Grammar Formalisms
Head-Driven Phrase Structure Grammar (HPSG)

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27.06.2007

Outline

- Feature Structure Basics
- The building blocks of HPSG
- Analyzing raising and control
- Analyzing long-distance dependencies

Subsumption and Unification

$$\begin{bmatrix} \text{ATTR}_1 & \text{val}_1 \\ \text{ATTR}_2 & \text{val}_2 \\ \ldots & \ldots \\ \text{ATTR}_n & \text{val}_n \end{bmatrix} \quad \{<\text{ATTR}_1,\text{val}_1>, <\text{ATTR}_2,\text{val}_2>, \ldots, <\text{ATTR}_n,\text{val}_n>\}$$

subsumption $\sqsubseteq$ **:** $A \sqsubseteq B$, iff if $t \in A$, then $t \in B$.

unification $\sqcup$ **:** $A \sqcup B = C$, iff C is the smallest feature structure such that $A \sqsubseteq C$ and $B \sqsubseteq C$.

Feature structures as Values

Feature structures as values:

- non-recursive: $\begin{bmatrix} \textsc{index} & \begin{bmatrix} \textsc{per} & 1 \\ \textsc{num} & \text{sg} \\ \textsc{gend} & \text{fem} \end{bmatrix} \end{bmatrix}$
- recursive: $\begin{bmatrix} \textsc{subcat} & \left\langle \begin{bmatrix} \textsc{subcat} & \begin{bmatrix} \ldots \end{bmatrix} \end{bmatrix} \right\rangle \end{bmatrix}$

$\Longrightarrow$ Other than FTAG, HPSG uses recursive feature structures!

Structure sharing (1)

Re-entrancies (or "structure sharing"):

- boxed numbers ($\boxed{1}$, $\boxed{2}$, ...) indicate structure sharing
- within feature structures:

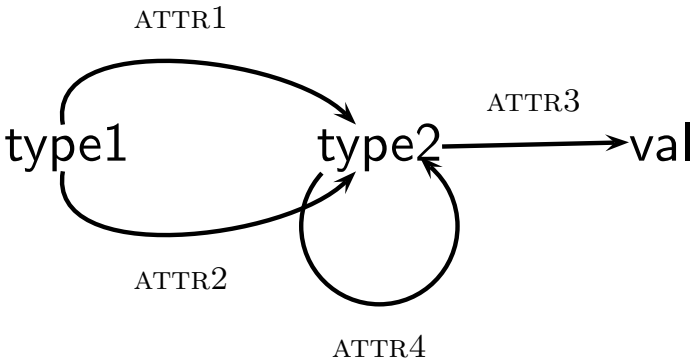
$$\begin{bmatrix} \text{ATTR}_1 & \boxed{1} \\ \text{ATTR}_2 & \boxed{1} \end{bmatrix} \qquad \begin{bmatrix} \text{ATTR}_1 & \boxed{1}\text{val}_1 \\ \text{ATTR}_2 & \boxed{1} \end{bmatrix} \qquad \begin{bmatrix} \text{ATTR}_1 & \boxed{1}\begin{bmatrix} \text{ATTR}_2 & \boxed{1} \end{bmatrix} \end{bmatrix}$$

Re-entrancies produce cyclic structures!

Structure sharing (2)

Correspondence between feature structures and graphs:

$$\begin{bmatrix} \textit{type1} & \\ \text{ATTR}_1 & \boxed{1} \\ \text{ATTR}_2 & \boxed{1} \begin{bmatrix} \textit{type2} & \\ \text{ATTR}_3 & \text{val} \\ \text{ATTR}_4 & \boxed{1} \end{bmatrix} \end{bmatrix}$$



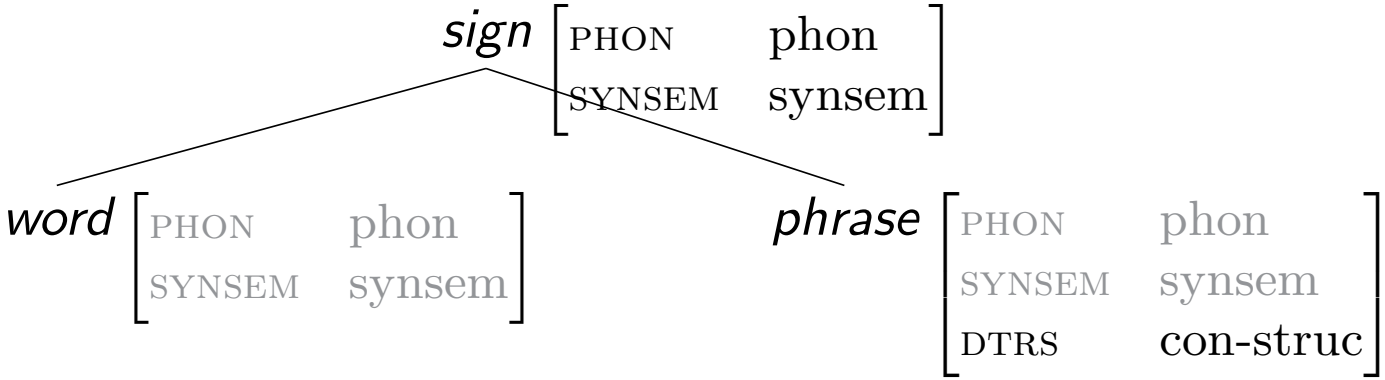
Types and type hierarchy

- **Types:** fixed bundles of attributes

$$\begin{bmatrix} \textit{index} & \\ \text{PER} & \boxed{1} \\ \text{NUM} & \boxed{2} \\ \text{GEND} & \boxed{3} \end{bmatrix} \begin{bmatrix} \textit{synsem} & \\ \text{LOC} & \boxed{1} \\ \text{NONLOC} & \boxed{2} \end{bmatrix}$$

