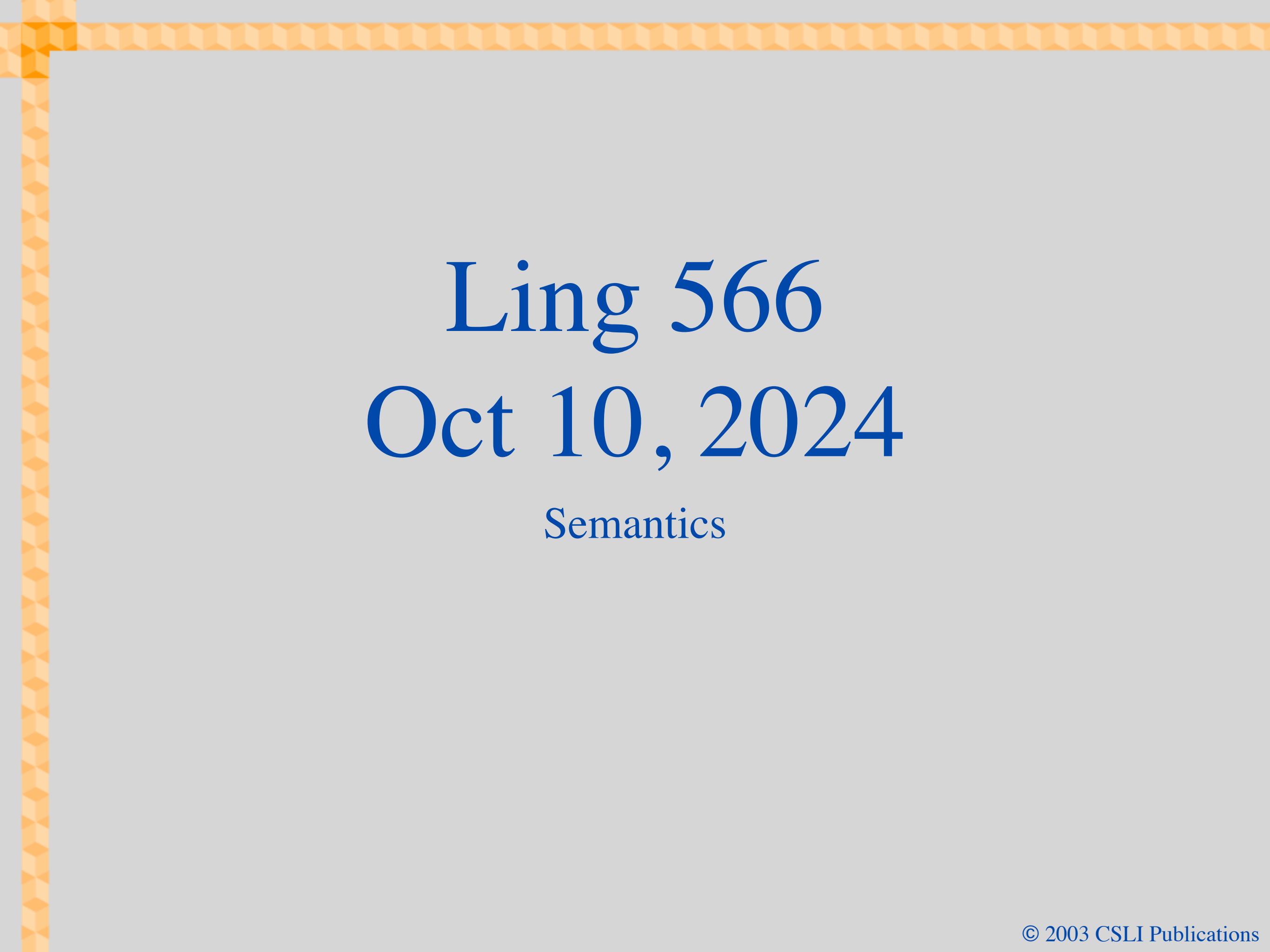


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Ling 566

Oct 10, 2024

Semantics

Announcements

- Midterm survey — see Canvas announcement
- HW1 answer key is up; apologies for the delay

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
- Reading questions

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 +]>]*.”

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

"Where's the Beef"?



Completely unfamiliar

0

That's a thing people say

0

I remember those commercials

0

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

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

“... 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

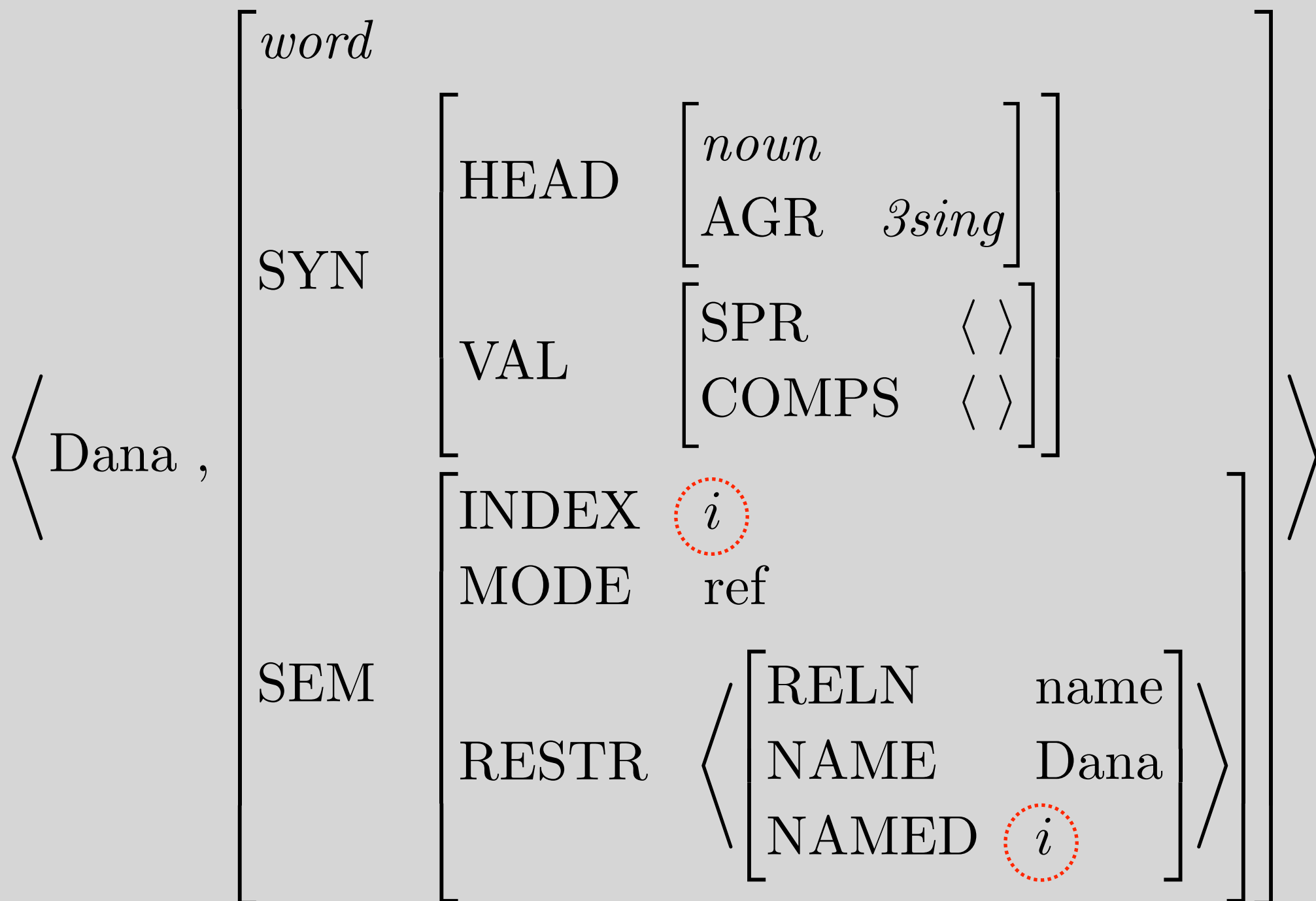
Semantics in Constraint-Based Grammar

- 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.

