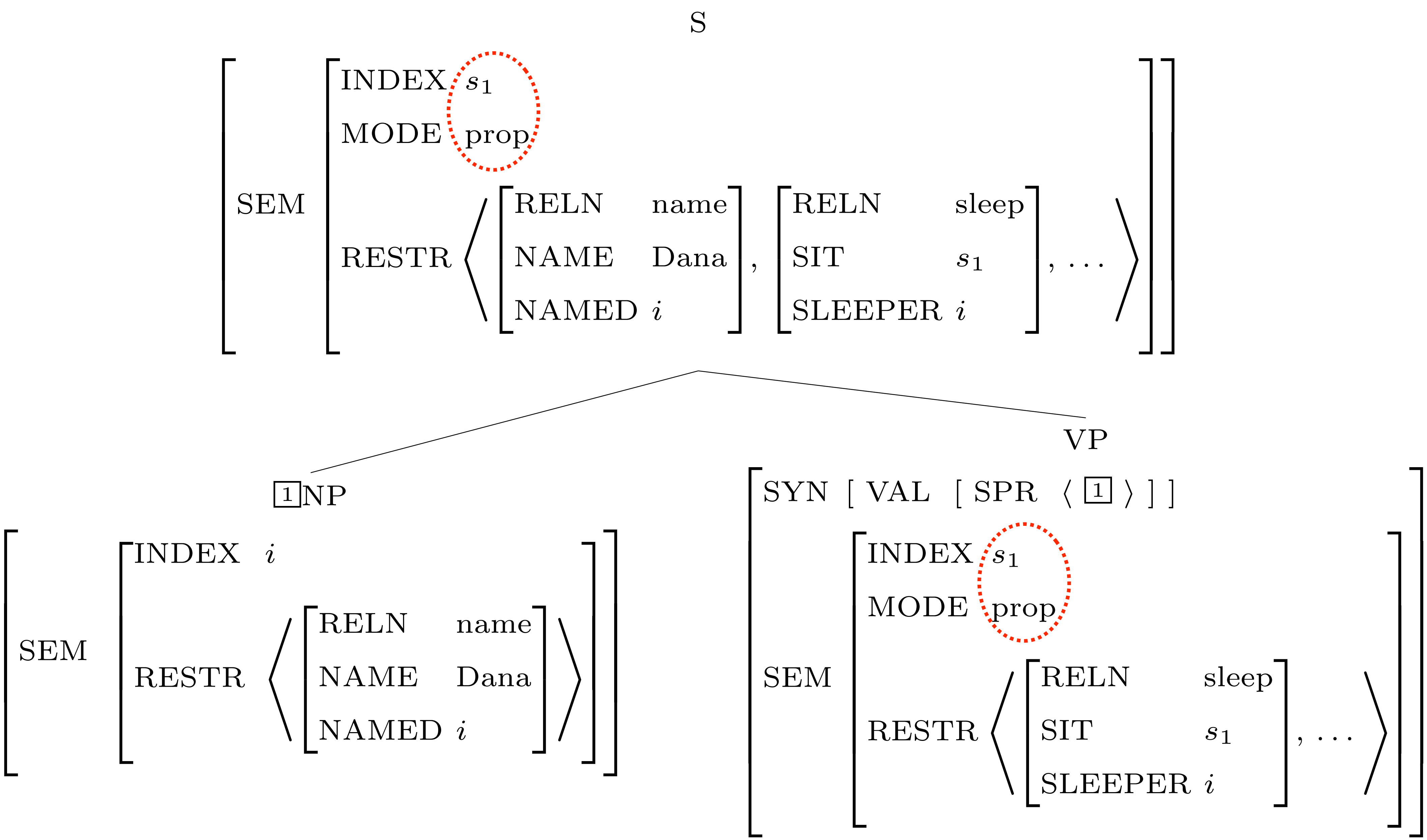
$$\begin{bmatrix} \textit{phrase} \\ \text{SYN} \begin{bmatrix}\text{VAL} \begin{bmatrix}\text{COMPS} & \langle\ \rangle\end{bmatrix}\end{bmatrix}\end{bmatrix} \rightarrow \mathbf{H}\begin{bmatrix} \textit{word} \\ \text{SYN} \begin{bmatrix}\text{VAL} \begin{bmatrix}\text{COMPS} & \langle \boxed{1}, \ldots, \boxed{n} \rangle\end{bmatrix}\end{bmatrix}\end{bmatrix} \quad \boxed{1} \ldots \boxed{n}$$