  $\rightsquigarrow$ specified in the **signature**

- **Type hierarchy:** order on types
  $\approx$ attribute inheritance



  $\rightsquigarrow$ specified in the **signature**

Signatures, constraints, and grammars (1)

The signature Σ

is a quadruple (in P&S,94):
$<$ types , type hierarchy , attributes , ((types $\times$ attributes) $\times$ types) $>$

The signature licenses possible feature structures.
(language independent)

A constraint $\tau \in \theta$

is based on Σ, but also contains variables, conjunction, disjunction, implication, negation ,...
Other name: **Principle**.

The constraints further restrict the set of well-formed feature structures.
(language independent and dependent)

Signatures, constraints, and grammars (2)

A grammar G

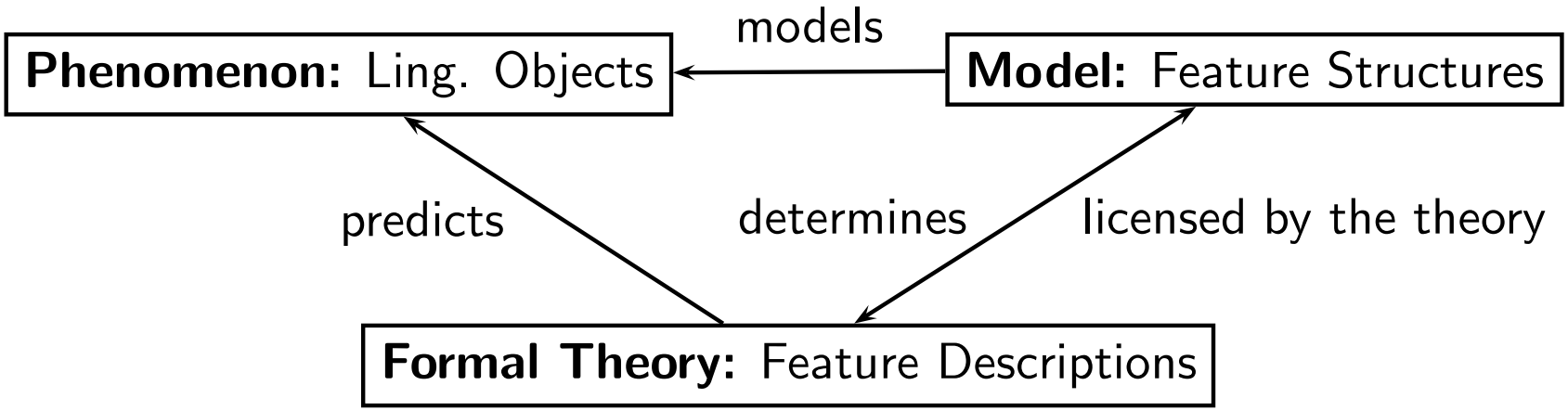
is a signature Σ and a set of constraints θ.

Each G-licensed feature structure must be

- **type-resolved**: each type is maximally specific.
- **totally well-typed**: exactly the legal attributes of a type must be present.

Phenomena, Model, Formal Theory

from Müller (2007)



The architecture of linguistic feature structures

$$\begin{bmatrix} \textit{sign} & \\ \text{PHON} & \textit{phon} \\ \text{SYNSEM} & \begin{bmatrix} \textit{synsem} & \\ \text{LOCAL} & \begin{bmatrix} \textit{local} & \\ \text{CATEGORY} & \textit{category} \\ \text{CONTENT} & \textit{content} \\ \text{CONTEXT} & \textit{context} \end{bmatrix} \\ \text{NONLOCAL} & \textit{nonlocal} \end{bmatrix} \end{bmatrix}$$

- PHON: The surface of a sign.
- SYNSEM: The core of a *sign*. Contains *syn*tactic and *sem*antic information.
- LOCAL: Contains information *local* to the linguistic sign, such as agreement information
- NONLOCAL: Contains non-local references, e.g. for long-distance dependencies

An example

$$
\begin{bmatrix}
\textit{word} & & & & & & & \\
\text{PHON} & \langle \text{she} \rangle & & & & & & \\
\text{SYNSEM} & \begin{bmatrix}
\textit{synsem} & & & & & & & \\
\text{LOCAL} & \begin{bmatrix}
\textit{local} & & & & & & & \\
\text{CATEGORY} & \begin{bmatrix}
\textit{cat} & & & & & & & \\
\text{HEAD} & \begin{bmatrix} \textit{noun} & & & & & & & \\ \text{CASE} & \text{nom} & & & & & & \end{bmatrix} & & & & & & \\
\text{SUBCAT} & \langle\rangle & & & & & & \end{bmatrix} & & & & & & \\
\text{CONTENT} & \begin{bmatrix}
\textit{ppro} & & & & & & & \\
\text{INDEX} & \boxed{1} & \begin{bmatrix} \textit{ref} & & & & & & & \\ \text{PER} & \text{3rd} & & & & & & \\ \text{NUM} & \text{sing} & & & & & & \\ \text{GEND} & \text{fem} & & & & & & \end{bmatrix} & & & & & & \end{bmatrix} & & & & & & \\
\text{CONTEXT} & \begin{bmatrix}
\textit{context} & & & & & & & \\
\text{BACKGR} & \left\{ \begin{bmatrix} \textit{psoa} & & & & & & & \\ \text{RELN} & \text{female} & & & & & & \\ \text{INST} & \boxed{1} & & & & & & \end{bmatrix} \right\} & & & & & & \end{bmatrix} & & & & & & \end{bmatrix} & & & & & & \\
\text{NONLOCAL} & \ldots & & & & & & \end{bmatrix} & & & & & & \end{bmatrix}
\end{bmatrix}
$$

