# Head-Driven Phrase Structure Grammar


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  - syntactic theory
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  - computational linguistics, grammar development
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- Web pages:
  http://hpsg.stanford.edu/ and
  http://hpsg.fu-berlin.de/HPSG-Bib/ (Literature)

# Course Page and Material

- Web page with the slides and handouts of the two lectures:
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- Further reading:
  - Overview article in English: Müller, In Preparationc
  - Introduction to HPSG in German: Müller, 2008
  - Introduction to several frameworks and comparison: Müller, In Preparationb

# Outline

- Motivation & Psychological Reality
- General Overview of the Framework
- Valency
- Head Argument Structures
- Semantics
- Hierarchical Organization of Knowledge
- Lexical Regularities
- Constituent Order
- Nonlocal Dependencies
- Comparison

# Motivations for HPSG

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- Psycholinguistic Plausibility

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# Important Moments in the History of Linguistics – I

Chomsky (1968) speaking of early psycholinguistic findings in relation to the ‘derivational theory of complexity’ (DTC):

> *The results show a remarkable correlation of the amount of memory and number of transformations. (Chomsky, 1968)*

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> *Investigations of DTC [...] have generally proved equivocal.*
> *This argues against the occurrence of grammatical derivations in the computations involved in sentence recognition.*

## HPSG as response to the Fodor, Bever, Garrett dilemma

- HPSG recognizes the 'linguistic structural descriptions'
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  e.g. phonological representations, semantic representations.

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- HPSG recognizes the 'linguistic structural descriptions' whose psychological reality is established, e.g. phonological representations, semantic representations.
- HPSG defines these descriptions via structural definitions and 'interface constraints' (Jackendoff), thus eliminating grammatical derivations in FBG's sense.

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  - Phonology
  - Syntax
  - Semantics

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# Valency and Grammar Rules: PSG

- huge number of rules:

| | |
|---|---|
| S → NP, V | *X schläft* ('sleeps') |
| S → NP, NP, V | *X Y liebt* ('loves') |
| S → NP, PP[*über*], V | *X über y spricht* ('talks about') |
| S → NP, NP, NP, V | *X Y Z gibt* ('gives') |
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- verbs have to be used with the right rule

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- arguments represented as complex categories in the lexical entry of the head (similar to categorial grammar)

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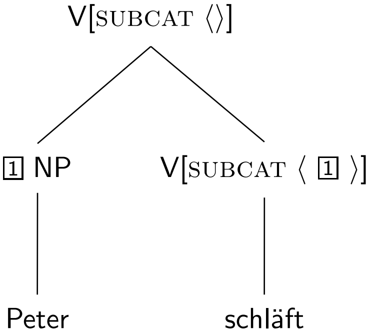
- arguments represented as complex categories in the lexical entry of the head (similar to categorial grammar)
- Verb SUBCAT

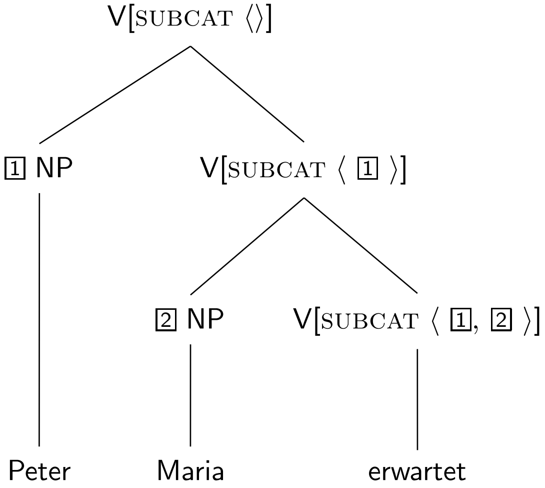
| Verb | SUBCAT |
|---|---|
| *schlafen* | $\langle$ NP $\rangle$ |
| *lieben* | $\langle$ NP, NP $\rangle$ |
| *sprechen* | $\langle$ NP, PP[*über*] $\rangle$ |
| *geben* | $\langle$ NP, NP, NP $\rangle$ |
| *dienen* | $\langle$ NP, NP, PP[*mit*] $\rangle$ |

# Example Tree with Valency Information (I)




V[SUBCAT ⟨ ⟩] corresponds to a fully saturated phrase (VP or S)

# Example Tree with Valency Information (II)



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- specific rules for head argument combination:
  $\text{V[SUBCAT } \boxed{A}] \quad \rightarrow \quad \boxed{1} \quad \text{V[SUBCAT } \boxed{A} \oplus \langle\ \boxed{1}\ \rangle\ ]$

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- $\oplus$ is a relation that concatenates two lists:
  $\langle\ a,\ b\ \rangle = \langle\ a\ \rangle \oplus \langle\ b\ \rangle$ or
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- In the rule above a list is split in a list that contains exactly one element ($\boxed{1}$) and a rest ($\boxed{A}$).
- Depending on the valency of the head the rest may contain zero or more elements.

# Generalization over Rules

- specific rules for head argument combinations:

$$\begin{array}{llll}
\mathrm{V}[\mathrm{SUBCAT}\ \boxed{A}] & \rightarrow & \boxed{1} & \mathrm{V}[\mathrm{SUBCAT}\ \boxed{A} \oplus \langle\ \boxed{1}\ \rangle\ ] \\
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\end{array}$$

- generalized, abstract schema (H = head):

$$\text{H[SUBCAT } \boxed{A}] \rightarrow \text{H[SUBCAT } \boxed{A} \oplus \langle \boxed{1} \rangle ] \quad \boxed{1}$$

# Application of the Rules

- generalized, abstract shema (H = head):
  $\mathrm{H}[\mathrm{SUBCAT}\ \boxed{A}] \quad \rightarrow \quad \mathrm{H}[\mathrm{SUBCAT}\ \boxed{A} \oplus \langle\ \boxed{1}\ \rangle\ ] \qquad \boxed{1}$

# Application of the Rules

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  H[SUBCAT $\boxed{A}$] $\rightarrow$ H[SUBCAT $\boxed{A} \oplus \langle\ \boxed{1}\ \rangle$ ] $\boxed{1}$
- possible instantiations of the schema:
  V[SUBCAT $\boxed{A}$] $\rightarrow$ V[SUBCAT $\boxed{A}\ \langle\rangle \oplus \langle\ \boxed{1}\ \mathrm{NP}\ \rangle$ ] $\boxed{1}$ NP

| | |
|---|---|
| Maria erwartet (Maria waits for) | Peter |
| schläft (sleeps) | Peter |

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| | | erwartet (wait for) | Maria |
| N[SUBCAT $\boxed{A}$] | $\rightarrow$ | N[SUBCAT $\boxed{A}$ $\langle\rangle \oplus \langle \boxed{1}\ \textsc{Det} \rangle$ ] | $\boxed{1}$ Det |
| | | Mann (man) | der (the) |

# Representation of Valency in Feature Descriptions

*gibt* ('gives', finite form):

$$\begin{bmatrix} \textsc{phon} & \langle \textit{gibt} \rangle \\ \textsc{part-of-speech} & \textit{verb} \\ \textsc{subcat} & \left\langle \mathrm{NP}[\textit{nom}],\ \mathrm{NP}[\textit{acc}],\ \mathrm{NP}[\textit{dat}] \right\rangle \end{bmatrix}$$

NP[*nom*], NP[*acc*] and NP[*dat*] are abbreviations of complex feature descriptions.