Head Modifier Rule

$$[\textit{phrase}] \rightarrow \mathbf{H}\ \boxed{1}\begin{bmatrix}\text{SYN}\begin{bmatrix}\text{COMPS} & \langle\ \rangle\end{bmatrix}\end{bmatrix} \quad \begin{bmatrix}\text{SYN}\begin{bmatrix}\text{VAL}\begin{bmatrix}\text{COMPS} & \langle\ \rangle \\ \text{MOD} & \langle \boxed{1} \rangle\end{bmatrix}\end{bmatrix}\end{bmatrix}$$

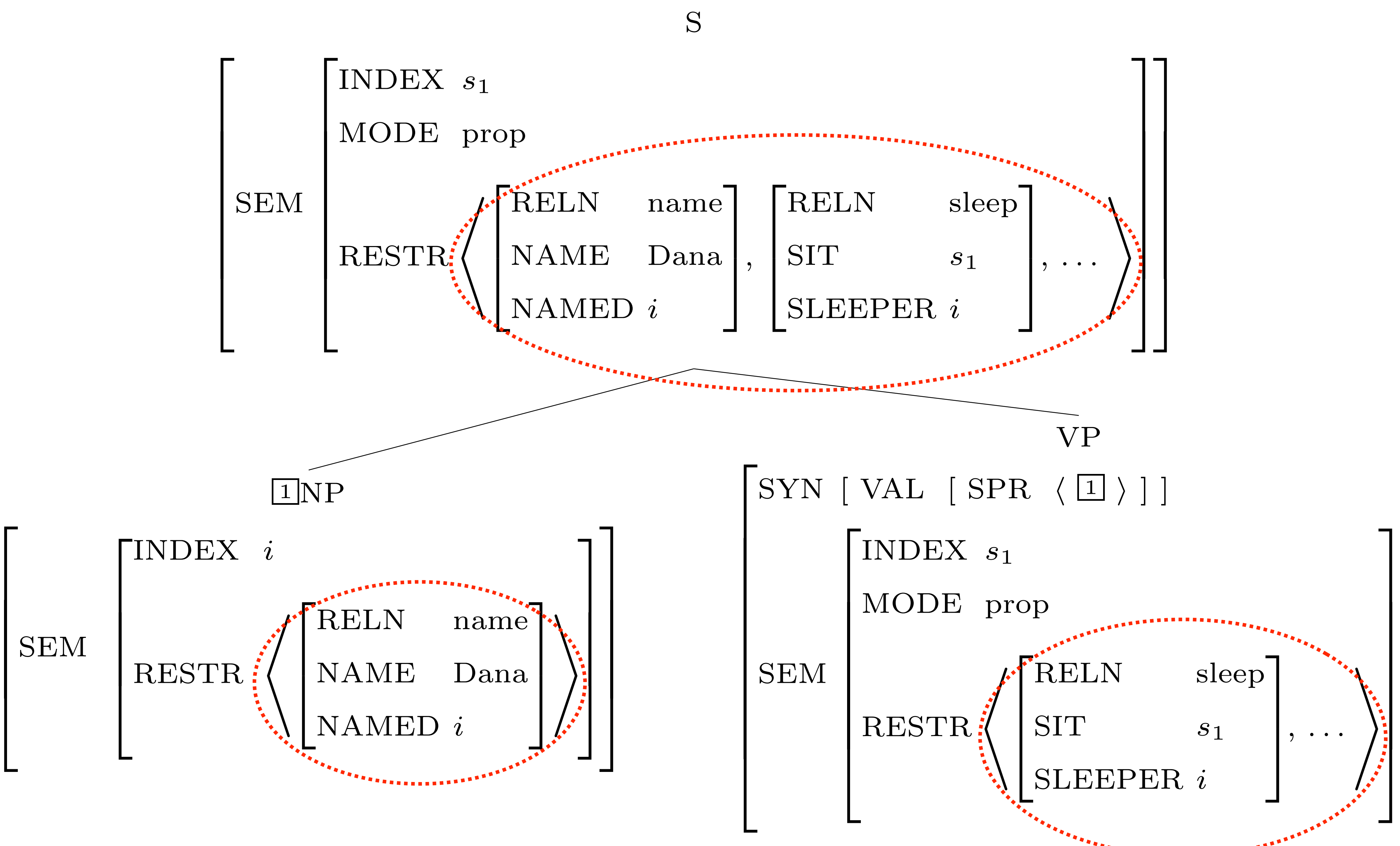
Summary: Grammar Rules ...