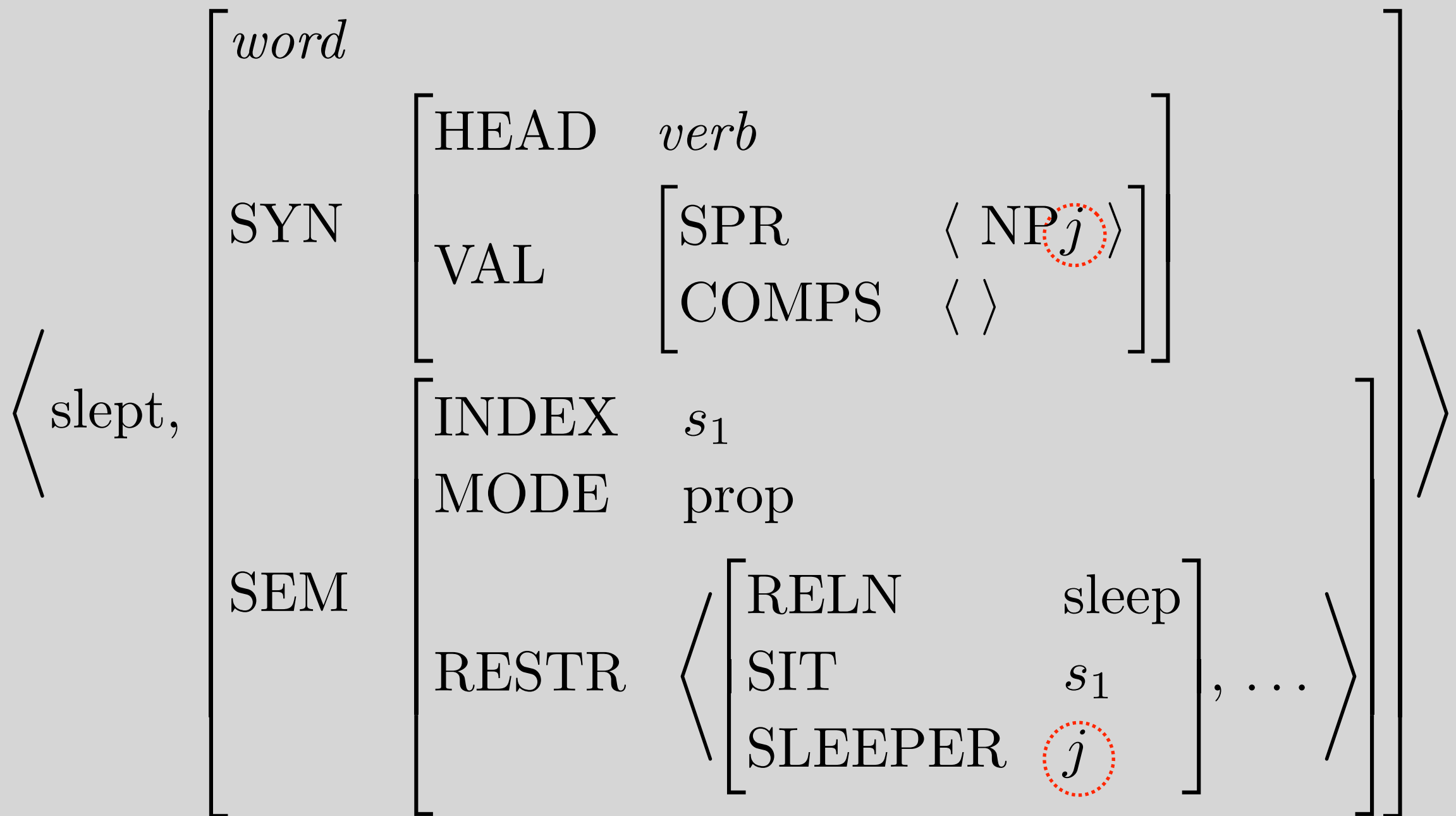
Feature Geometry

SYN	HEAD	pos				
	VAL	<table> <tr> <td>SPR</td> <td>$list(expression)$</td> </tr> <tr> <td>COMPS</td> <td>$list(expression)$</td> </tr> </table>	SPR	$list(expression)$	COMPS	$list(expression)$
	SPR	$list(expression)$				
COMPS	$list(expression)$					
SEM	MODE	$\{ prop , ques , dir , ref , none \}$				
	INDEX	$\{ i , j , k , \dots s_1 , s_2 , \dots \}$				
	RESTR	$list(pred)$				