# Demo: Grammar 3

(1) a. der Mann schläft
the man sleeps
'The man sleeps'

b. der Mann die Frau kennt
the man the woman knows
'The man knows the woman.'

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- Feature Descriptions as uniform means for describing linguistic objects
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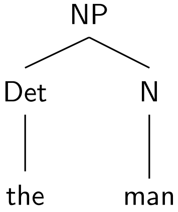
- separation of immediate dominance (ID) and linearer precedence (LP)
- dominance in DTR features (head daughters and non-head daughters)
- precedence is implicit in PHON

# Part of the Structure in AVM Representation – PHON values (I)




$$\begin{bmatrix} \text{PHON} & \langle \textit{the man} \rangle \\ \text{HEAD-DTR} & \begin{bmatrix}\text{PHON} & \langle \textit{man}\rangle\end{bmatrix} \\ \text{NON-HEAD-DTRS} & \left\langle \begin{bmatrix}\text{PHON} & \langle \textit{the}\rangle\end{bmatrix}\right\rangle \end{bmatrix}$$

- There is exactly one head daughter (HEAD-DTR).
  The head daughter contains the head.
  a structure with the daughters *the* and *picture of Mary* →
  *picture of Mary* is the head daughter, since *picture* is the head.

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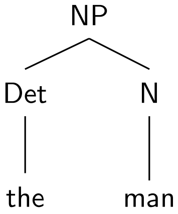


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  a structure with the daughters *the* and *picture of Mary* $\rightarrow$
  *picture of Mary* is the head daughter, since *picture* is the head.
- There may be several non-head daughters
  (if we assume flat structures or in headless binary branching structures).

# Representation of Grammar Rules

- Dominance Rule:

  *head-argument-phrase* $\rightarrow$

  $$\begin{bmatrix} \text{SUBCAT } \boxed{A} \\ \text{HEAD-DTR}|\text{SUBCAT } \boxed{A} \oplus \langle \boxed{1} \rangle \\ \text{NON-HEAD-DTRS } \langle \boxed{1} \rangle \end{bmatrix}$$

  The arrow stands for implication

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- Dominance Rule:

  *head-argument-phrase* $\rightarrow$

  $$\begin{bmatrix} \textsc{subcat} & \boxed{A} \\ \textsc{head-dtr}|\textsc{subcat} & \boxed{A} \oplus \langle\ \boxed{1}\ \rangle \\ \textsc{non-head-dtrs} & \langle\ \boxed{1}\ \rangle \end{bmatrix}$$

  The arrow stands for implication

- alternative spelling, inspired by the $\overline{\text{X}}$ Schema:
  $\text{H[SUBCAT } \boxed{A}] \rightarrow \text{H[SUBCAT } \boxed{A} \oplus \langle\ \boxed{1}\ \rangle\ ] \quad \boxed{1}$

  The arrow stands for replacement (rewriting)

## Representation of Grammar Rules

- Dominance Rule:

  *head-argument-phrase* $\rightarrow$

  $$\begin{bmatrix} \text{SUBCAT } \boxed{A} \\ \text{HEAD-DTR}|\text{SUBCAT } \boxed{A} \oplus \langle \boxed{1} \rangle \\ \text{NON-HEAD-DTRS } \langle \boxed{1} \rangle \end{bmatrix}$$

  The arrow stands for implication

- alternative spelling, inspired by the $\overline{\text{X}}$ Schema:

  $\text{H[SUBCAT } \boxed{A}] \rightarrow \text{H[SUBCAT } \boxed{A} \oplus \langle \boxed{1} \rangle ] \quad \boxed{1}$

  The arrow stands for replacement (rewriting)

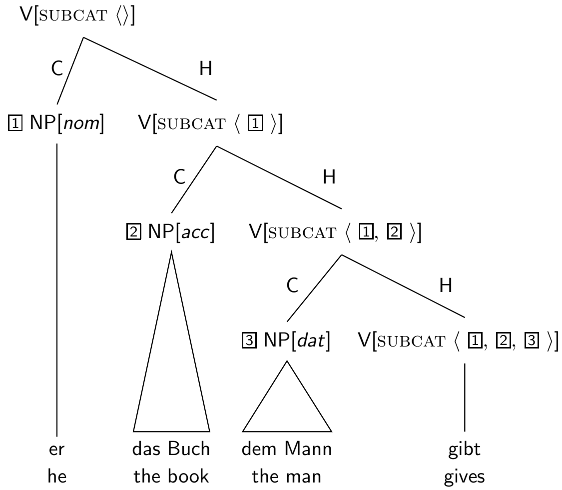
- possible instantiations:

  $\text{N[SUBCAT } \boxed{A}] \rightarrow \text{N[SUBCAT } \boxed{A} \langle\rangle \oplus \langle \text{DET} \rangle ] \text{ Det}$

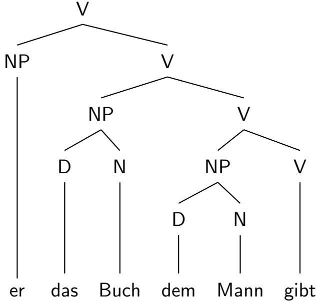
  $\text{V[SUBCAT } \boxed{A}] \rightarrow \text{V[SUBCAT } \boxed{A} \langle\rangle \oplus \langle \text{NP} \rangle ] \quad \text{NP}$

  $\text{V[SUBCAT } \boxed{A}] \rightarrow \text{V[SUBCAT } \boxed{A} \langle \text{NP} \rangle \oplus \langle \text{NP} \rangle ] \quad \text{NP}$

# An Example


V[SUBCAT ⟨⟩]
C
H
1 NP[*nom*]
V[SUBCAT ⟨ 1 ⟩]
C
H
2 NP[*acc*]
V[SUBCAT ⟨ 1, 2 ⟩]
C
H
3 NP[*dat*]
V[SUBCAT ⟨ 1, 2, 3 ⟩]
er
he
das Buch
the book
dem Mann
the man
gibt
gives