- 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



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



Other Aspects of Semantics

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

Evolution of a Phrase Structure Rule

Ch. 2: NOM --> NOM PP

VP --> VP PP

Ch. 3: $\begin{bmatrix} \textit{phrase} & \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \text{itr} \\ \text{SPR} & - \end{bmatrix} \end{bmatrix} \rightarrow \mathbf{H}\begin{bmatrix} \textit{phrase} & \\ \text{VAL} & \begin{bmatrix} \text{SPR} & - \end{bmatrix} \end{bmatrix} \text{PP}$

Ch. 4: $[\textit{phrase}] \rightarrow \mathbf{H}\begin{bmatrix} \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \text{PP}$

Ch. 5: $[\textit{phrase}] \rightarrow \mathbf{H}\boxed{1}\begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\ \rangle \end{bmatrix} \end{bmatrix} \end{bmatrix} \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle\ \rangle \\ \text{MOD} & \langle \boxed{1} \rangle \end{bmatrix} \end{bmatrix} \end{bmatrix}$

Ch. 5 (abbreviated): $[\textit{phrase}] \rightarrow \mathbf{H}\boxed{1}\begin{bmatrix} \text{COMPS} & \langle\ \rangle \end{bmatrix} \begin{bmatrix} \text{COMPS} & \langle\ \rangle \\ \text{MOD} & \langle \boxed{1} \rangle \end{bmatrix}$

Evolution of Another Phrase Structure Rule

Ch. 2: X --> X$^+$ CONJ X

Ch. 3: $\boxed{1} \rightarrow \boxed{1}^+ \begin{bmatrix} \textit{word} \\ \text{HEAD} \quad \textit{conj} \end{bmatrix} \boxed{1}$

Ch. 4: $\begin{bmatrix} \text{VAL} \ \boxed{1} \end{bmatrix} \rightarrow \begin{bmatrix} \text{VAL} \ \boxed{1} \end{bmatrix}^+ \begin{bmatrix} \textit{word} \\ \text{HEAD} \quad \textit{conj} \end{bmatrix} \begin{bmatrix} \text{VAL} \ \boxed{1} \end{bmatrix}$

Ch. 5: $\begin{bmatrix} \text{SYN} & [\text{VAL} \ \boxed{0}] \\ \text{SEM} & [\text{IND} \ s_0] \end{bmatrix} \rightarrow$

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

Ch. 5 (abbreviated):