Category

CATEGORY: Contains *syntactic* information

$$\begin{bmatrix} \textit{cat} & \\ \text{HEAD} & \begin{bmatrix} \textit{noun} & \\ \text{CASE} & \text{nom} \end{bmatrix} \\ \text{SUBCAT} & \langle\rangle \end{bmatrix}$$

- HEAD: Syntactic features (roughly part-of-speech)
- SUBCAT: Subcategorization information

Content and Context

CONTENT: Contains *semantic* information

$$\begin{bmatrix} \textit{ppro} & \\ \text{INDEX} & \boxed{1}\begin{bmatrix} \textit{ref} & \\ \text{PER} & \text{3rd} \\ \text{NUM} & \text{sing} \\ \text{GEND} & \text{fem} \end{bmatrix} \end{bmatrix}$$

CONTEXT: Contains *pragmatic* information

$$\begin{bmatrix} \textit{context} & \\ \text{BACKGR} & \left\{ \begin{bmatrix} \textit{psoa} & \\ \text{RELN} & \text{female} \\ \text{INST} & \boxed{1} \end{bmatrix} \right\} \end{bmatrix}$$

Abbreviations of feature structures (1)

$$\begin{bmatrix} \textit{synsem} & \\ \text{LOC} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{noun} & \\ \text{CASE} & \text{case} \end{bmatrix} \\ \text{SUBCAT} & \langle\rangle \end{bmatrix} \\ \text{CONT} \mid \text{INDEX} & \boxed{i} \begin{bmatrix} \text{PER} & \text{per} \\ \text{NUM} & \text{num} \\ \text{GEND} & \text{gend} \end{bmatrix} \end{bmatrix} \end{bmatrix} \quad \rightsquigarrow \quad \text{NP}_{\boxed{i}[\textit{per},\textit{num},\textit{gend}]}[\text{case}]$$

$$\begin{bmatrix} \textit{synsem} & \\ \text{LOC} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{verb} & \\ \text{VFORM} & \text{vform} \end{bmatrix} \\ \text{SUBCAT} & \langle \textit{synsem} \rangle \end{bmatrix} \\ \text{CONT} & \boxed{i} \end{bmatrix} \end{bmatrix} \quad \rightsquigarrow \quad \text{VP}[\text{vform}]:\boxed{i}$$

Abbreviations of feature structures (2)

$$\begin{bmatrix} \textsc{head} & \begin{bmatrix} \textit{noun} & \\ \textsc{case} & \text{nom} \end{bmatrix} \end{bmatrix} \rightsquigarrow \begin{bmatrix} \textsc{head} & \text{Noun}[\text{nom}] \end{bmatrix}$$

$$\begin{bmatrix} \textsc{cont} & \begin{bmatrix} \textsc{index} & \boxed{i} \\ \textsc{restr} & \begin{bmatrix} \textit{rel} & \\ \textsc{arg}1 & \boxed{1} \end{bmatrix} \end{bmatrix} \end{bmatrix} \rightsquigarrow \begin{bmatrix} \textsc{content} & \begin{bmatrix} \textsc{index} & \boxed{i} \\ \textit{rel}(\boxed{1}) & \end{bmatrix} \end{bmatrix}$$

$$\begin{bmatrix} \textsc{head} & \begin{bmatrix} \textit{verb} & \\ \textsc{vform} & \text{fin} \end{bmatrix} \end{bmatrix} \rightsquigarrow \begin{bmatrix} \textsc{head} & \text{Verb}[\text{fin}] \end{bmatrix}$$

$$\begin{bmatrix} \textsc{cont} & \begin{bmatrix} \textit{rel} & \\ \textsc{arg}1 & \boxed{1} \\ \ldots & \ldots \\ \textsc{argn} & \boxed{n} \end{bmatrix} \end{bmatrix} \rightsquigarrow \begin{bmatrix} \textsc{content} & \textit{rel}(\boxed{1}, \ldots, \boxed{n}) \end{bmatrix}$$

Abbreviations in action

$$\begin{bmatrix} \textit{word} \\ \text{PHON} \left\langle \textit{walks} \right\rangle \\ \text{SYNSEM} \mid \text{LOC} \mid \text{CAT} \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{verb} \\ \text{VFORM} & \textit{fin} \end{bmatrix} \\ \text{SUBCAT} & \left\langle \begin{bmatrix} \text{LOC} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{noun} \\ \text{CASE} & \textit{nom} \end{bmatrix} \\ \text{SUBCAT} & \langle\rangle \end{bmatrix} \\ \text{CONT} & \begin{bmatrix} \text{INDEX} & \begin{bmatrix} \text{PER} & \textit{3} \\ \text{NUM} & \textit{sg} \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix}$$