# Part of the Structure in AVM Representation – PHON values (I)




$$\begin{bmatrix} \text{PHON} & \langle \textit{ dem Mann gibt } \rangle \\ \text{HEAD-DTR} & \begin{bmatrix} \text{PHON} \; \langle \textit{ gibt } \rangle \end{bmatrix} \\ \text{NON-HEAD-DTRS} & \left\langle \begin{bmatrix} \text{PHON} & \langle \textit{ dem Mann } \rangle \\ \text{HEAD-DTR} & \begin{bmatrix} \text{PHON} \; \langle \textit{ Mann } \rangle \end{bmatrix} \\ \text{NON-HEAD-DTRS} & \left\langle \begin{bmatrix} \text{PHON} \; \langle \textit{ dem } \rangle \end{bmatrix} \right\rangle \end{bmatrix} \right\rangle \end{bmatrix}$$

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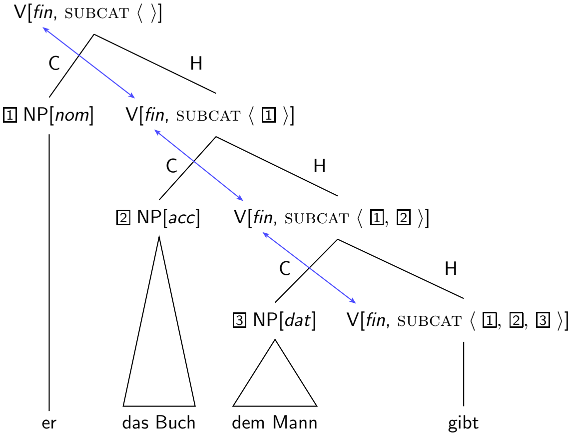
# Partial Structure in Feature Structure Representation

$$
\left[\begin{array}{ll}
\textsc{phon} & \langle\ \textit{dem Mann gibt}\ \rangle \\
\textsc{subcat} & \boxed{A}\ \langle \mathrm{NP}[\textit{nom}],\ \mathrm{NP}[\textit{acc}] \rangle \\
\textsc{head-dtr} & \left[\begin{array}{ll}
\textsc{phon} & \langle\ \textit{gibt}\ \rangle \\
\textsc{subcat} & \boxed{A} \oplus \langle \boxed{1} \rangle
\end{array}\right] \\
\textsc{non-head-dtrs} & \left\langle \boxed{1} \left[\begin{array}{ll}
\textsc{phon} & \langle\ \textit{dem Mann}\ \rangle \\
\textsc{p-o-s} & \textit{noun} \\
\textsc{subcat} & \langle\rangle \\
\textsc{head-dtr} & \ldots \\
\textsc{non-head-dtrs} & \ldots \\
\multicolumn{2}{l}{\textit{head-argument-phrase}}
\end{array}\right] \right\rangle \\
\multicolumn{2}{l}{\textit{head-argument-phrase}}
\end{array}\right]
$$

# Projection of Head Properties




The finite verb is the head.

# Feature Structure Representation: the HEAD Value

- possible feature geometry:

$$\begin{bmatrix} \textsc{phon} & \textit{list of phoneme strings} \\ \textsc{p-o-s} & \textit{p-o-s} \\ \textsc{vform} & \textit{vform} \\ \textsc{subcat} & \textit{list} \end{bmatrix}$$

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- more structure, bundling of information that has to be projected:

$$\begin{bmatrix} \textsc{phon} & \textit{list of phoneme strings} \\ \textsc{head} & \begin{bmatrix} \textsc{p-o-s} & \textit{p-o-s} \\ \textsc{vform} & \textit{vform} \end{bmatrix} \\ \textsc{subcat} & \textit{list} \end{bmatrix}$$

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- Possible structure: a structure that contains all features:

$$\begin{bmatrix} \text{P-O-S} & \textit{p-o-s} \\ \text{VFORM} & \textit{vform} \\ \text{CASE} & \textit{case} \end{bmatrix}$$

CASE has no value for verbs, VFORM has no value for nouns

# Different Heads Project Different Features

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  CASE has no value for verbs, VFORM has no value for nouns
- Better solution: different types of feature structures
  - for verbs:

$$\begin{bmatrix} \text{VFORM} & \textit{vform} \\ \textit{verb} & \end{bmatrix}$$

  - for nouns:

$$\begin{bmatrix} \text{CASE} & \textit{case} \\ \textit{noun} & \end{bmatrix}$$

# A Lexical Entry with Head Features

- A lexical entry contains the following:
  *gibt*: ('gives')

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  *gibt*: ('gives')

  $$\begin{bmatrix} \text{PHON} & \langle \textit{gibt} \rangle \\ & \\ & \\ & \end{bmatrix}$$

  - phonological information

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$$\begin{bmatrix} \textsc{phon} & \langle \textit{gibt} \rangle \\ \textsc{head} & \begin{bmatrix} \textsc{vform} & \textit{fin} \\ \textit{verb} & \end{bmatrix} \\ & \end{bmatrix}$$

  - phonological information
  - head information (part of speech, verb form, ...)

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  - phonological information
  - head information (part of speech, verb form, . . . )
  - valency information: a list of descriptions of arguments

# The Head Feature Principle

- In a headed structure the head features of the mother are identical to the head features of the head daughter.

$$\textit{headed-phrase} \rightarrow \begin{bmatrix} \text{HEAD } \boxed{1} \\ \text{HEAD-DTR}|\text{HEAD } \boxed{1} \end{bmatrix}$$

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  $\rightarrow$ All constraints apply to structures of this type as well.

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- *head-argument-phrase* is a subtype of *headed-phrase*
  $\rightarrow$ All constraints apply to structures of this type as well.
- *head-argument-phrase* inherits properties of/constraints on *headed-phrase*.

# Demo: Grammar 4

(2) a. der Mann schläft
the man sleeps
'The man sleeps'

b. der Mann die Frau kennt
the man the woman knows
'The man knows the woman.'

# Outline

- Motivation & Psychological Reality
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# Semantics

- Pollard and Sag (1987) and Ginzburg and Sag (2000) assume Situation Semantics (Barwise and Perry, 1983; Cooper, Mukai and Perry, 1990; Devlin, 1992).

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- More recent work (in particular work in relation to computational implementations) uses *Minimal Recursion Semantics* (Copestake, Flickinger, Pollard and Sag, 2005).