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

Combining Constraints and Coordination

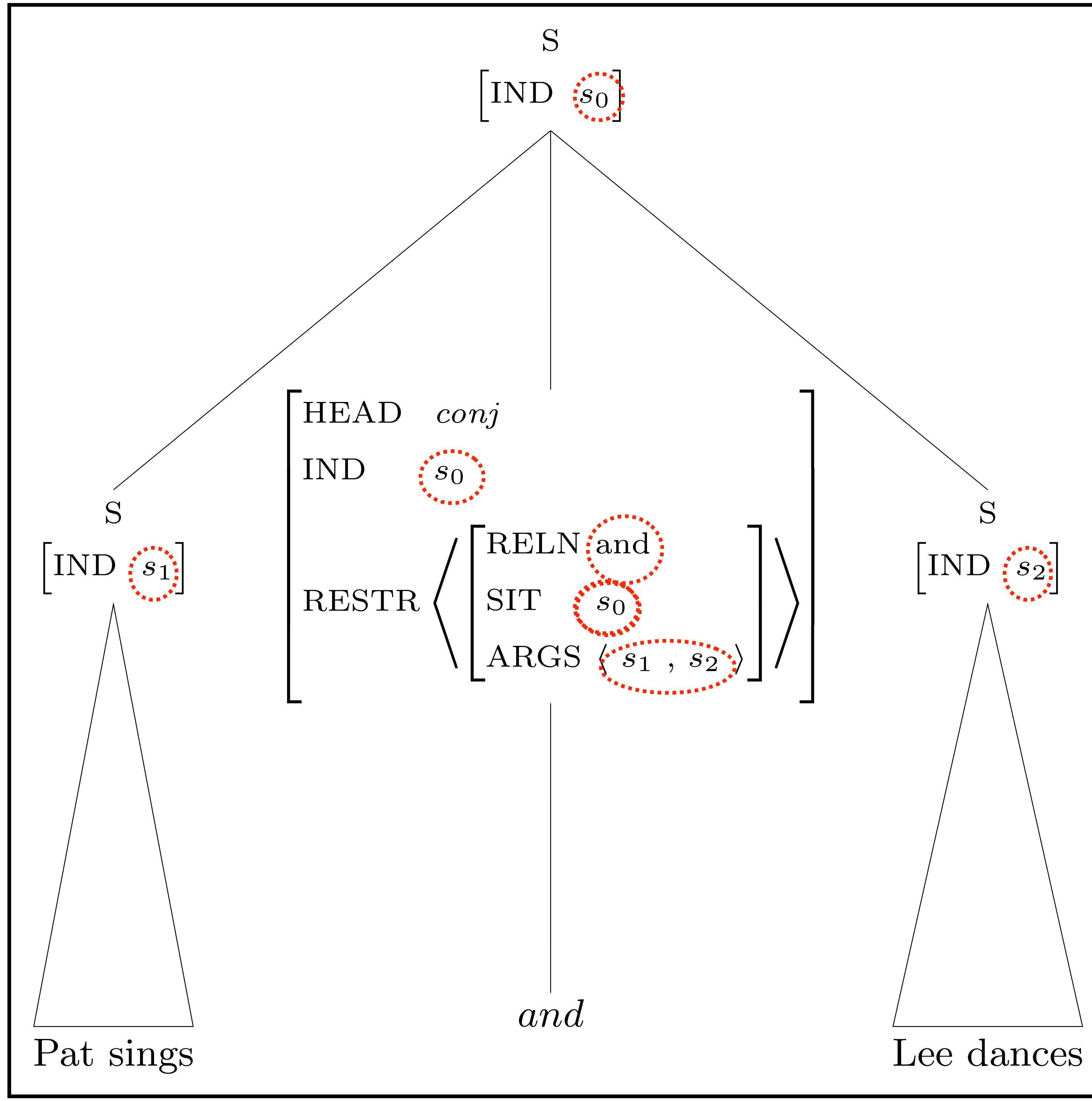
Coordination Rule

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

Lexical Entry for a Conjunction

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

Combining Constraints and Coordination



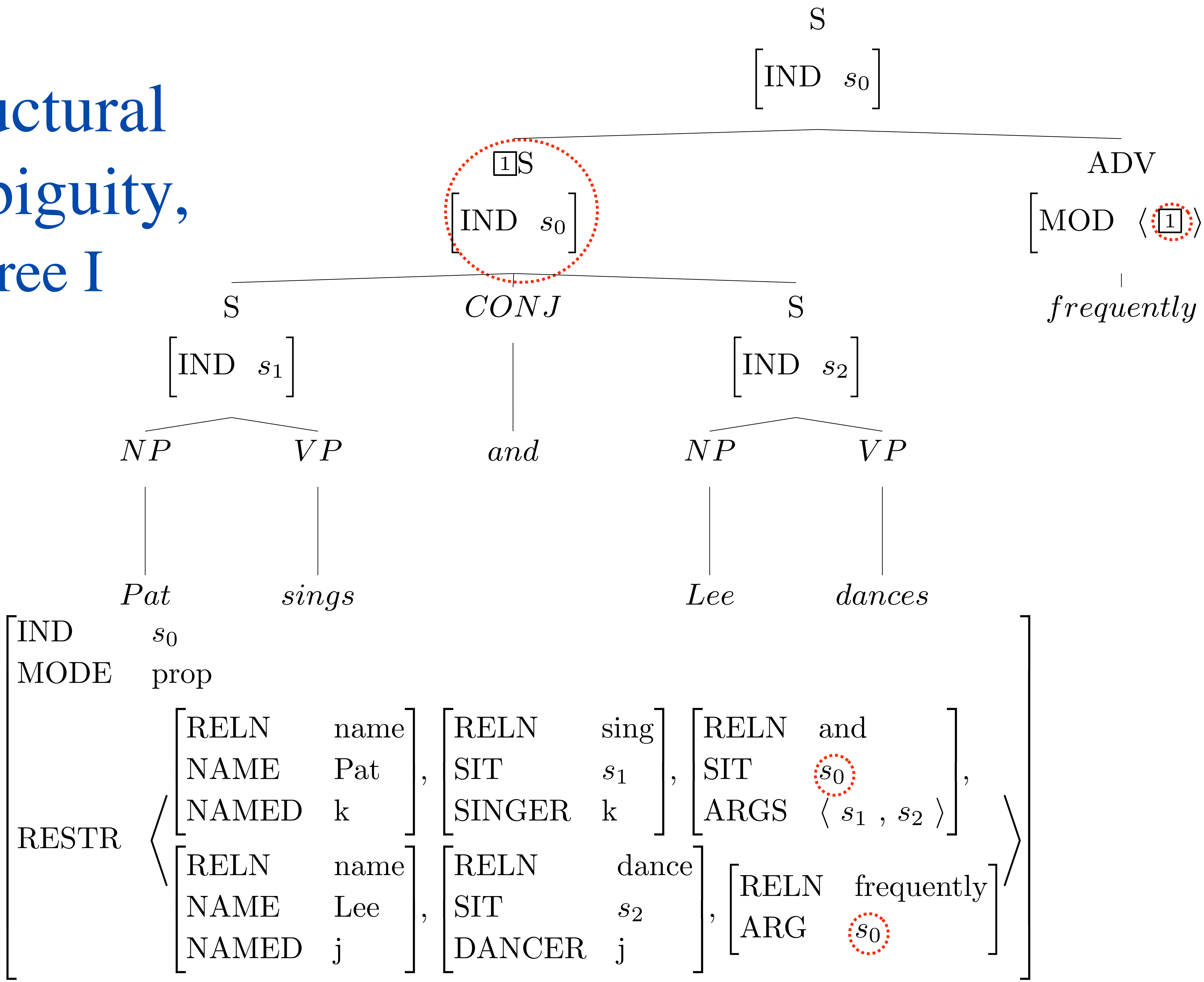
Lexical Entry for *and*

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