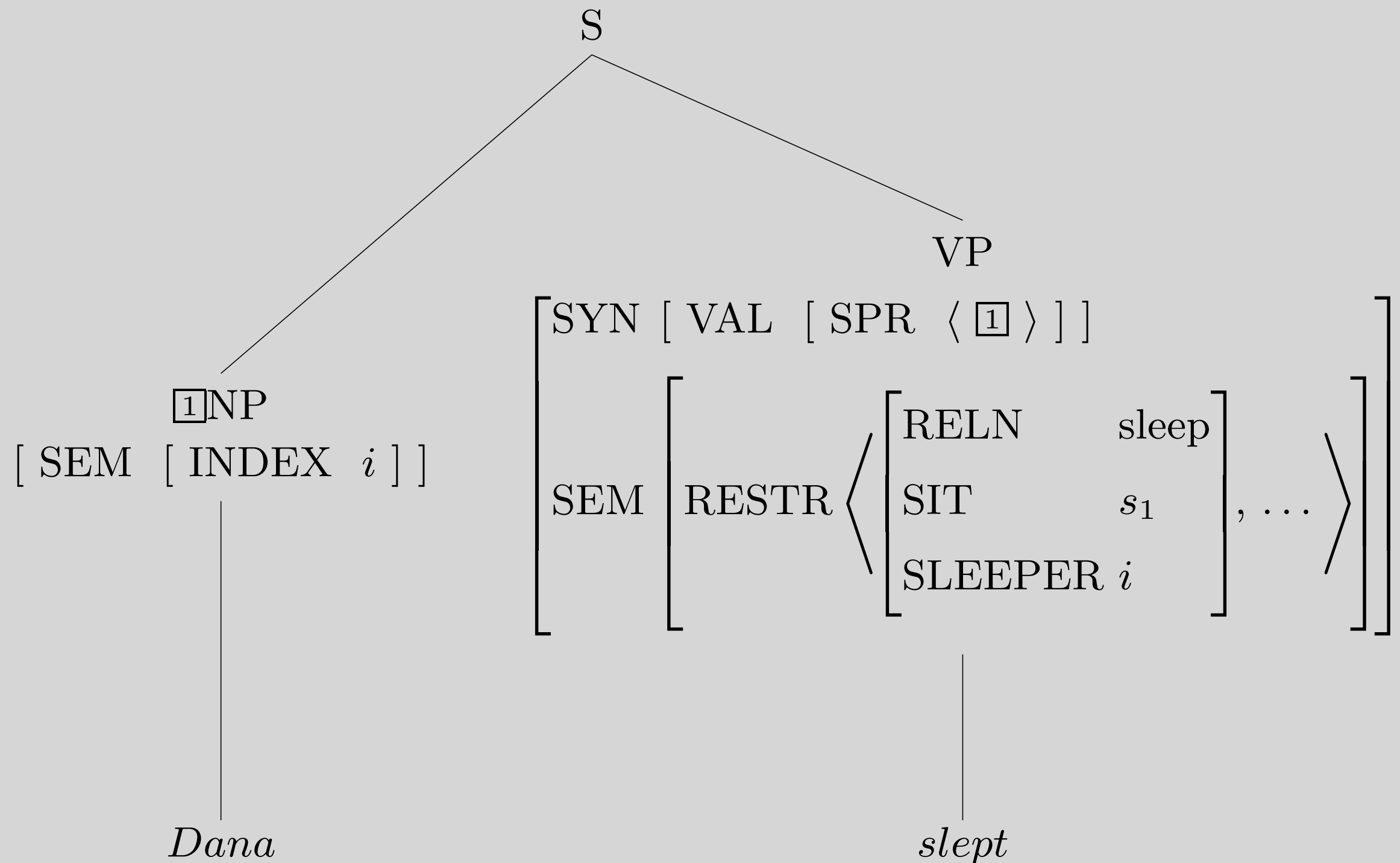
How the Pieces Fit Together



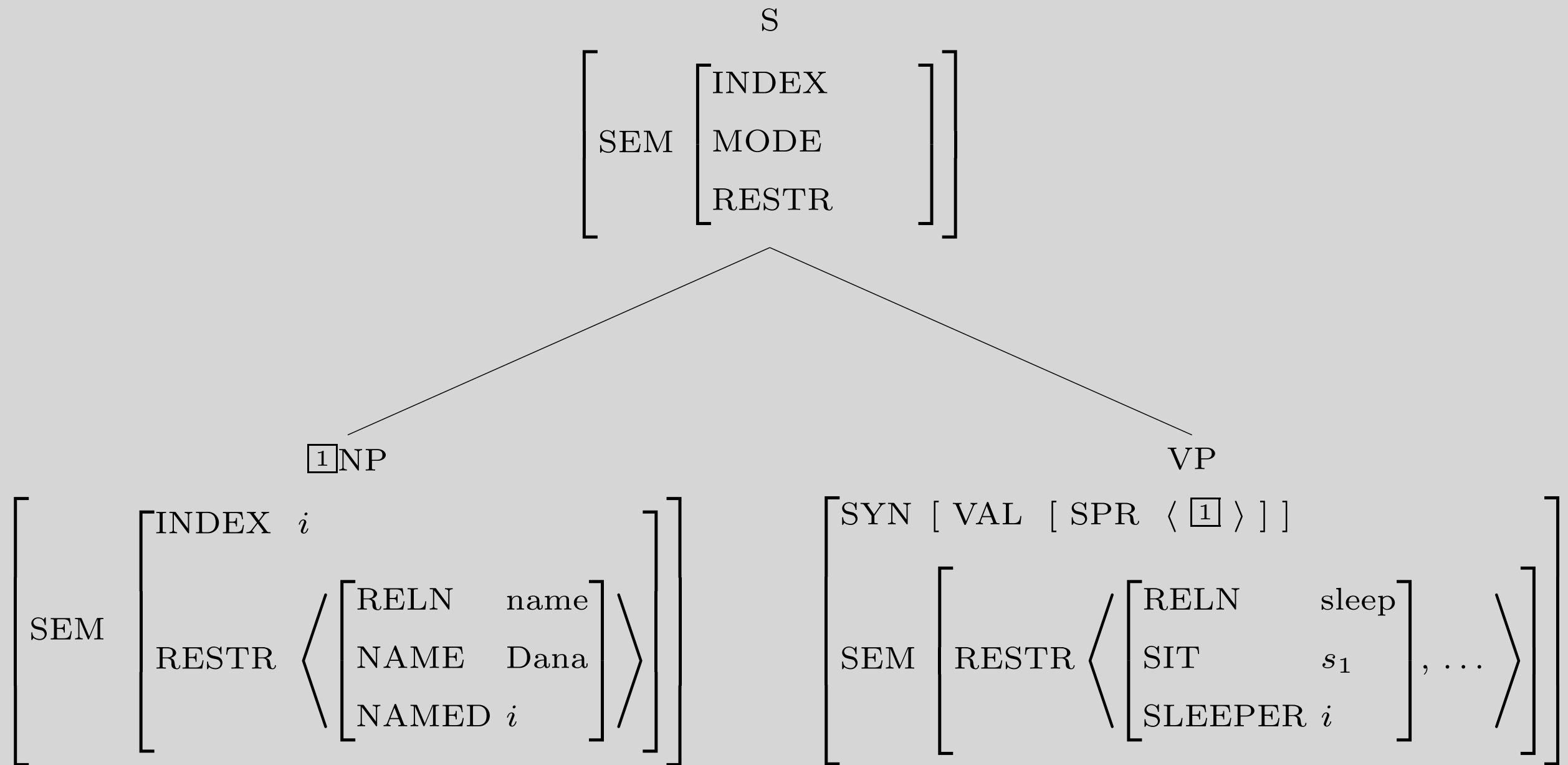
How the Pieces Fit Together



The Pieces Together



A More Detailed View of the Same Tree



To Fill in Semantics for the S-node

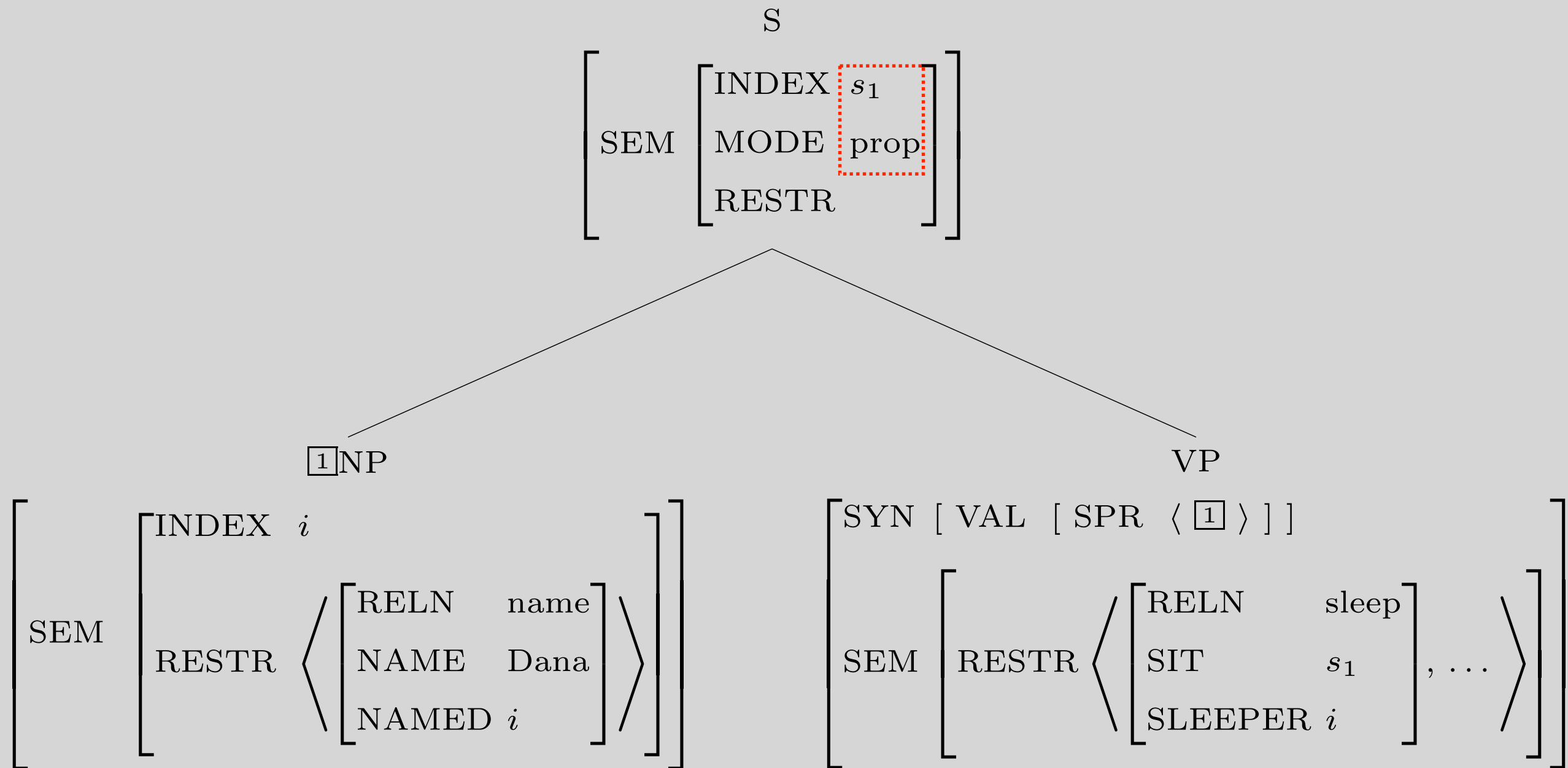
We need the Semantics Principles

- 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:

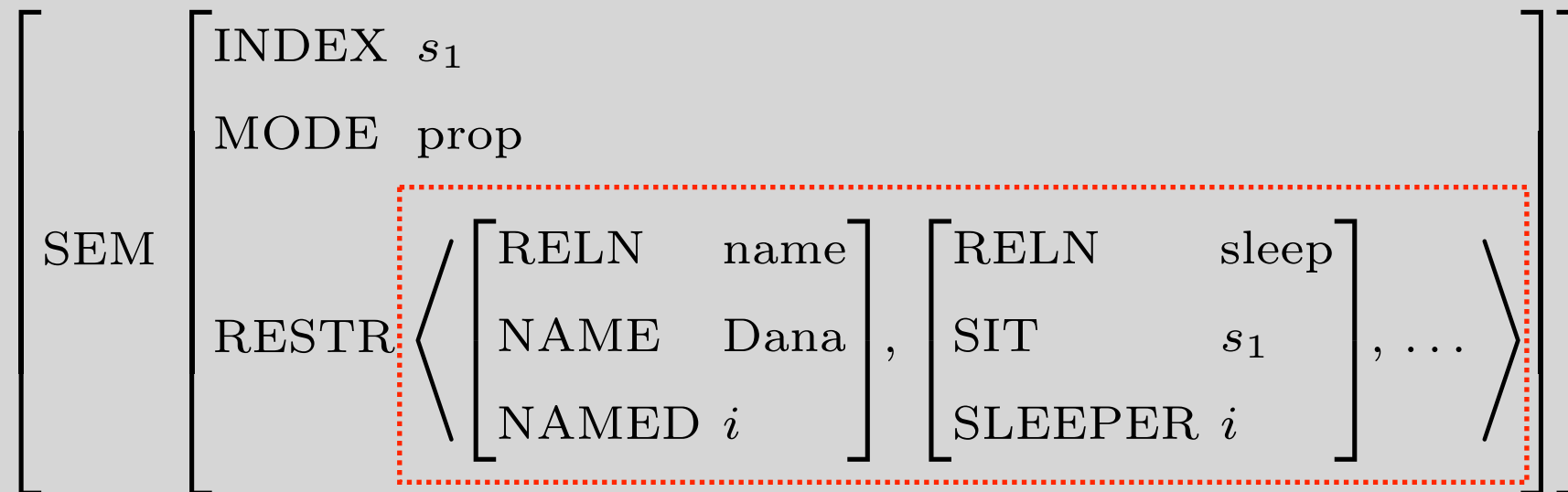
In any headed phrase, the mother's MODE and INDEX are identical to those of the head daughter.