# The Representation of Relations with Feature Descriptions

love(e,x,y)

$$\begin{bmatrix} \text{ARG0} & \textit{event} \\ \text{ARG1} & \textit{index} \\ \text{ARG2} & \textit{index} \\ \textit{love} & \end{bmatrix}$$

# The Representation of Relations with Feature Descriptions

love(e,x,y)    book(x)

$$\begin{bmatrix} \textsc{arg0} & \textit{event} \\ \textsc{arg1} & \textit{index} \\ \textsc{arg2} & \textit{index} \\ \textit{love} & \end{bmatrix} \qquad \begin{bmatrix} \textsc{arg0} & \textit{index} \\ \textit{book} & \end{bmatrix}$$

# Representation of the CONT Value

- possible data structure (CONT = CONTENT):

$$\begin{bmatrix} \text{PHON} & \textit{list of phoneme strings} \\ \text{HEAD} & \textit{head} \\ \text{SUBCAT} & \textit{list} \\ \text{CONT} & \textit{mrs} \end{bmatrix}$$

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- more structure:
  partition into syntactic and semantic information (CAT = CATEGORY)

$$\begin{bmatrix} \text{PHON} & \textit{list of phoneme strings} \\ \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{head} \\ \text{SUBCAT} & \textit{list} \\ \textit{cat} & \end{bmatrix} \\ \text{CONT} & \textit{mrs} \end{bmatrix}$$

- $\rightarrow$ it is now possible to share syntactic information only

# Sharing of Syntactic Information in Coordinations

- symmetric coordination: the CAT value is identical

$$\begin{bmatrix} \textsc{phon} & \textit{list of phoneme strings} \\ \textsc{cat} & \begin{bmatrix} \textsc{head} & \textit{head} \\ \textsc{subcat} & \textit{list} \\ \textit{cat} & \end{bmatrix} \\ \textsc{cont} & \textit{mrs} \end{bmatrix}$$

- Examples:

(3) a. [the man and the woman]
b. He [knows and likes] this record.
c. He is [stupid and arrogant].

# The Semantic Contribution of Nominal Objects

- semantic index + restrictions

$$\begin{bmatrix} \text{PHON} & \langle \textit{Buch} \rangle \\ \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{noun} \\ \text{SUBCAT} & \left\langle \text{DET} \right\rangle \end{bmatrix} \\ \text{CONT} & \begin{bmatrix} \text{IND} & \boxed{1} \begin{bmatrix} \text{PER} & \textit{3} \\ \text{NUM} & \textit{sg} \\ \text{GEN} & \textit{neu} \\ \textit{index} & \end{bmatrix} \\ \text{RELS} & \left\langle \begin{bmatrix} \text{ARG0} & \boxed{1} \\ \textit{buch} & \end{bmatrix} \right\rangle \\ \textit{mrs} & \end{bmatrix} \end{bmatrix}$$

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- Person, number, and gender are relevant for reference/coreference:

(4) Die Frau$_i$ kauft ein Buch$_j$. Sie$_i$ liest es$_j$.
the woman buys a book she reads it

# Abbreviations

$$\mathrm{NP}_{[3,\mathit{sg},\mathit{fem}]} \quad \begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \mathit{noun} \\ \text{SUBCAT} & \langle\rangle \end{bmatrix} \\ \text{CONT}|\text{IND} & \begin{bmatrix} \text{PER} & \mathit{3} \\ \text{NUM} & \mathit{sg} \\ \text{GEN} & \mathit{fem} \end{bmatrix} \end{bmatrix}$$

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$$\mathrm{NP}_{\boxed{1}} \left[\begin{array}{ll} \text{CAT} & \left[\begin{array}{ll} \text{HEAD} & \mathit{noun} \\ \text{SUBCAT} & \langle\rangle \end{array}\right] \\ \text{CONT} & \left[\begin{array}{ll} \text{IND} & \boxed{1} \end{array}\right] \end{array}\right]$$

# The Semantic Contribution of Verbs and Linking

- Linking of valency information and semantic contribution

  *gibt* (*gives*, finite Form):

$$
\left[\begin{array}{ll}
\text{CAT} & \left[\begin{array}{ll}
\text{HEAD} & \left[\begin{array}{ll}\text{VFORM} & \textit{fin}\\ \textit{verb} & \end{array}\right]\\
\text{SUBCAT} & \left\langle \text{NP}[\textit{nom}]_{\boxed{1}}, \text{NP}[\textit{acc}]_{\boxed{2}}, \text{NP}[\textit{dat}]_{\boxed{3}} \right\rangle
\end{array}\right]\\
\text{CONT} & \left[\begin{array}{ll}
\text{IND} & \boxed{4}\ \textit{event}\\
\text{RELS} & \left\langle \left[\begin{array}{ll}
\text{ARG0} & \boxed{4}\\
\text{ARG1} & \boxed{1}\\
\text{ARG2} & \boxed{2}\\
\text{ARG3} & \boxed{3}\\
\textit{geben} &
\end{array}\right] \right\rangle\\
\textit{mrs} &
\end{array}\right]
\end{array}\right]
$$

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- The referential indices of the NPs are identified with the semantic roles.

# Semantics Principle (Part)

In headed strucutres the semantic index of the mother is identical to the semantic index of the head daughter.

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In headed strucutres the semantic index of the mother is identical to the semantic index of the head daughter.

The RELS list of the mother is the concatenation of the RELS lists of the daughters.

# Demo: Berligram

(5) Jeder Sohn eines Beamten rennt.
every son of.a state.employee runs

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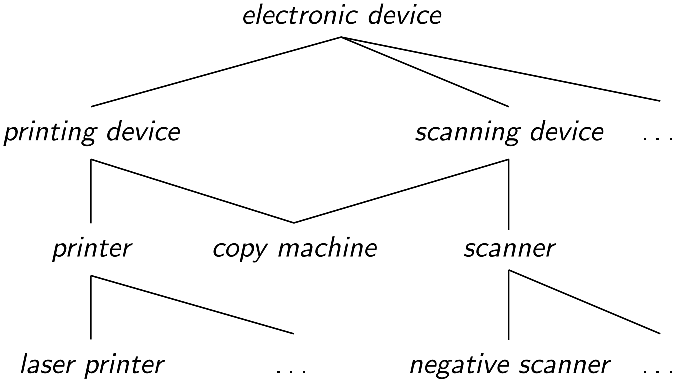
# Types: A Non-Linguistic Example for Multiple Inheritance



# Properties of Type Hierarchies

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  General restrictions are represented at types that are high in the hierarchy.
- More special types inherit from their super types.
- We can represent information with no redundancy.

# Linguistic Generalizations in the Type System

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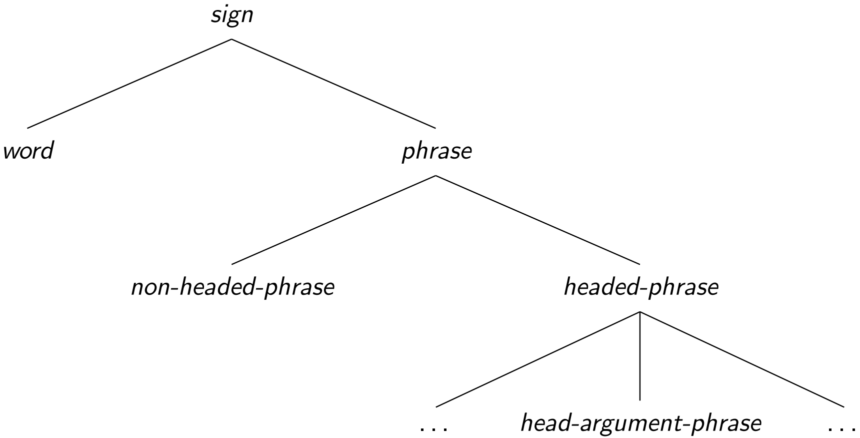
- Example: Entries in an Encyclopedia.
  Entry refers to more general concepts,
  no repitition of information that is present at more general concepts.
- The upper part of the hierarchy is relevant for all languages ("universal grammar").
- More specific type can be relevant for certain classes of languages or even single languages only.