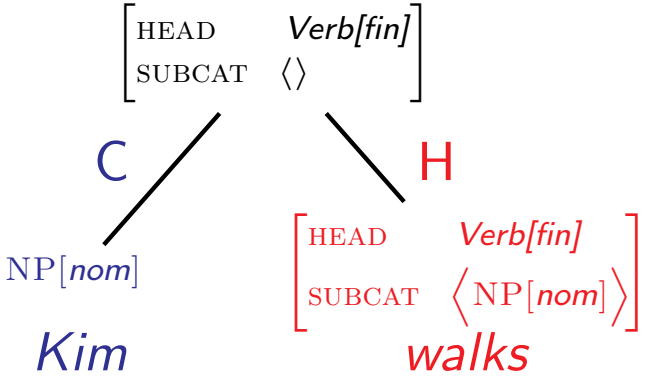
$$\rightsquigarrow \begin{bmatrix} \textit{word} \\ \text{PHON} \left\langle \textit{walks} \right\rangle \\ \text{SYNSEM} \mid \text{LOC} \mid \text{CAT} \begin{bmatrix} \text{HEAD} & \textit{Verb[fin]} \\ \text{SUBCAT} & \left\langle \text{NP}_{\boxed{1}[\textit{3sg}]} [\textit{nom}] \right\rangle \end{bmatrix} \end{bmatrix}$$

Phrases - Syntactic composition

$\Longrightarrow$ Structures of type *phrase* have the feature DTRS.

$$\begin{bmatrix} \textit{phrase} & \\ \text{PHON} & \langle \textit{Kim, walks} \rangle \\ \text{SYNSEM} \mid \text{LOC} \mid \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{Verb[fin]} \\ \text{SUBCAT} & \langle\rangle \end{bmatrix} \\ \text{DTRS} & \begin{bmatrix} \textit{head-comp-struc} & \\ \text{HEAD-DTR} & \begin{bmatrix} \textit{phrase} & \\ \text{PHON} & \langle \textit{walks} \rangle \\ \text{SYNSEM} \mid \text{LOC} \mid \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{Verb[fin]} \\ \text{SUBCAT} & \langle \text{NP}[\textit{nom}] \rangle \end{bmatrix} \end{bmatrix} \\ \text{COMP-DTRS} & \left\langle \begin{bmatrix} \text{PHON} & \langle \textit{Kim} \rangle \\ \text{SYNSEM} & \text{NP}[\textit{nom}] \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix}$$

Tree notation:



Principles

The Word Principle

$word \Rightarrow \mathrm{LE}_1 \vee \ldots \vee \mathrm{LE}_n$

The Head Feature Principle

$$\begin{bmatrix} \text{SYNSEM} \mid \text{LOC} \mid \text{CAT} \mid \text{HEAD} & \boxed{1} \\ \text{DTRS} \mid \text{HEAD-DTR} \mid \text{SYNSEM} \mid \text{LOC} \mid \text{CAT} \mid \text{HEAD} & \boxed{1} \end{bmatrix}$$

The Subcategorization Principle (binary version)

$$\begin{bmatrix} \text{SYNSEM} \mid \text{LOC} \mid \text{CAT} \mid \text{SUBCAT} & \left\langle \boxed{2} \right\rangle \\ \text{DTRS} & \begin{bmatrix} \text{HEAD-DTR} \mid \text{SYNSEM} \mid \text{LOC} \mid \text{CAT} \mid \text{SUBCAT} & \left\langle \boxed{2} \mid \boxed{1} \right\rangle \\ \text{COMP-DTR} \mid \text{SYNSEM} & \boxed{1} \end{bmatrix} \end{bmatrix}$$

The Immediate Dominance Schemata (1)

The ID Principle

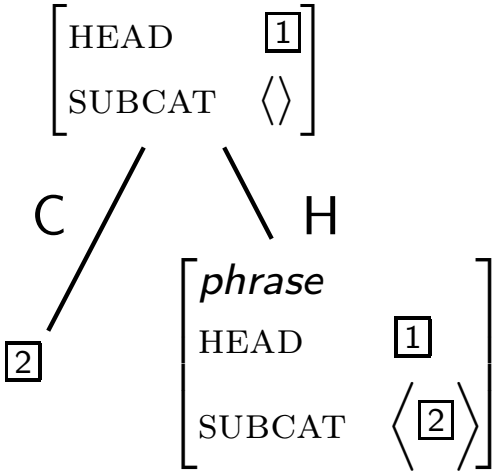
Every headed phrase must satisfy exactly one of the ID schemata.

- $\approx$ phrase structure rules
- For example (from P&S,94):
  - Head-Subject Schema
  - Head-Complement Schema
  - Head-Subject-Complement Schema
  - Head-Marker Schema
  - Head-Adjunct Schema
  - Head-Filler Schema

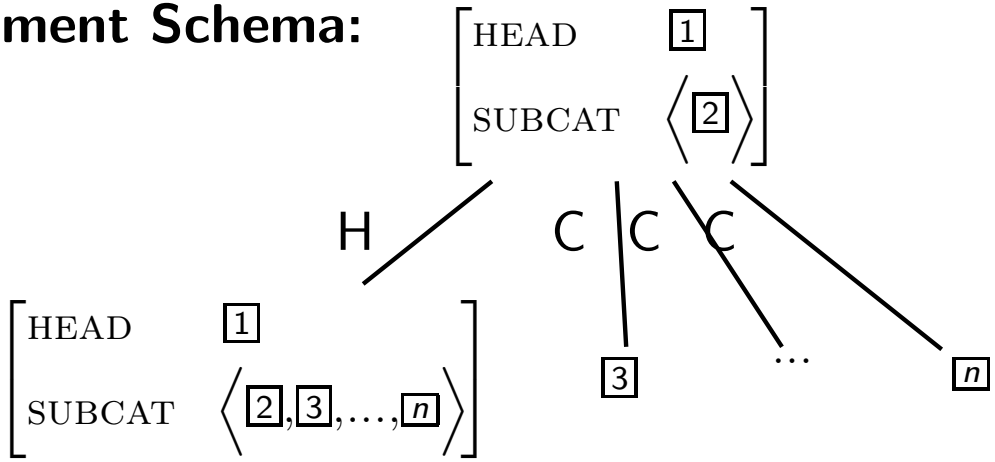
The Immediate Dominance Schemata (1)

$\Longrightarrow$ including Head Feature Principle and Subcategorization Principle!