- The Semantic Compositionality Principle:

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

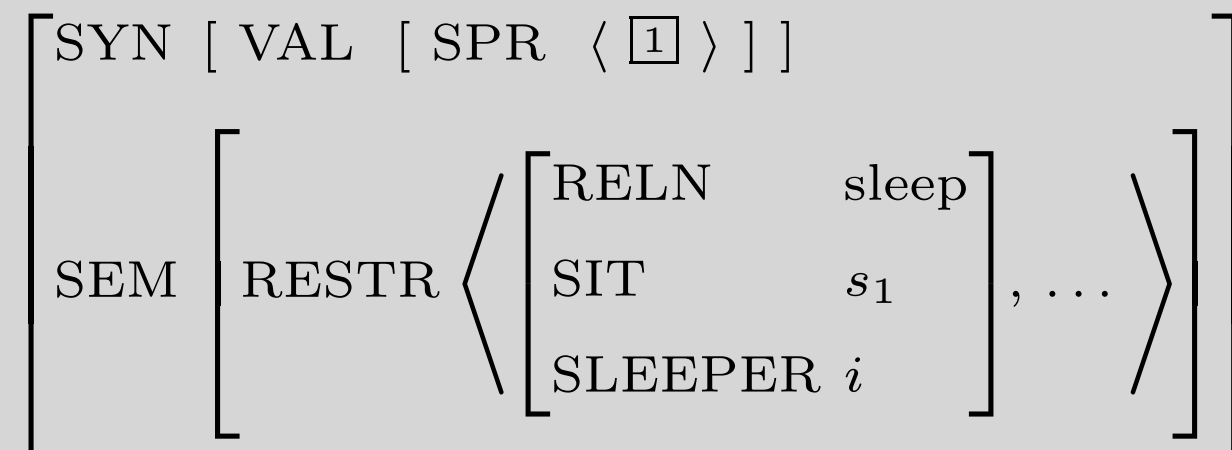
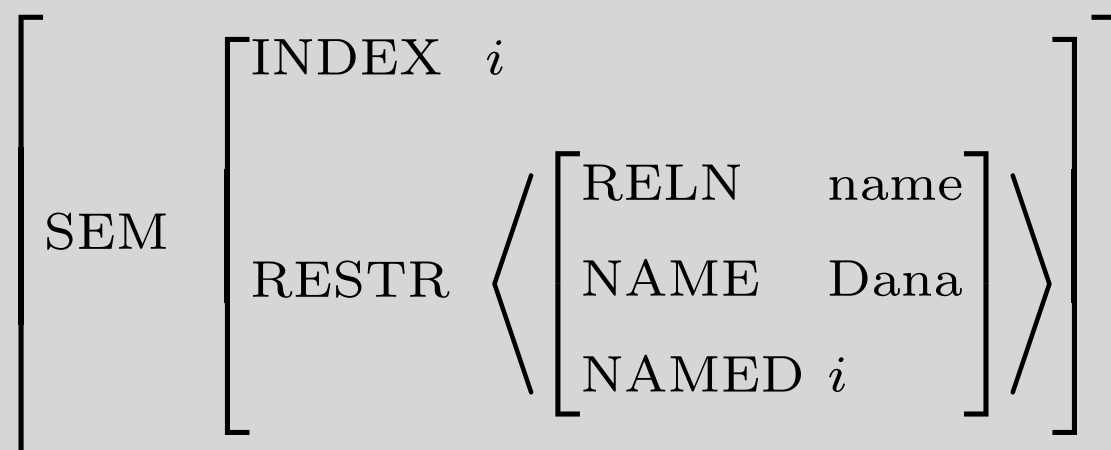
Semantic Compositionality Illustrated

S

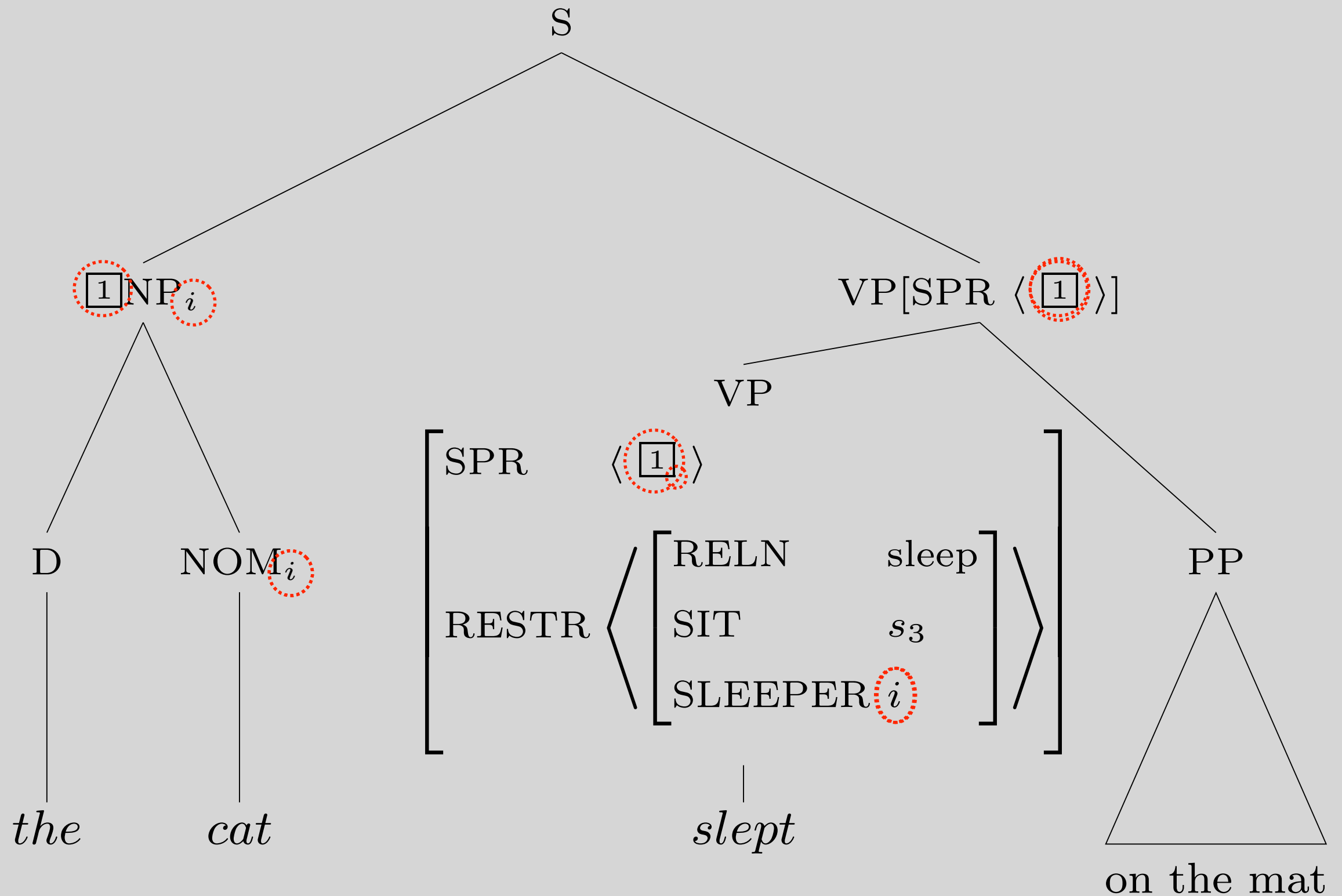


[1]NP

VP

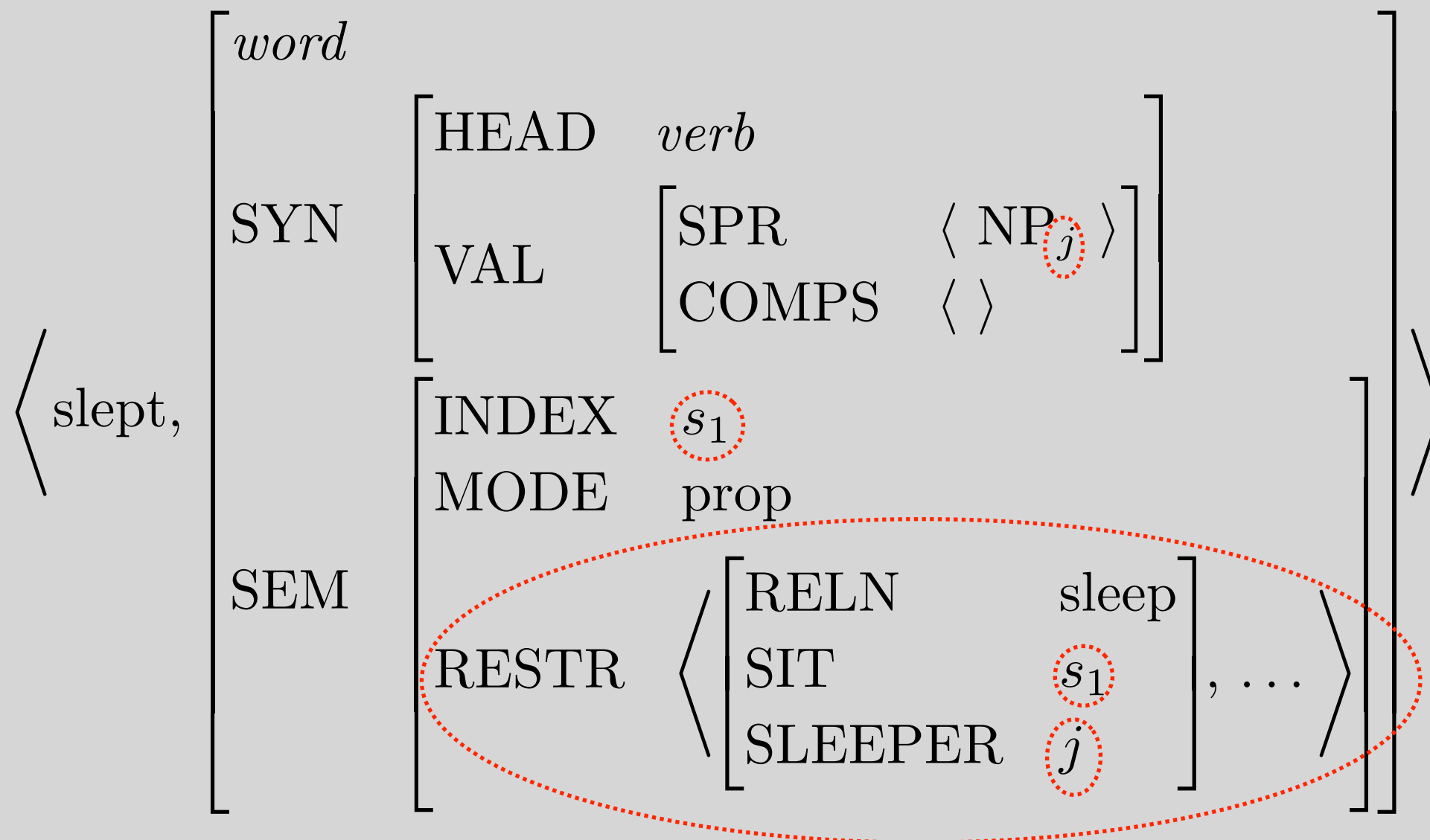


What Identifies Indices?