# Type Hierarchy for *sign*




all subtypes of *headed-phrase* inherit restrictions

# All Constraints for a Local Tree (Head-Argument)

$$\begin{bmatrix} \text{HEAD} & \boxed{1} \\ \text{SUBCAT} & \boxed{A} \\ \text{HEAD-DTR} & \begin{bmatrix} \text{HEAD} & \boxed{1} \\ \text{SUBCAT} & \boxed{A} \oplus \langle \boxed{2} \rangle \end{bmatrix} \\ \text{NON-HEAD-DTRS} & \langle \boxed{2} \rangle \\ \textit{head-argument-phrase} & \end{bmatrix}$$

# Partial Structure in Feature Structure Representation

$$\begin{bmatrix}
\text{PHON} & \langle \textit{dem Mann gibt} \rangle \\
\text{HEAD} & \boxed{1} \\
\text{SUBCAT} & \boxed{A}\ \langle \text{NP}[\textit{nom}],\ \text{NP}[\textit{acc}] \rangle \\
\text{HEAD-DTR} & \begin{bmatrix}
\text{PHON} & \langle \textit{gibt} \rangle \\
\text{HEAD} & \boxed{1} \begin{bmatrix} \text{VFORM} & \textit{fin} \\ \textit{verb} & \end{bmatrix} \\
\text{SUBCAT} & \boxed{A} \oplus \langle \boxed{2} \rangle \\
\textit{word} &
\end{bmatrix} \\
\text{NON-HEAD-DTRS} & \left\langle \boxed{2} \begin{bmatrix}
\text{PHON} & \langle \textit{dem Mann} \rangle \\
\text{HEAD} & \begin{bmatrix} \text{CAS} & \textit{dat} \\ \textit{noun} & \end{bmatrix} \\
\text{SUBCAT} & \langle\rangle \\
\text{HEAD-DTR} & \ldots \\
\text{NON-HEAD-DTRS} & \ldots \\
\textit{head-argument-phrase} &
\end{bmatrix} \right\rangle \\
\textit{head-argument-phrase} &
\end{bmatrix}$$

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# Outline

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- lexicalization $\rightarrow$
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- lexicalization →
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- but very complex lexical entries
- structuring and classification →
  capturing of generalizations & avoidance of redundancies
- type hierarchies and lexical rules

# The Complexitiy of a Lexical Entry of a Count Noun

$$\begin{bmatrix} \text{PHON} & \langle \textit{Frau} \rangle \\ \text{CAT} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \textit{noun} \end{bmatrix} \\ \text{SUBCAT} & \left\langle \text{DET} \right\rangle \\ \ldots & \ldots \end{bmatrix} \\ \text{CONT} & \begin{bmatrix} \text{IND} & \boxed{1} \begin{bmatrix} \text{PER} & \textit{3} \\ \text{GEN} & \textit{fem} \end{bmatrix} \\ \text{RELS} & \left\langle \begin{bmatrix} \text{INST} & \boxed{1} \\ \textit{frau} & \end{bmatrix} \right\rangle \end{bmatrix} \\ \ldots & \ldots \end{bmatrix}$$

Only a very small part of this is idiosyncratic.

# Partitioning of the Information

a. all nouns

$$\begin{bmatrix} \text{CAT}|\text{HEAD} \ \textit{noun} \\ \text{CONT} \ \textit{nom-obj} \end{bmatrix}$$

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a. all nouns

$$\begin{bmatrix} \text{CAT}|\text{HEAD}\ \textit{noun} \\ \text{CONT}\ \textit{nom-obj} \end{bmatrix}$$

b. all referential non-pronominal Ns taking a determiner (in addition to a)

$$\begin{bmatrix} \text{CAT}|\text{SUBCAT}\ \left\langle \text{DET} \right\rangle \\ \text{CONT} \begin{bmatrix} \text{IND} & \boxed{1} \begin{bmatrix} \text{PER}\ \textit{3} \end{bmatrix} \\ \text{RELS} & \left\langle \begin{bmatrix} \text{INST}\ \boxed{1} \\ \textit{psoa} \end{bmatrix}, \ldots \right\rangle \end{bmatrix} \end{bmatrix}$$

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$$\begin{bmatrix} \text{CAT}|\text{HEAD } \textit{noun} \\ \text{CONT } \textit{nom-obj} \end{bmatrix}$$

b. all referential non-pronominal Ns taking a determiner (in addition to a)

$$\begin{bmatrix} \text{CAT}|\text{SUBCAT } \left\langle \text{DET} \right\rangle \\ \text{CONT} \begin{bmatrix} \text{IND} & \boxed{1} \begin{bmatrix} \text{PER } \textit{3} \end{bmatrix} \\ \text{RELS} & \left\langle \begin{bmatrix} \text{INST } \boxed{1} \\ \textit{psoa} \end{bmatrix}, \ldots \right\rangle \end{bmatrix} \end{bmatrix}$$

c. all feminine nouns (in addition to a)

$$\begin{bmatrix} \text{CONT}|\text{IND}|\text{GEN } \textit{fem} \end{bmatrix}$$

# The Complexity of a Lexical Entry for a Verb

*helf-* (Lexical entry (root)):

$$\begin{bmatrix} \text{PHON} & \langle \textit{helf} \rangle \\ \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{SUBCAT} & \left\langle \text{NP}[\textit{nom}]_{\boxed{1}},\ \text{NP}[\textit{dat}]_{\boxed{2}} \right\rangle \end{bmatrix} \\ \text{CONT} & \begin{bmatrix} \text{IND} & \boxed{3} \\ \text{RELS} & \left\langle \begin{bmatrix} \text{ARG0} & \boxed{3} \\ \text{ARG1} & \boxed{1} \\ \text{ARG2} & \boxed{2} \\ \textit{helfen} & \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix}$$

# Partitioning of the Information

a. all verbs

$$\begin{bmatrix} \text{CAT}|\text{HEAD} \ \textit{verb} \\ \text{CONT} \begin{bmatrix} \text{IND} & \boxed{3} \\ \text{RELS} & \left\langle \begin{bmatrix} \text{ARG0} \ \boxed{3} \\ \textit{relation} \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix}$$