Head-Subject Schema:



Head-Complement Schema:



Raising and control (1) - A semantic distinction

(1) a. John seems to leave.
b. John tries to leave.

"seems": $\begin{bmatrix} \textit{word} & \\ \text{CAT} & \begin{bmatrix} \text{HEAD} & \text{Verb[fin]} \\ \text{SUBCAT} & \left\langle \boxed{1}_{[3sg]}[\textit{nom}],\ \text{VP}[\textit{inf}, \text{SUBCAT}\langle\boxed{1}\rangle]:\boxed{3} \right\rangle \end{bmatrix} \\ \text{CONT} & \textit{seem}(\boxed{3}) \end{bmatrix}$

"tries": $\begin{bmatrix} \textit{word} & \\ \text{CAT} & \begin{bmatrix} \text{HEAD} & \text{Verb[fin]} \\ \text{SUBCAT} & \left\langle \text{NP}_{\boxed{1}[3sg]}[\textit{nom}],\ \text{VP}[\textit{inf}, \text{SUBCAT}\langle\text{NP}_{\boxed{1}}\rangle]:\boxed{3} \right\rangle \end{bmatrix} \\ \text{CONT} & \textit{try}(\boxed{1}[\textit{ref}], \boxed{3}) \end{bmatrix}$

$\Longrightarrow$ no PRO and no ECM!
$\Longrightarrow$ by and large: control and raising only differ semantically!

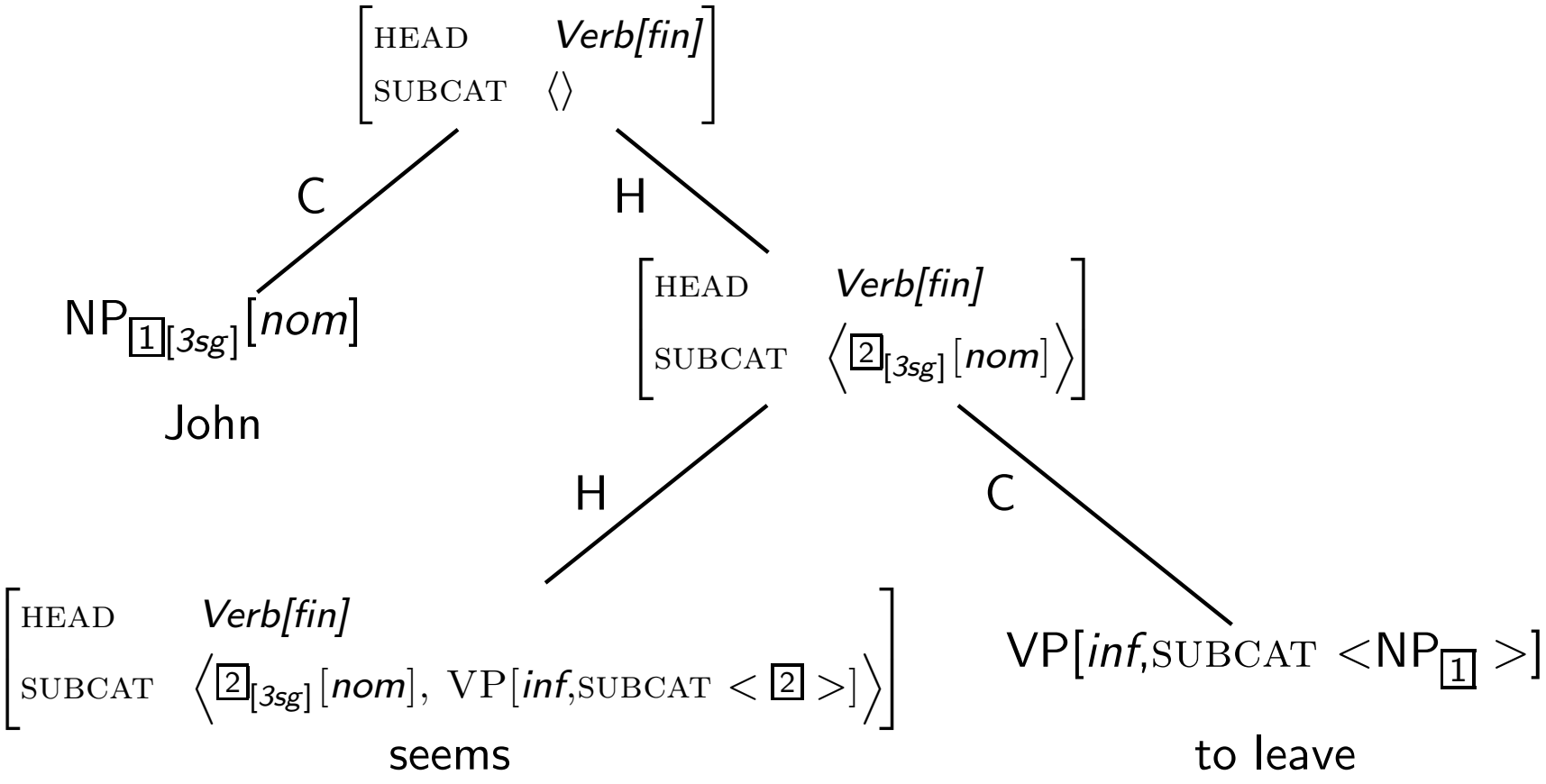
Raising and control (2) - The other lexical entries