Summary: Words ...

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



Summary: Grammar Rules ...

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

Head Specifier Rule

$$\left[\begin{array}{c} \textit{phrase} \\ \text{SYN} \left[\text{VAL} \left[\text{SPR} \quad \langle \rangle \right] \right] \end{array} \right] \rightarrow \boxed{1} \mathbf{H} \left[\text{SYN} \left[\text{VAL} \left[\begin{array}{c} \text{SPR} \\ \text{COMPS} \end{array} \right] \left[\begin{array}{c} \langle \boxed{1} \rangle \\ \langle \rangle \end{array} \right] \right] \right] \right]$$

Head Complement Rule

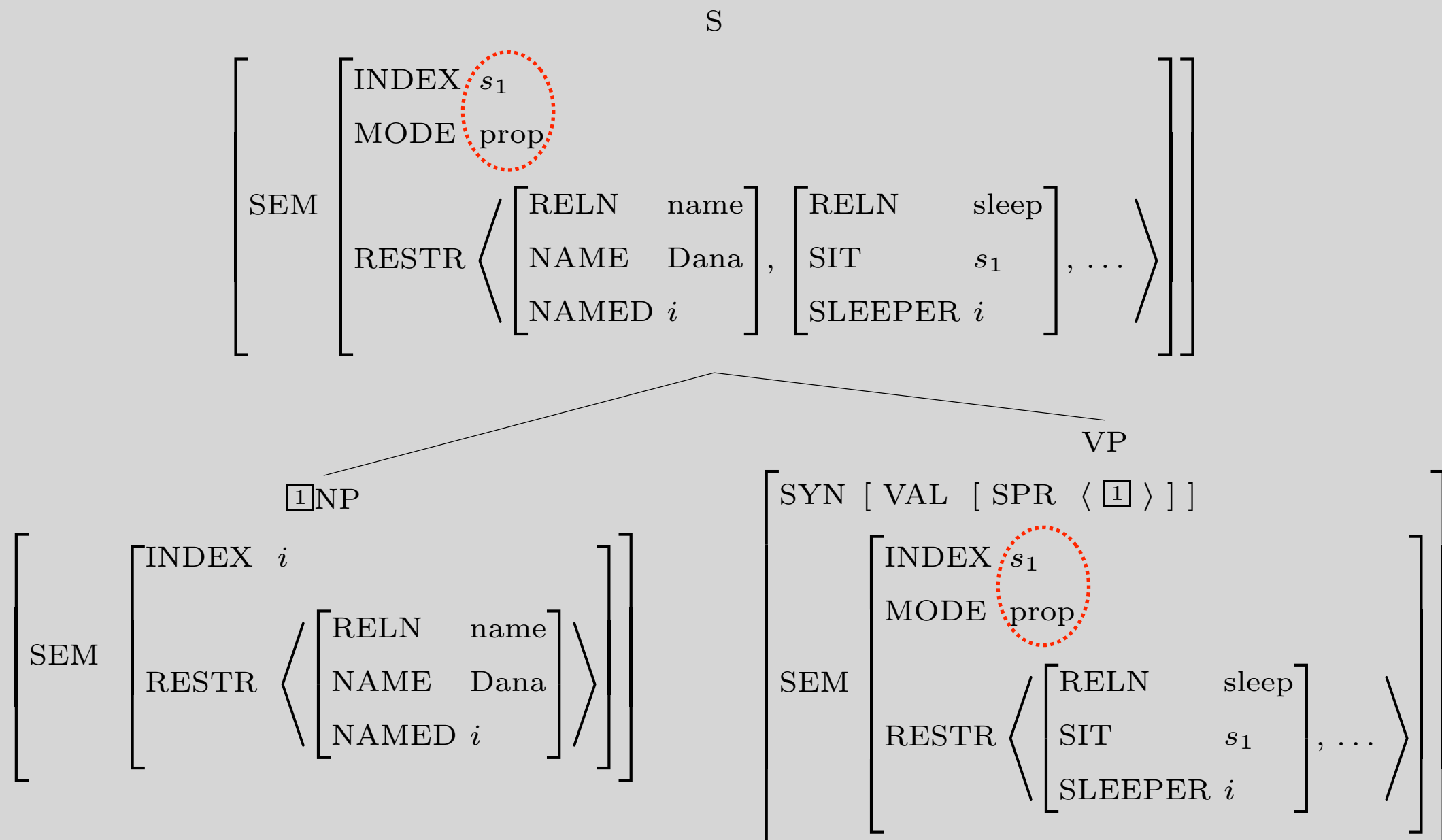
$$\left[\begin{array}{c} \textit{phrase} \\ \text{SYN} \left[\text{VAL} \left[\text{COMPS} \quad \langle \rangle \right] \right] \end{array} \right] \rightarrow \mathbf{H} \left[\begin{array}{c} \textit{word} \\ \text{SYN} \left[\text{VAL} \left[\text{COMPS} \quad \langle \boxed{1}, \dots, \boxed{n} \rangle \right] \right] \end{array} \right] \boxed{1} \dots \boxed{n}$$

Head Modifier Rule

$$[\textit{phrase}] \rightarrow \mathbf{H} \boxed{1} \left[\text{SYN} \left[\text{COMPS} \quad \langle \rangle \right] \right] \left[\text{SYN} \left[\text{VAL} \left[\begin{array}{c} \text{COMPS} \\ \text{MOD} \end{array} \right] \left[\begin{array}{c} \langle \rangle \\ \langle \boxed{1} \rangle \end{array} \right] \right] \right] \right]$$

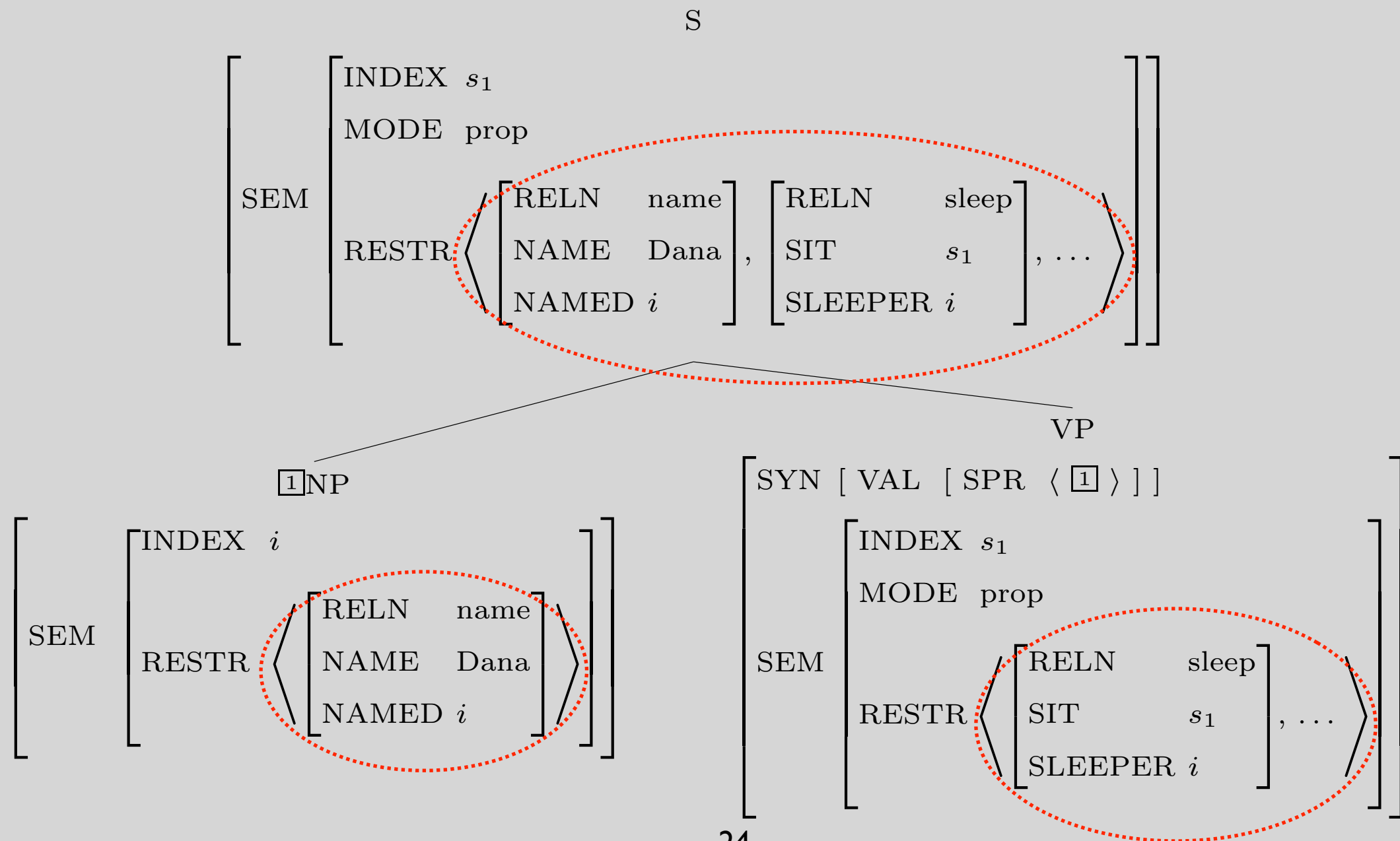
Summary: Grammar Rules ...