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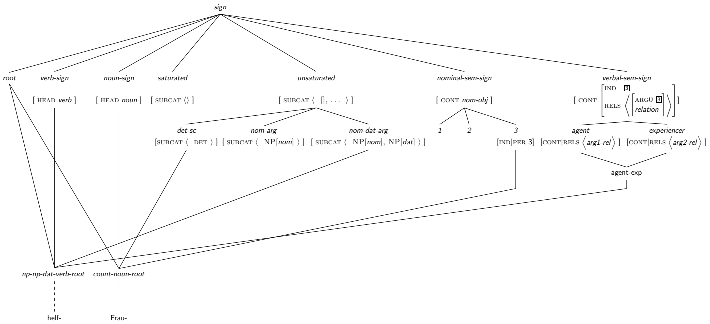
c. all bivalent verbs with ARG1 and ARG2 (in addition to a)

$$\begin{bmatrix} \text{CAT}|\text{SUBCAT} & \left\langle \begin{bmatrix}\text{CONT}|\text{IND}\ \boxed{1}\end{bmatrix}, \begin{bmatrix}\text{CONT}|\text{IND}\ \boxed{2}\end{bmatrix} \right\rangle \\ \text{CONT} & \begin{bmatrix} \text{RELS} & \left\langle \begin{bmatrix} \text{ARG1} & \boxed{1} \\ \text{ARG2} & \boxed{2} \\ \textit{arg1-arg2-rel} & \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix}$$

# Part of a Possible Type Hierarchy

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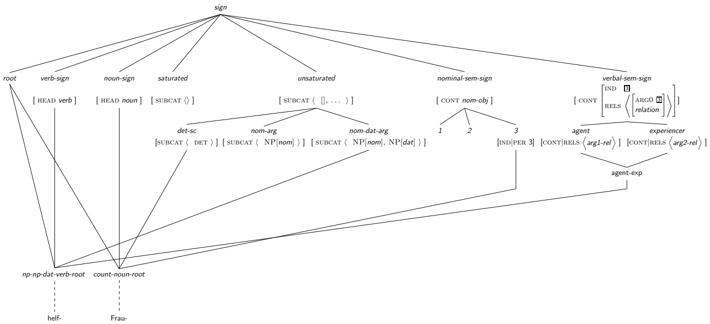


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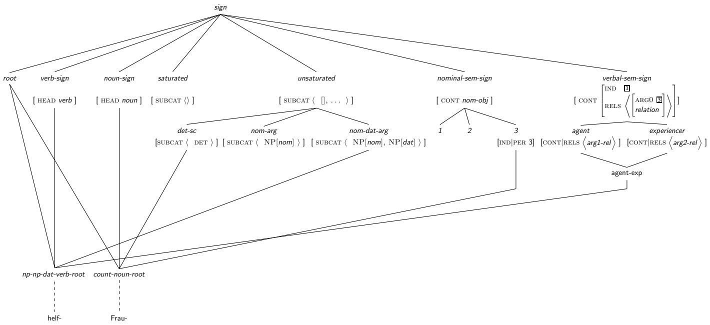


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- Instances are connected via dashed lines.

# Examples for Lexical Items

$$\begin{bmatrix} \text{PHON} & \langle \textit{ Frau } \rangle \\ \text{CONT}|\text{RELS} & \langle \textit{ frau } \rangle \\ \textit{count-noun-root} & \end{bmatrix}$$

$$\begin{bmatrix} \text{PHON} & \langle \textit{ helf } \rangle \\ \text{CONT}|\text{RELS} & \langle \textit{ helfen } \rangle \\ \textit{np-np-dat-verb-root} & \end{bmatrix}$$

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- Remark: There are proposals in the literature to treat passive by inheritance, but this does not work in general (Müller, 2006, 2007).

# Lexical Rules

- Instead of inheritance we use lexical rules.
  Jackendoff (1975), Williams (1981), Bresnan (1982), Shieber, Uszkoreit, Pereira, Robinson and Tyson (1983), Flickinger, Pollard and Wasow (1985), Flickinger (1987), Copestake and Briscoe (1992), Meurers (2000)

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- Example passive:
  A lexical rule relates a stem to the corresponding passive form.
- There are different conceptions of lexical rules:
  Meta Level Lexical Rules (MLR) vs.
  Description Level Lexical Rules (DLR)
  See Meurers, 2000 for a detailed discussion.

# Lexical Rule for the Passive

Lexical Rule for the passive:

$$\begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{SUBCAT} & \left\langle \text{NP}[\textit{nom}],\ \text{NP}[\textit{acc}]_{\boxed{1}} \right\rangle \oplus \boxed{A} \end{bmatrix} \\ \textit{stem} & \end{bmatrix} \mapsto$$

$$\begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \text{VFORM} & \textit{passiv-part} \end{bmatrix} \\ \text{SUBCAT} & \left\langle \text{NP}[\textit{nom}]_{\boxed{1}} \right\rangle \oplus \boxed{A} \end{bmatrix} \\ \textit{word} & \end{bmatrix}$$

(6) a. The man beats the dog.

b. The dog was beaten.

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(6) a. The man beats the dog.
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Note: This is simplified, see Müller, 2002 for Haider's passive analysis in HPSG.

# Conventions for the Interpretation of Lexical Rules

- Information that is not mentioned in the output,
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- Information that is not mentioned in the output, is carried over from the input.
- Example: Passive preserves meaning.
  The CONT values of input and output are identical.
  Linking information is preserved:

Active:

$$\begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{SUBCAT} & \left\langle \text{NP}[\textit{nom}]_{\boxed{1}},\ \text{NP}[\textit{acc}]_{\boxed{2}} \right\rangle \end{bmatrix} \\ \text{CONT} & \begin{bmatrix} \text{IND} & \boxed{3} \\ \text{RELS} & \left\langle \begin{bmatrix} \text{ARG0} & \boxed{3} \\ \text{ARG1} & \boxed{1} \\ \text{ARG2} & \boxed{2} \\ \textit{beat} & \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix}$$

Passive:

$$\begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{SUBCAT} & \left\langle \text{NP}[\textit{nom}]_{\boxed{2}} \right\rangle \end{bmatrix} \\ \text{CONT} & \begin{bmatrix} \text{IND} & \boxed{3} \\ \text{RELS} & \left\langle \begin{bmatrix} \text{ARG0} & \boxed{3} \\ \text{ARG1} & \boxed{1} \\ \text{ARG2} & \boxed{2} \\ \textit{beat} & \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix}$$

# The Lexical Rule for the Passive in a Different Notation

$$\left[\begin{array}{ll} \text{CAT} & \left[\begin{array}{ll} \text{HEAD}|\text{VFORM} & \textit{passiv-part} \\ \text{SUBCAT} & \left\langle \text{NP}[\textit{nom}]_{\boxed{1}} \right\rangle \oplus \boxed{A} \end{array}\right] \\ \text{LEX-DTR} & \left[\begin{array}{ll} \text{CAT} & \left[\begin{array}{ll} \text{HEAD} & \textit{verb} \\ \text{SUBCAT} & \left\langle \text{NP}[\textit{nom}],\ \text{NP}[\textit{acc}]_{\boxed{1}} \right\rangle \oplus \boxed{A} \end{array}\right] \\ \multicolumn{2}{l}{\textit{stem}} \end{array}\right] \\ \multicolumn{2}{l}{\textit{acc-passive-lexical-rule}} \end{array}\right]$$

- like a unary projection, but restricted to the lexicon

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- This form of lexical rule is fully integrated into the HPSG formalism.