"to leave": $\begin{bmatrix} \textit{word} & \\ \text{CAT} & \begin{bmatrix} \text{HEAD} & \text{Verb[inf]} \\ \text{SUBCAT} & \left\langle \text{NP}_{\boxed{1}} \right\rangle \end{bmatrix} \\ \text{CONT} & \textit{leave}(\boxed{1}) \end{bmatrix}$

"John": $\begin{bmatrix} \textit{word} & \\ \text{CAT} & \begin{bmatrix} \text{HEAD} & \text{Noun[nom]} \\ \text{SUBCAT} & \langle\rangle \end{bmatrix} \\ \text{CONT} & \begin{bmatrix} \text{INDEX} & \boxed{1} \begin{bmatrix} \text{PER} & 3 \\ \text{NUM} & \text{sg} \\ \text{GEND} & \text{masc} \end{bmatrix} \\ \textit{john}(\boxed{1}) & \end{bmatrix} \end{bmatrix}$

Raising and control (3) - The derivation

(2) John seems to leave.



Extraction - Traces

(3) Kim we know Sandy claims Dana hates __.

Trace (simplified version):

$$\begin{bmatrix} \text{PHON} & \langle\rangle \\ \text{SYNSEM} & \begin{bmatrix} \text{LOCAL} & \boxed{1} \\ \text{NONLOCAL} & \begin{bmatrix} \text{SLASH} & \left\{\boxed{1}\right\} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

- SLASH collects LOCAL-values of traces.
- LOCAL-values of traces and their fillers are structure shared.

Extraction - Principle and ID Schema

Nonlocal Feature Principle (for *head-comp-struc*)

$$\begin{bmatrix} \text{SYSNEM} \mid \text{NONLOC} \mid \text{SLASH} & \bigcup \boxed{2} \ldots \boxed{n} \\ \text{DTRS} & \begin{bmatrix} \textit{head-comp-struc} & \\ \text{HEAD-DTR} \mid \text{SYNSEM} \mid \text{NONLOC} \mid \text{SLASH} & \boxed{2} \\ \text{COMP-DTRS} & \left\langle \begin{matrix} \begin{bmatrix} \text{SYNSEM} \mid \text{NONLOC} \mid \text{SLASH} & \boxed{3} \end{bmatrix}, \\ \ldots, \\ \begin{bmatrix} \text{SYNSEM} \mid \text{NONLOC} \mid \text{SLASH} & \boxed{n} \end{bmatrix} \end{matrix} \right\rangle \end{bmatrix} \end{bmatrix}$$

Head-Filler Schema (≈ P&S,94):

$$\begin{bmatrix} \text{SYNSEM} \mid \text{NONLOC} \mid \text{SLASH} & \boxed{2} \backslash \left\{ \boxed{1} \right\} \end{bmatrix}$$

F

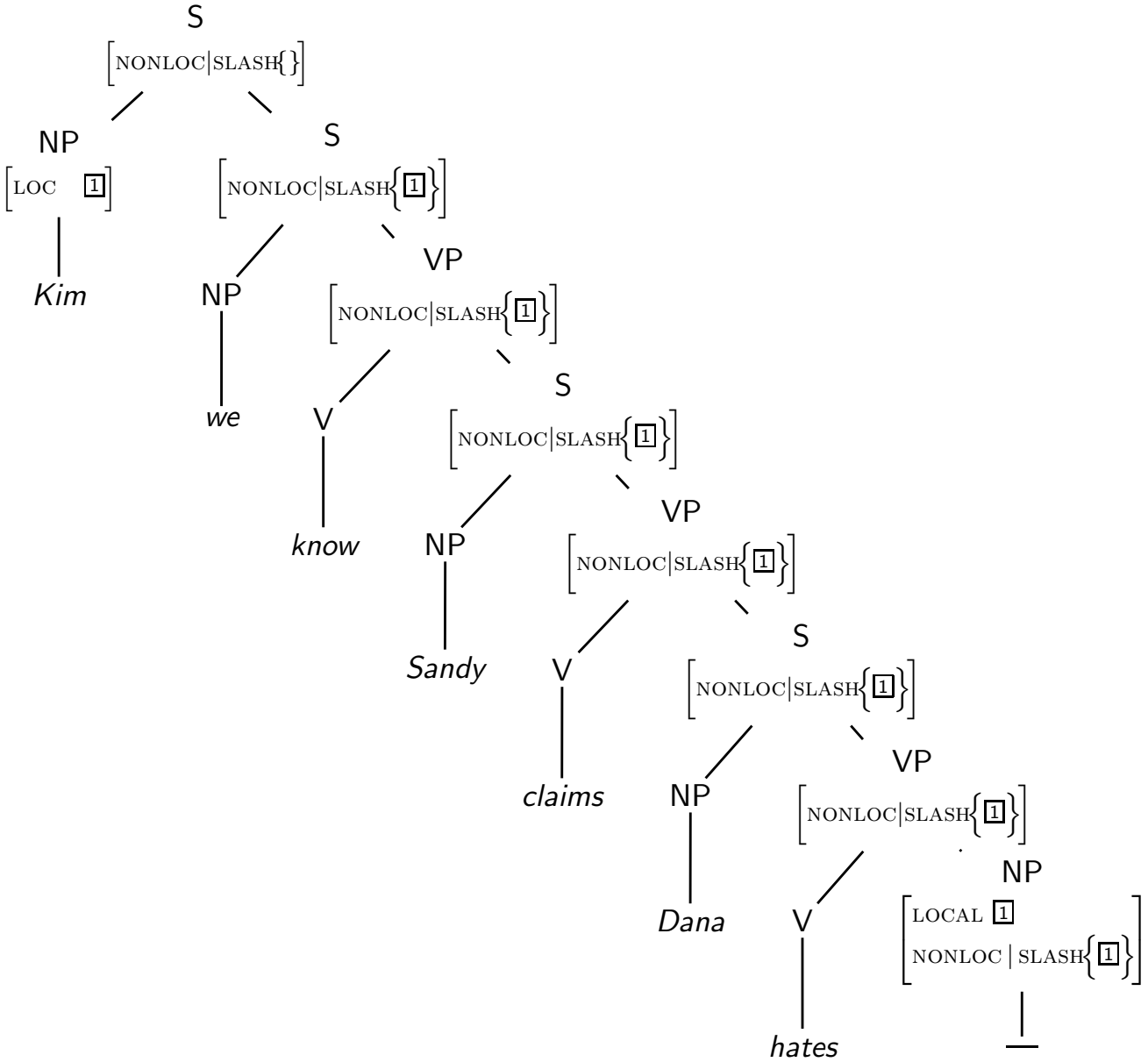
$$\begin{bmatrix} \text{SYNSEM} \mid \text{LOC} & \boxed{1} \end{bmatrix}$$