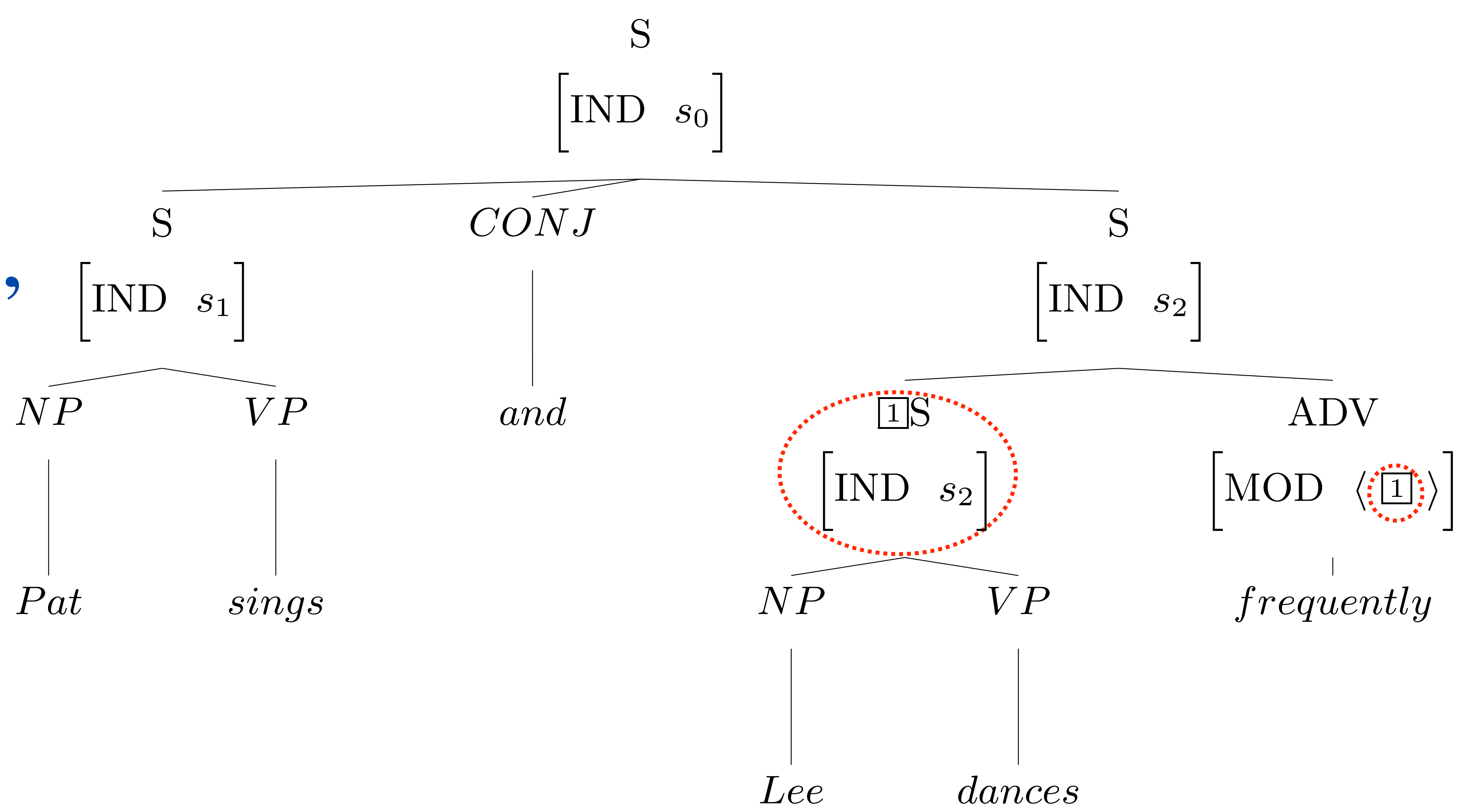
Coordination Rule

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

Structural Ambiguity, Tree I



Structural Ambiguity, Tree II



$$\begin{bmatrix} \text{IND} & s_0 \\ \text{MODE} & \text{prop} \\ \text{RESTR} & \left\langle \begin{matrix} \begin{bmatrix} \text{RELN} & \text{name} \\ \text{NAME} & \text{Pat} \\ \text{NAMED} & \text{k} \end{bmatrix}, \begin{bmatrix} \text{RELN} & \text{sing} \\ \text{SIT} & s_1 \\ \text{SINGER} & \text{k} \end{bmatrix}, \begin{bmatrix} \text{RELN} & \text{and} \\ \text{SIT} & s_0 \\ \text{ARGS} & \langle\, s_1 \,,\, s_2 \,\rangle \end{bmatrix}, \\ \begin{bmatrix} \text{RELN} & \text{name} \\ \text{NAME} & \text{Lee} \\ \text{NAMED} & \text{j} \end{bmatrix}, \begin{bmatrix} \text{RELN} & \text{dance} \\ \text{SIT} & s_2 \\ \text{DANCER} & \text{j} \end{bmatrix}, \begin{bmatrix} \text{RELN} & \text{frequently} \\ \text{ARG} & s_2 \end{bmatrix} \end{matrix} \right\rangle \end{bmatrix}$$