# The Lexical Rule for the Passive with Morphology

$$\left[\begin{array}{ll}
\textsc{phon} & f(\boxed{1}) \\
\textsc{cat} & \left[\begin{array}{ll} \textsc{head}|\textsc{vform} & \textit{passiv-part} \\ \textsc{subcat} & \left\langle \mathrm{NP}[\textit{nom}]_{\boxed{2}} \right\rangle \oplus \boxed{A} \end{array}\right] \\
\textsc{lex-dtr} & \left[\begin{array}{ll} \textsc{phon} & \boxed{1} \\ \textsc{cat}|\textsc{subcat} & \left\langle \mathrm{NP}[\textit{nom}],\ \mathrm{NP}[\textit{acc}]_{\boxed{2}} \right\rangle \oplus \boxed{A} \\ \multicolumn{2}{l}{\textit{stem}} \end{array}\right] \\
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- *f* is a function that returns the passive form that corresponds to the PHON value of the LEX-DTR (*kick* → *kicked*)
- Alternative: Head Affix Structures
  (similar to binary branching structures in syntax)

# Head Affix Structures vs. Lexical Rules

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  (Orgun, 1996; Riehemann, 1998; Ackerman and Webelhuth, 1998; Koenig, 1999; Müller, 2002)

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- Sometimes it is regarded as an advantage that lexical rules make the stipulation of hundreds of empty affixes for zero inflection and conversion unnecessary.
- Subtractive morphemes are not needed in an LR-based approach.
- Some languages have affixal material that realizes more than one argument (Crysmann, 2002, Chapter 2.1.1.4 and p. 169–171).

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# Outline

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- How do we account for the serialization of arguments?
- How do we account for the verb position?

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# Relatively Free Constituent Order

- Arguments can be serialized in almost any order:

(7) a. weil der Mann der Frau das Buch gibt
because the man the woman the book gives
'because the man gives the book to the woman'

b. weil der Mann das Buch der Frau gibt

c. weil das Buch der Mann der Frau gibt

d. weil das Buch der Frau der Mann gibt

e. weil der Frau der Mann das Buch gibt

f. weil der Frau das Buch der Mann gibt

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- (7b–f) require a different prosody and a more restrictive context than (7a) (Höhle, 1982).

# Adjuncts in the Mittelfeld

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- In addition to the arguments, adjuncts may be serialized in the Mittelfeld.
- These can be placed at arbitrary positions between the arguments:

(8) a.

| | | | | | | |
|---|---|---|---|---|---|---|
| weil | morgen | der Mann | das Buch | | der Frau | gibt |
| because | tomorrow | the man | | the woman | the book | gives |

‘because the man gives the book to the woman tomorrow’

b. weil der Mann morgen das Buch der Frau gibt

c. weil der Mann das Buch morgen der Frau gibt

d. weil der Mann das Buch der Frau morgen gibt

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# Binary Branching Structures

- Sentences like (9) are unproblematic:

(9) weil [der Mann [das Buch [der Frau gibt]]]
because the man the book the woman gives

| | | | | | |
|---|---|---|---|---|---|
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|---|---|---|---|---|---|
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| | because | the man | the book | the woman | gives |

- The integration of adjuncts is straightforward as well:

(10) a. weil [morgen [der Mann [das Buch [der Frau gibt]]]]
b. weil [der Mann [morgen [das Buch [der Frau gibt]]]]
c. weil [der Mann [das Buch [morgen [der Frau gibt]]]]
d. weil [der Mann [das Buch [der Frau [morgen gibt]]]]

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# Permutation of Arguments in the Mittelfeld

- Permutation of arguments is not explained yet.

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- Thus far, we have combined the head with the last element in the SUBCAT list.

*head-argument-phrase* $\rightarrow$

$$\begin{bmatrix} \text{CAT}|\text{SUBCAT } \boxed{A} \\ \text{HEAD-DTR}|\text{CAT}|\text{SUBCAT } \boxed{A} \oplus \langle \boxed{1} \rangle \\ \text{NON-HEAD-DTRS } \langle \boxed{1} \rangle \end{bmatrix}$$

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- Generalization of the Head-Argument-Schema:
  We allow to take arguments from the middle of the list.

# The Head-Argument-Schema

- old:

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- new:

*head-argument-phrase* $\rightarrow$

$$\begin{bmatrix} \text{CAT}|\text{SUBCAT } \boxed{A} \oplus \boxed{B} \\ \text{HEAD-DTR}|\text{CAT}|\text{SUBCAT } \boxed{A} \oplus \langle\, \boxed{1} \,\rangle \oplus \boxed{B} \\ \text{NON-HEAD-DTRS } \langle\, \boxed{1} \,\rangle \end{bmatrix}$$

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# The Head-Argument-Schema

- old:

  *head-argument-phrase* →

$$\begin{bmatrix} \text{CAT}|\text{SUBCAT}\ \boxed{A} \\ \text{HEAD-DTR}|\text{CAT}|\text{SUBCAT}\ \boxed{A} \oplus \langle\ \boxed{1}\ \rangle \\ \text{NON-HEAD-DTRS}\ \langle\ \boxed{1}\ \rangle \end{bmatrix}$$

- new:

  *head-argument-phrase* →

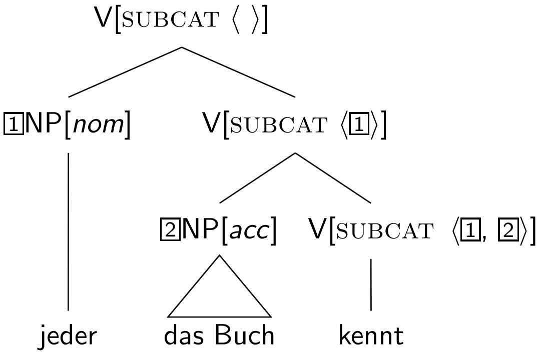
$$\begin{bmatrix} \text{CAT}|\text{SUBCAT}\ \boxed{A} \oplus \boxed{B} \\ \text{HEAD-DTR}|\text{CAT}|\text{SUBCAT}\ \boxed{A} \oplus \langle\ \boxed{1}\ \rangle \oplus \boxed{B} \\ \text{NON-HEAD-DTRS}\ \langle\ \boxed{1}\ \rangle \end{bmatrix}$$