- 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:
$$\begin{bmatrix} phrase \\ VAL \begin{bmatrix} COMPS & itr \\ SPR & - \end{bmatrix} \end{bmatrix} \rightarrow \mathbf{H} \begin{bmatrix} phrase \\ VAL \begin{bmatrix} SPR & - \end{bmatrix} \end{bmatrix} PP$$

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

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

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

Evolution of Another Phrase Structure Rule

Ch. 2: $X \rightarrow X^+ \text{ CONJ } X$

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

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

Ch. 5: $\begin{bmatrix} \text{SYN} & [\text{VAL } \boxed{0}] \\ \text{SEM} & [\text{IND } s_0] \end{bmatrix} \rightarrow$
 $\begin{bmatrix} \text{SYN} & [\text{VAL } \boxed{0}] \\ \text{SEM} & [\text{IND } s_1] \end{bmatrix} \cdots \begin{bmatrix} \text{SYN} & [\text{VAL } \boxed{0}] \\ \text{SEM} & [\text{IND } s_{n-1}] \end{bmatrix} \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{HEAD} & \textit{conj} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{IND} & s_0 \\ \text{RESTR} & \langle [\text{ARGS } \langle s_1 \dots s_n \rangle \rangle] \end{bmatrix} \end{bmatrix} \begin{bmatrix} \text{SYN} & [\text{VAL } \boxed{0}] \\ \text{SEM} & [\text{IND } s_n] \end{bmatrix}$

Ch. 5 (abbreviated):

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

Combining Constraints and Coordination

Coordination Rule

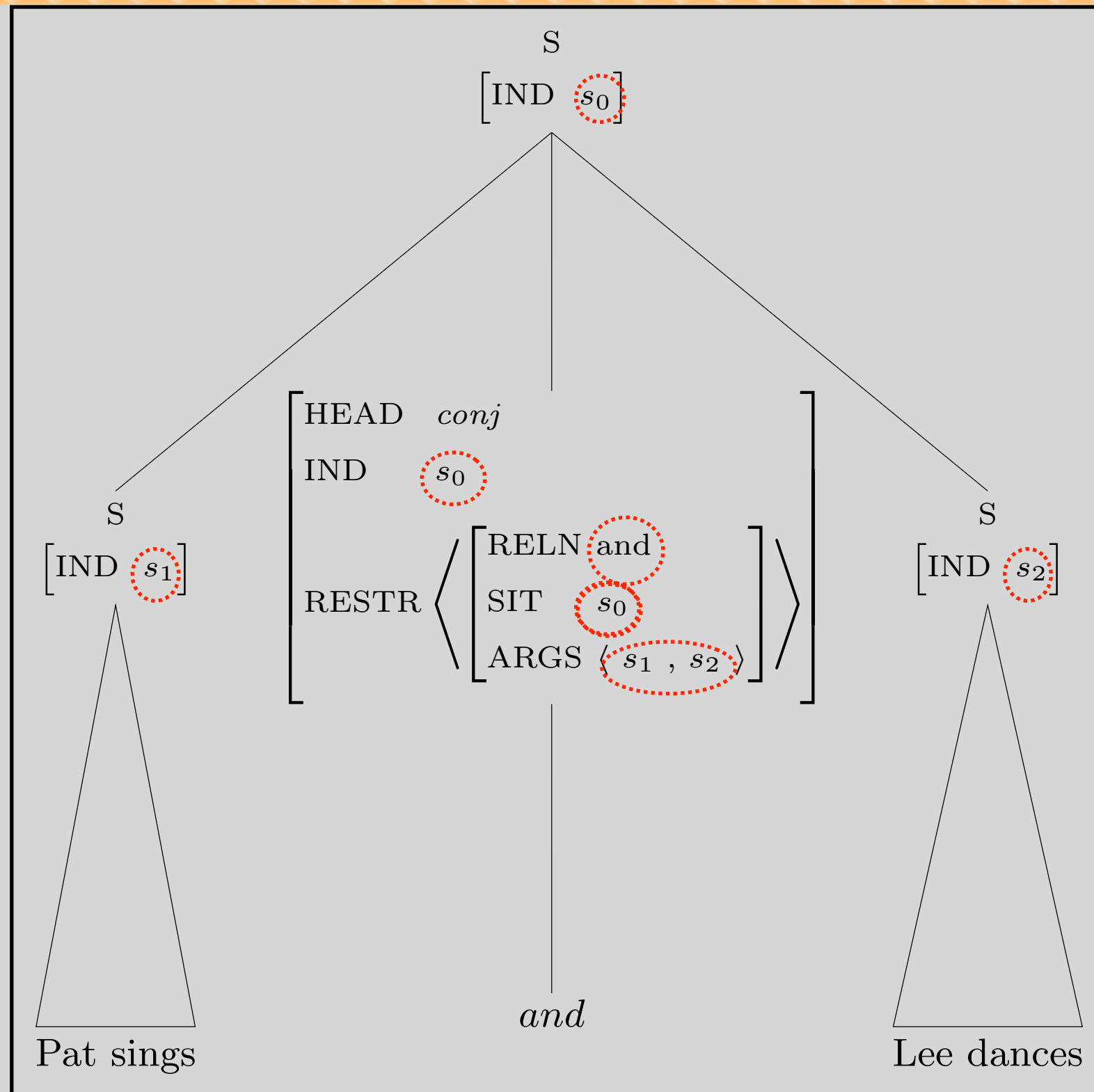
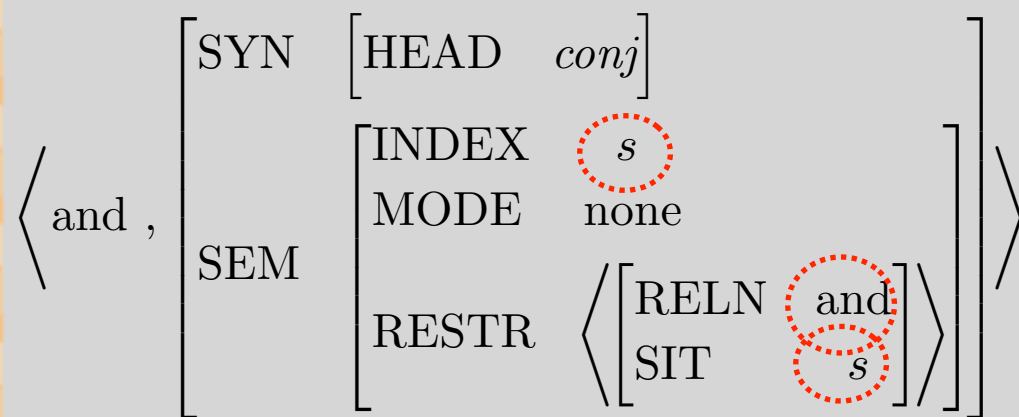
$$\begin{bmatrix} \text{VAL} & \boxed{0} \\ \text{IND} & s_0 \end{bmatrix} \rightarrow \begin{bmatrix} \text{VAL} & \boxed{0} \\ \text{IND} & s_1 \end{bmatrix} \cdots \begin{bmatrix} \text{VAL} & \boxed{0} \\ \text{IND} & s_{n-1} \end{bmatrix} \begin{bmatrix} \text{HEAD} & conj \\ \text{IND} & s_0 \\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