Question About Structural Ambiguity

Why isn't this a possible semantic representation for the string *Pat sings and Lee dances frequently*?

$$\begin{bmatrix} \text{IND} & s_0 \\ \text{MODE} & \text{prop} \\ \text{RESTR} & \left\langle \begin{array}{l} \begin{bmatrix} \text{RELN} & \text{name} \\ \text{NAME} & \text{Pat} \\ \text{NAMED} & \text{k} \end{bmatrix}, \begin{bmatrix} \text{RELN} & \text{sing} \\ \text{SIT} & s_1 \\ \text{SINGER} & \text{k} \end{bmatrix}, \begin{bmatrix} \text{RELN} & \text{and} \\ \text{SIT} & s_0 \\ \text{ARGS} & \langle\, s_1 \,,\, s_2 \,\rangle \end{bmatrix}, \\ \begin{bmatrix} \text{RELN} & \text{name} \\ \text{NAME} & \text{Lee} \\ \text{NAMED} & \text{j} \end{bmatrix}, \begin{bmatrix} \text{RELN} & \text{dance} \\ \text{SIT} & s_2 \\ \text{DANCER} & \text{j} \end{bmatrix}, \begin{bmatrix} \text{RELN} & \text{frequently} \\ \text{ARG} & s_1 \end{bmatrix} \end{array} \right\rangle \end{bmatrix}$$

Semantic Compositionality

$$
\begin{bmatrix}
\text{IND} & s_0 \\
\text{MODE} & \text{prop} \\
\text{RESTR} & \left\langle
\begin{matrix}
\begin{bmatrix} \text{RELN} & \text{name} \\ \text{NAME} & \text{Pat} \\ \text{NAMED} & \text{k} \end{bmatrix},
\begin{bmatrix} \text{RELN} & \text{sing} \\ \text{SIT} & s_1 \\ \text{SINGER} & \text{k} \end{bmatrix},
\begin{bmatrix} \text{RELN} & \text{and} \\ \text{SIT} & s_0 \\ \text{ARGS} & \langle\, s_1 \,,\, s_2 \,\rangle \end{bmatrix}, \\
\begin{bmatrix} \text{RELN} & \text{name} \\ \text{NAME} & \text{Lee} \\ \text{NAMED} & \text{j} \end{bmatrix},
\begin{bmatrix} \text{RELN} & \text{dance} \\ \text{SIT} & s_2 \\ \text{DANCER} & \text{j} \end{bmatrix},
\begin{bmatrix} \text{RELN} & \text{frequently} \\ \text{ARG} & s_0 \end{bmatrix}
\end{matrix}
\right\rangle
\end{bmatrix}
$$

$$
\begin{bmatrix}
\text{IND} & s_0 \\
\text{MODE} & \text{prop} \\
\text{RESTR} & \left\langle
\begin{matrix}
\begin{bmatrix} \text{RELN} & \text{name} \\ \text{NAME} & \text{Pat} \\ \text{NAMED} & \text{k} \end{bmatrix},
\begin{bmatrix} \text{RELN} & \text{sing} \\ \text{SIT} & s_1 \\ \text{SINGER} & \text{k} \end{bmatrix},
\begin{bmatrix} \text{RELN} & \text{and} \\ \text{SIT} & s_0 \\ \text{ARGS} & \langle\, s_1 \,,\, s_2 \,\rangle \end{bmatrix}, \\
\begin{bmatrix} \text{RELN} & \text{name} \\ \text{NAME} & \text{Lee} \\ \text{NAMED} & \text{j} \end{bmatrix},
\begin{bmatrix} \text{RELN} & \text{dance} \\ \text{SIT} & s_2 \\ \text{DANCER} & \text{j} \end{bmatrix},
\begin{bmatrix} \text{RELN} & \text{frequently} \\ \text{ARG} & s_2 \end{bmatrix}
\end{matrix}
\right\rangle
\end{bmatrix}
$$

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
- Next time: How the grammar works