H

$$\begin{bmatrix} \text{LOC} \mid \text{CAT} \mid \text{HEAD} & \begin{bmatrix} \text{VERB}[\textit{fin}] \\ \text{SUBCAT} \ \langle\rangle \end{bmatrix} \\ \text{NONLOC} \mid \text{SLASH} & \boxed{2} \left\{ \boxed{1}, \ldots \right\} \end{bmatrix}$$

Extraction - An example

(4) Kim we know Sandy claims Dana hates __.



Extraction - Ways to model islands (1)

1.) Finite sentences with complementizer (that, whether)

(5) *Who$_i$ did the elephant whisper that the emu saw __$_i$?
Who$_i$ did the elephant say that the emu saw __$_i$?

- **Non-Bridge Verbs (whisper):** specify their sentential complement having a empty SLASH-set:

$$\begin{bmatrix} \text{LOC} \mid \text{HEAD} \mid \text{SUBCAT} \left\langle \ldots, \begin{bmatrix} \text{NONLOC} \mid \text{SLASH} \quad \{\} \end{bmatrix}, \ldots \right\rangle \end{bmatrix}$$

- **Brigde Verbs (say):** don't specify the sentential complement's SLASH-set.

Extraction - Ways to model islands (2)

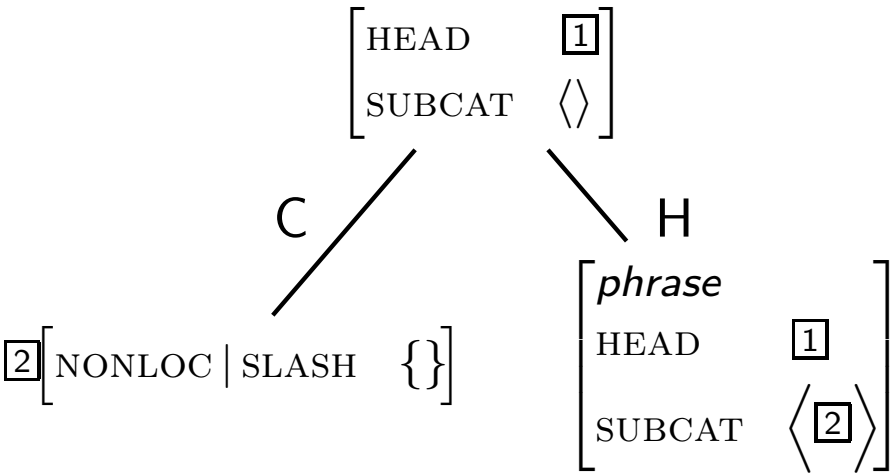
2.) Subjects from finite sentences with complementizer

(6) *Who$_i$ did Alice say that __$_i$ left.
Who$_i$ did Alice say __$_i$ left.

Trace Principle:

SYNSEM values of traces must be a noninitial member of a (substantive head's) SUBCAT list.

$\rightsquigarrow$ implementation within the **Head-Subject Schema**:



2.) Subjects from finite sentences with complementizer

(7) *Who$_i$ did Alice say that __$_i$ left.
Who$_i$ did Alice say __$_i$ left.