Lexical Entry for a Conjunction

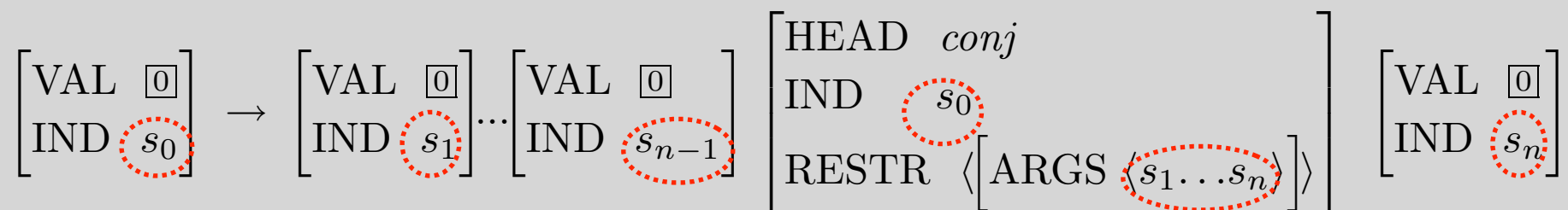
$$\left\langle \text{and} , \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{HEAD} & conj \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{INDEX} & s \\ \text{MODE} & none \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & and \\ \text{SIT} & s \end{bmatrix} \right\rangle \end{bmatrix}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

Combining Constraints and Coordination

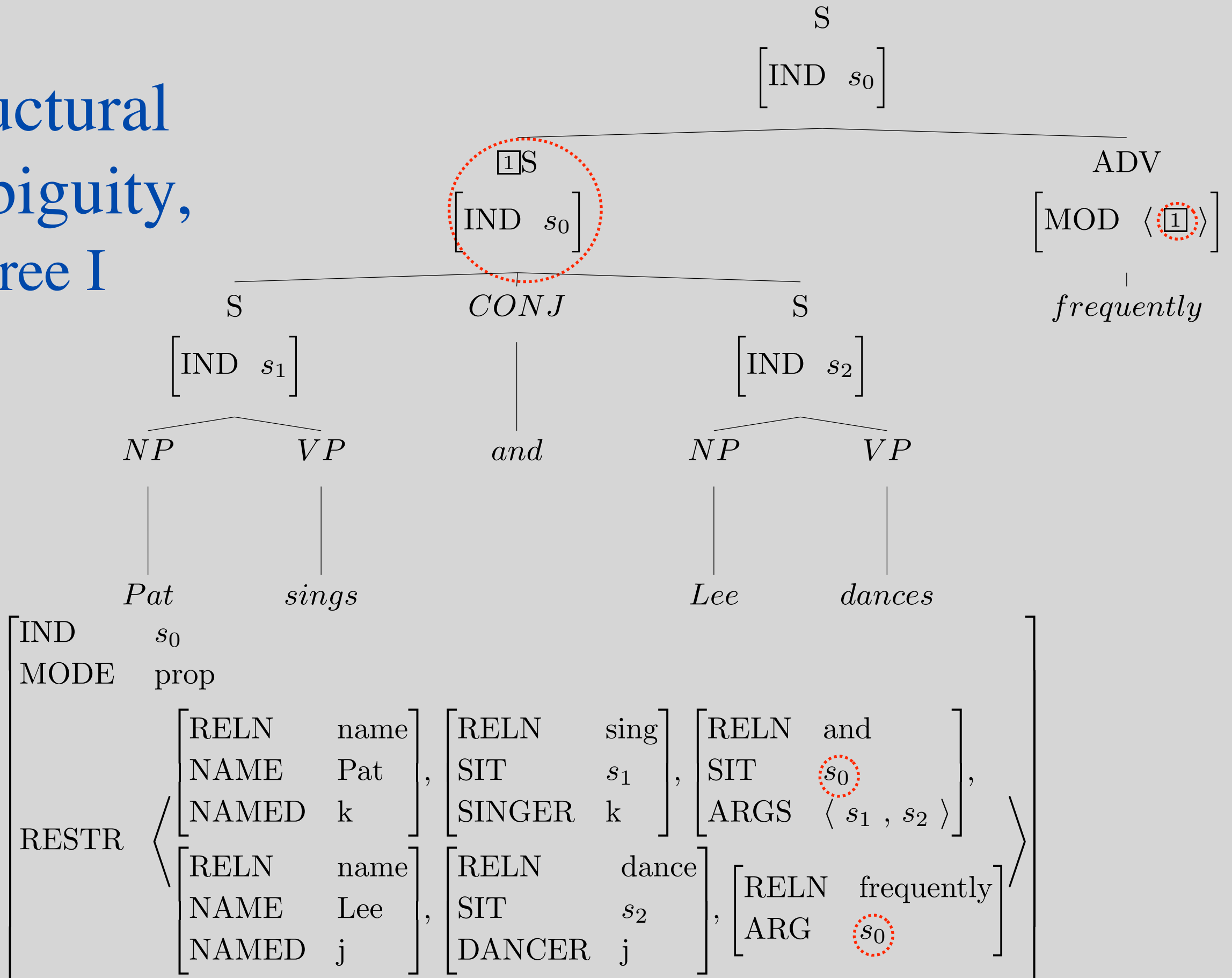
Lexical Entry for *and*



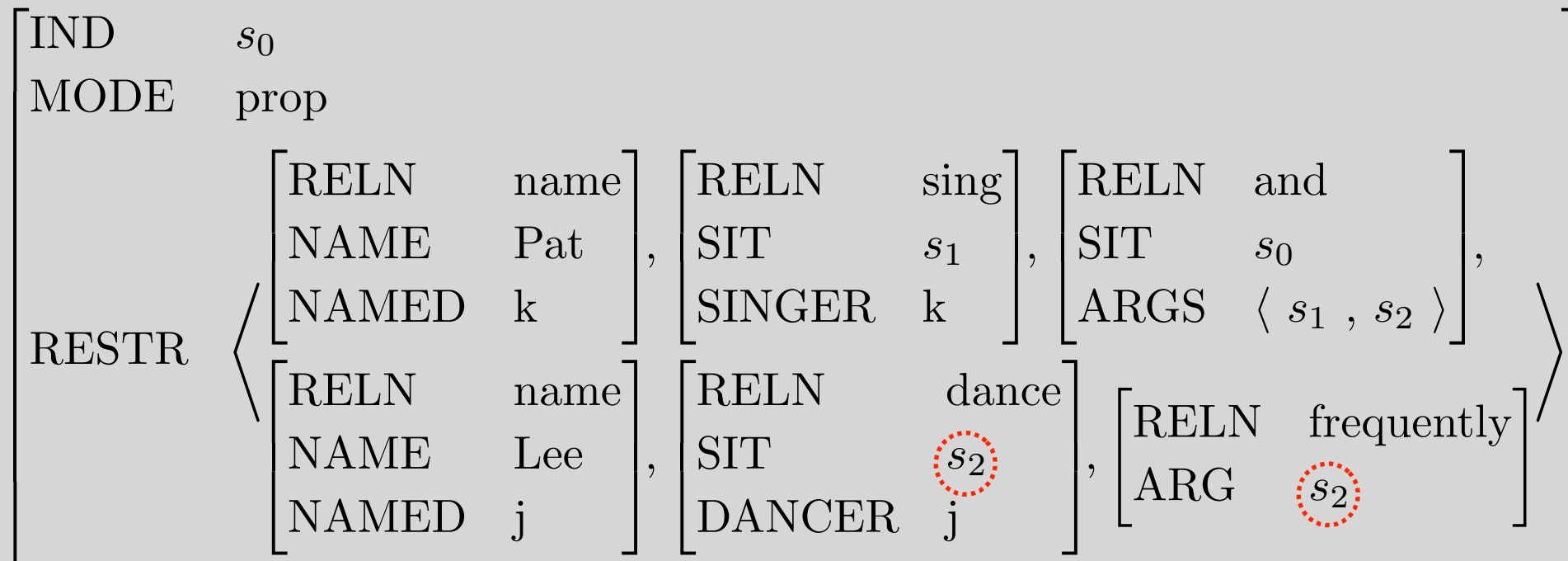
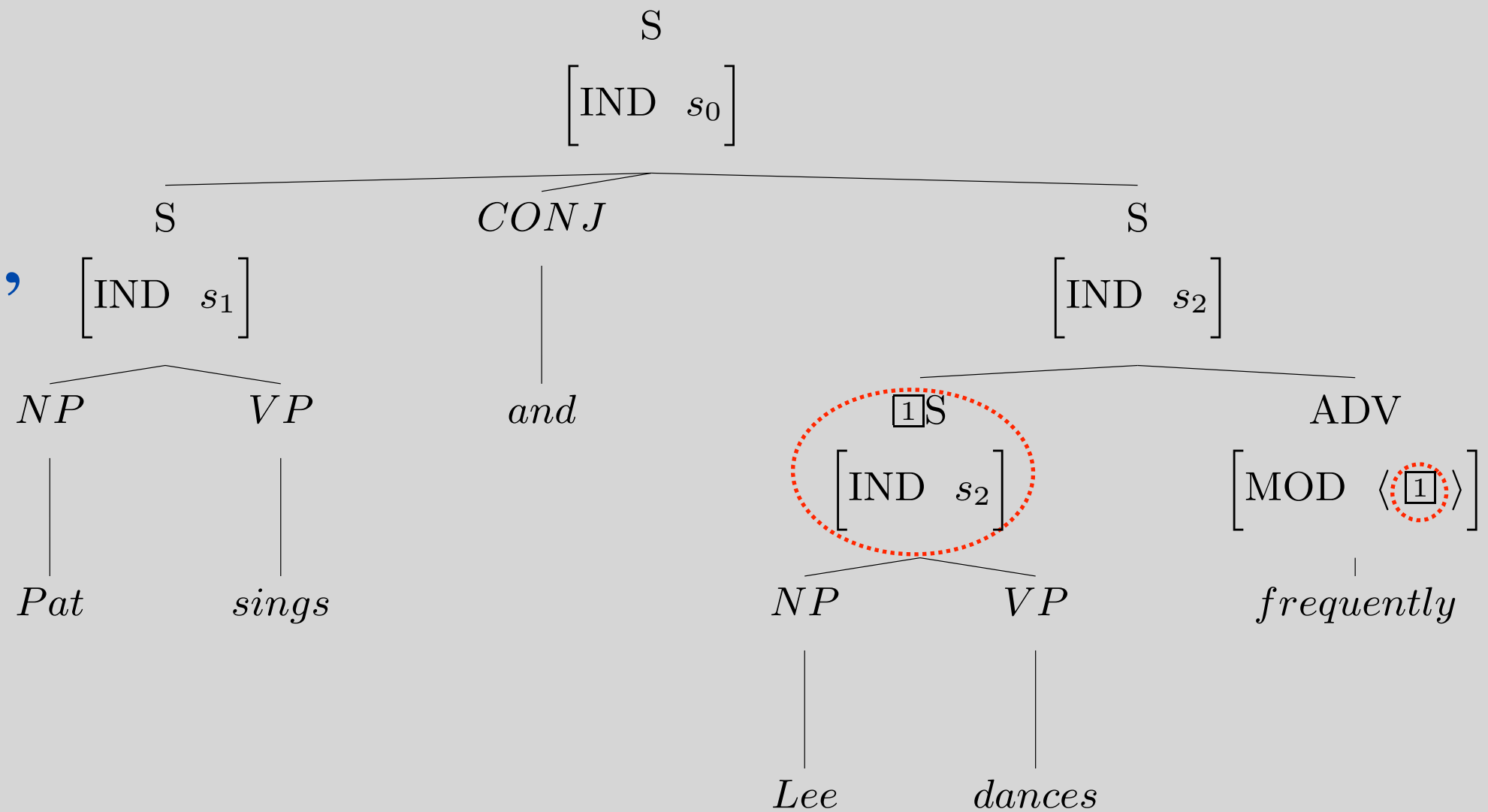
Coordination Rule