Subject Extraction Lexical Rule (SELR):

$$\left[\textsc{synsem}\,|\,\textsc{loc}\,|\,\textsc{cat}\,|\,\textsc{head}\,|\,\textsc{subcat}\ \left\langle \ldots,\mathrm{S}[\textsc{unmarked}],\ldots \right\rangle\right]$$

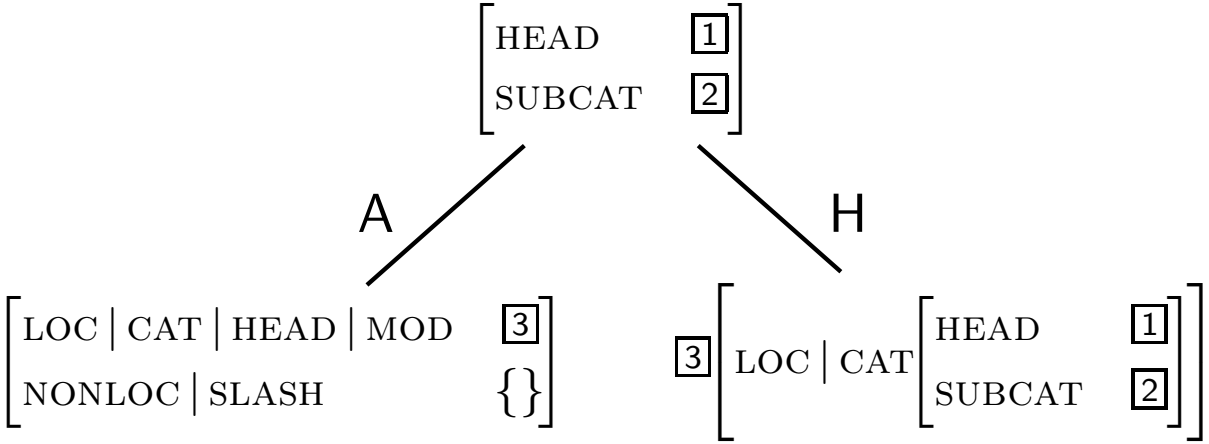
$$\Downarrow$$

$$\left[\textsc{synsem}\left[\begin{array}{l}\textsc{loc}\left[\begin{array}{l}\textsc{cat}\,|\,\textsc{head}\,|\,\textsc{subcat}\left\langle \ldots,\mathrm{VP}\left[\begin{array}{l}\textsc{loc}\,|\,\textsc{head}\,|\,\textsc{subcat}\left\langle\left[\textsc{loc}\ \ \boxed{1}\right]\right\rangle \\ \textsc{nonloc}\,|\,\textsc{slash}\ \{\}\end{array}\right],\ldots\right\rangle\end{array}\right] \\ \textsc{nonloc}\,|\,\textsc{slash}\ \left\{\boxed{1}\right\}\end{array}\right]\right]$$

3.) Adjuncts

(8) *[Which movie]$_i$ did Gorgette fall asleep after watching __$_i$.

⇝ **Head-Adjunct Schema:**



The lexicon

Lexical items are encoded as AVMs, such as the one we have already seen:

$$\begin{bmatrix} \textit{word} & & & & & & \\ \text{PHON} & \langle \text{she} \rangle & & & & & \\ \text{SYNSEM} & \begin{bmatrix} \textit{synsem} & & & & & & \\ \text{LOCAL} & & \begin{bmatrix} \textit{local} & & & & & \\ \text{CATEGORY} & & \begin{bmatrix} \textit{cat} & & & & \\ \text{HEAD} & & \begin{bmatrix} \textit{noun} & & \\ \text{CASE} & \text{NOM} & \end{bmatrix} & & \\ \text{SUBCAT} & \langle\rangle & & & \end{bmatrix} & & \\ \text{CONTENT} & & \begin{bmatrix} \textit{ppro} & & & & \\ \text{INDEX} & \boxed{1} & \begin{bmatrix} \textit{ref} & & \\ \text{PER} & \text{3RD} & \\ \text{NUM} & \text{SING} & \\ \text{GEND} & \text{FEM} & \end{bmatrix} & & \end{bmatrix} & & \\ \text{CONTEXT} & & \begin{bmatrix} \textit{context} & & & & \\ \text{BACKGR} & & \left\{ \begin{bmatrix} \textit{psoa} & & \\ \text{RELN} & \text{FEMALE} & \\ \text{INST} & \boxed{1} & \end{bmatrix} \right\} & & \end{bmatrix} & & \end{bmatrix} & & \\ \text{NONLOCAL} & \ldots & & & & & \end{bmatrix} & & \end{bmatrix}$$

Generalization in the lexicon (1)

“Vertical” generalizations: Make use of underspecification possible through clever design of the type hierarchy

Generalization in the lexicon (2)

"Horizontal" generalizations: Lexical rules which "automatically" license lexical entries based on the present ones.

Example: Passivization (Kiss, 1992):

$$\begin{bmatrix} \textit{stem} & \\ \textsc{cat} & \begin{bmatrix} \textsc{head} & \text{verb} \\ \textsc{subcat} & \left\langle \text{NP}[\textsc{nom}],\ \text{NP}[\textsc{acc}]_{\boxed{1}} \right\rangle \oplus \boxed{2} \end{bmatrix} \end{bmatrix} \mapsto$$

$$\begin{bmatrix} \textit{word} & \\ \textsc{cat} & \begin{bmatrix} \textsc{head} & \begin{bmatrix} \textsc{vform} & \text{passiv-part} \end{bmatrix} \\ \textsc{subcat} & \left\langle \text{NP}[\textsc{nom}]_{\boxed{1}} \right\rangle \oplus \boxed{2} \end{bmatrix} \end{bmatrix}$$

Summary

For a linguistic theory following HPSG, we need at least the following:

- **Signature**
  - Type hierarchy
  - Feature geometry
- **Principles**,
  - general **principles**, restrictions on linguistic objects
  - **ID schemata**, licensing the combination of lexical items
- **Lexicon**:
  - **Lexical entries** (AVMs)
  - **Lexical rules** (AVMs), licensing more lexical items

References

Please see the reference list on the course web page at
`http://www.sfb441.uni-tuebingen.de/emmy/gf/references.pdf`