Structural Ambiguity, Tree I

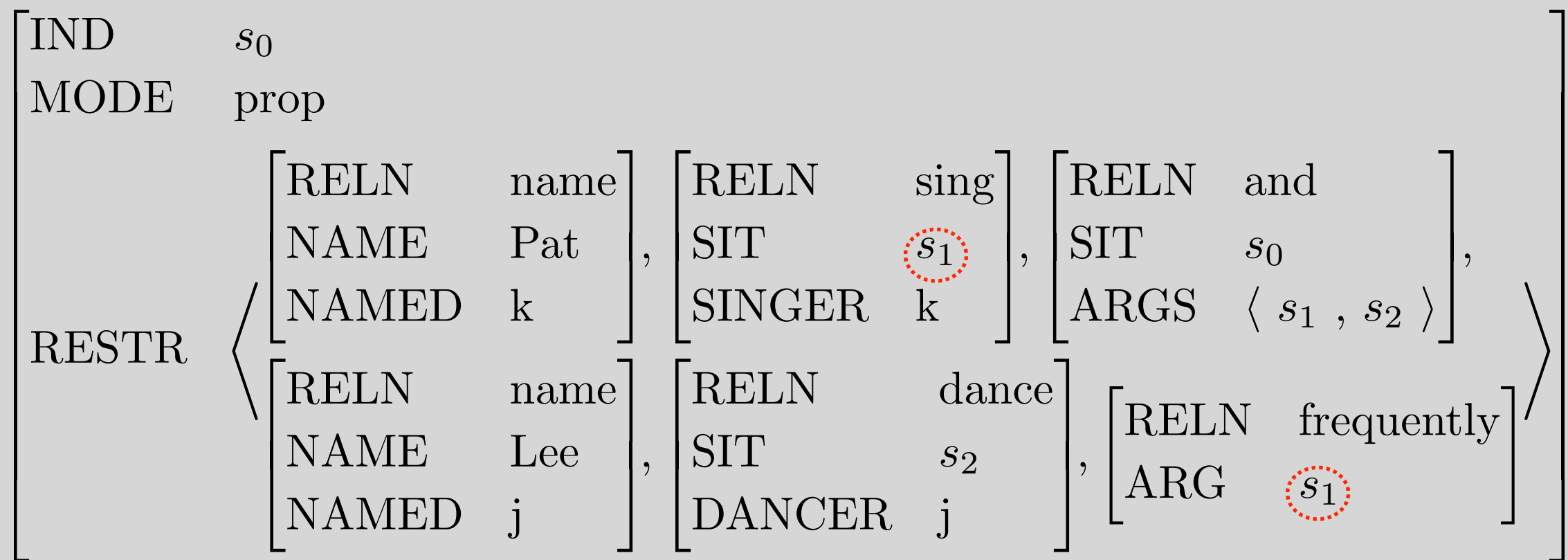


Structural Ambiguity, Tree II



Question About Structural Ambiguity

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



Semantic Compositionality

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

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

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

RQs: Quantifiers

- What is up with QRESTR and QSCOPE?

$$(50) \left[\text{RESTR} \left\langle \begin{bmatrix} \text{RELN} & \text{exist} \\ \text{BV} & i \\ \text{QRESTR} & \boxed{1} \\ \text{QSCOPE} & \boxed{2} \end{bmatrix}, \boxed{1} \begin{bmatrix} \text{RELN} & \text{dog} \\ \text{INST} & i \end{bmatrix}, \boxed{2} \begin{bmatrix} \text{RELN} & \text{all} \\ \text{BV} & j \\ \text{QRESTR} & \boxed{3} \\ \text{QSCOPE} & \boxed{4} \end{bmatrix}, \right. \\ \left. \boxed{3} \begin{bmatrix} \text{RELN} & \text{family} \\ \text{INST} & j \end{bmatrix}, \boxed{4} \begin{bmatrix} \text{RELN} & \text{save} \\ \text{SAVER} & i \\ \text{SAVED} & j \end{bmatrix} \right\rangle \right]$$

And to represent the reading where the universal quantifier outscopes the existential, as in (46b), we can simply identify the QSCOPE values differently, as shown in (51):

$$(51) \left[\text{RESTR} \left\langle \boxed{2} \begin{bmatrix} \text{RELN} & \text{exist} \\ \text{BV} & i \\ \text{QRESTR} & \boxed{1} \\ \text{QSCOPE} & \boxed{4} \end{bmatrix}, \boxed{1} \begin{bmatrix} \text{RELN} & \text{dog} \\ \text{INST} & i \end{bmatrix}, \begin{bmatrix} \text{RELN} & \text{all} \\ \text{BV} & j \\ \text{QRESTR} & \boxed{3} \\ \text{QSCOPE} & \boxed{2} \end{bmatrix}, \right. \\ \left. \boxed{3} \begin{bmatrix} \text{RELN} & \text{family} \\ \text{INST} & j \end{bmatrix}, \boxed{4} \begin{bmatrix} \text{RELN} & \text{save} \\ \text{SAVER} & i \\ \text{SAVED} & j \end{bmatrix} \right\rangle \right]$$

RQs: Quantifiers

- If I understood clearly, under-specifying QSCOPE (quantifier scope) values is appealing not because it is useful in resolving syntactic ambiguities, but rather because humans are inherently bad at resolving scope when reading.
- What's the point of BV?

RQs: Lists vs. multi-sets

- Why is RESTR a list-valued feature?

RQs: Feature names

- How are RELN values are assigned, particularly where the RELN value is something other than a word itself? While it feels intuitive for names to have a RELN value of name, and I can see why the numbers in Problem 3 (p163) have a RELN value of constant, will we be dealing with any other predications that have RELN values which differ from the words they originate from? (Is this also out of the scope of the book as in my comment above?)

RQs: Feature names

- In the tree on page 144 (23), NAME and NAMED are features of word "Pat" and ACHER is the feature of word "aches". How can we have a varying list of features that ultimately depending on the word itself?

RQs: Feature names

- Would it make sense at all to try to collapse the varied predication types like WALKER, LOVER, LOVED, etc. into just a few like AGENT, EXPERIENCER, PATIENT, THEME, etc.? It seems to me that having different and arbitrary predications for every word in the lexicon would lose some linguistic generality that we might want to capture.

RQs: Apportioning semantics

- The RESTR feature makes me nervous because I feel like I'm unsure of when it is satisfied or I guess contains the correct amount of elements to fully describe the relationships. In the example of "a dog saved every family", theres an "exist" RESTR element, but does this describe the dog or the family or both? and if it only describes the dog, why do we not need an "exist" element for the family as well?

RQs: Apportioning semantics

- Page 149: how would we model "or" semantically? Since either one daughter or the other (not both) must be true in order for the whole proposition to be true, wouldn't this violate the semantic compositionality principle?

RQs: Vector space representations

- I am starting to guess at how a theory like HPSG might allow feature vectors to be created for words, and for words to map to a semantic space that relates them to each other. Is that where this is going?