- Note: If we want binary branching for English: $\boxed{A} = \langle\rangle$

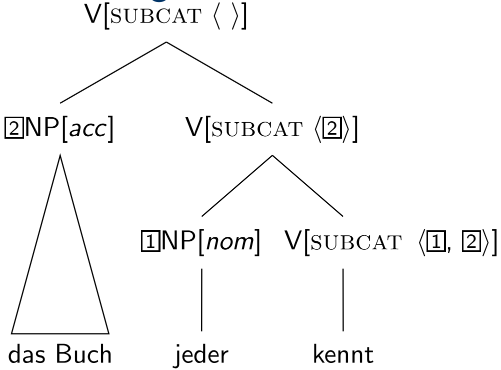
# Example: Normal Order

(11) a. weil jeder das Buch kennt
because everybody the book knows

b. weil das Buch jeder kennt

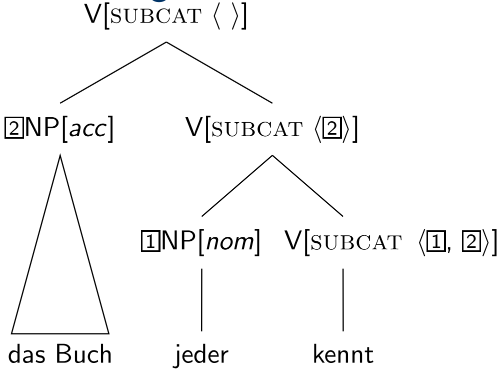


# Example: Reordering




The difference is the order in which the elements in SUBCAT get saturated.

# Example: Reordering




The difference is the order in which the elements in SUBCAT get saturated.

See Gunji, 1986 for similar suggestions for Japanese.

See Fanselow, 2001 for an aequivalent suggestion in the Minimalist Program.

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# Demo: Grammar 9

(12) a. daß der Mann der Frau das Buch gibt
that the $man_{nom}$ the $woman_{dat}$ the $book_{acc}$ gives

b. daß der Mann das Buch der Frau gibt
that the $man_{nom}$ the $book_{acc}$ the $woman_{dat}$ gives

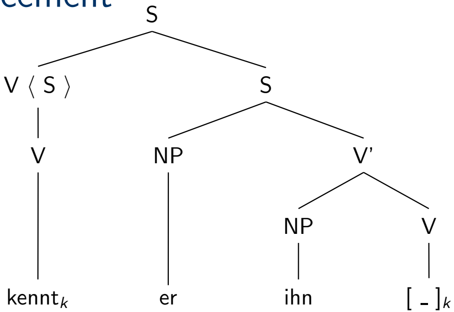
c. daß der Mann der Frau das Buch morgen gibt
that the $man_{nom}$ the $woman_{dat}$ the $book_{acc}$ tomorrow gives

d. daß der Mann der Frau morgen das Buch gibt
that the $man_{nom}$ the $woman_{dat}$ tomorrow the $book_{acc}$ gives

e. daß er oft nicht lacht
that he often not laughs

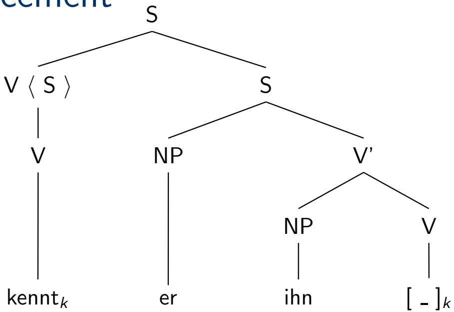
f. daß er nicht oft lacht
that he not often laughs

# Verb Placement




- A trace takes the position of the finite verb in verb-initial sentences.

# Verb Placement

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- A special form of the verb is in initial position.
  It selects the projection of the empty verb.

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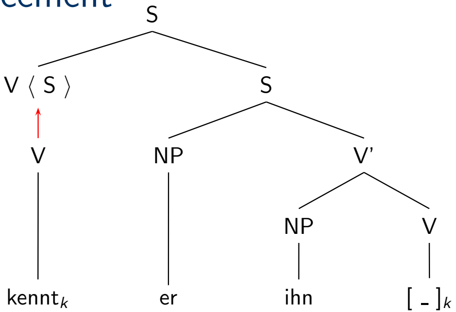


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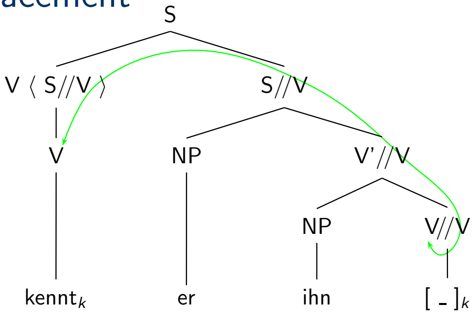


- A trace takes the position of the finite verb in verb-initial sentences.
- A special form of the verb is in initial position.
  It selects the projection of the empty verb.
- The special lexical item is licensed by a lexical rule.
- Connection between verb and trace is established by percolation.

# Demo: Grammar 9

(13) Gibt der Mann der Frau das Buch.
gives the $man_{nom}$ the $woman_{dat}$ the $book_{acc}$

## Outline

- Motivation & Psychological Reality
- General Overview of the Framework
- Valency
- Head Argument Structures
- Semantics
- Hierarchical Organization of Knowledge
- Lexical Regularities
- Constituent Order
- Nonlocal Dependencies
- Comparison

# Vorfeldbesetzung in German is a Nonlocal Dependency

- One constituent (adjunct, subject or complement) can be placed in the Vorfeld (Erdmann, 1886; Paul, 1919) → V2 language

[3] Scherpenisse, 1986, p. 84.

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- Fronting is a non-local dependency:

(14) a. [Um zwei Millionen Mark]$_i$ soll er versucht haben, [eine Versicherung $\_{i}$ zu betrügen].[1]

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c. Wen$_i$ glaubst du, daß ich _$_i$ gesehen habe.[3]
who believes you that I seen have
‘Who do you believe that I saw?’

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[2] Spiegel, 8/1999, p. 18.
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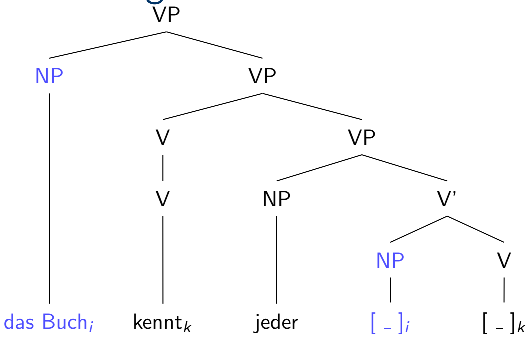
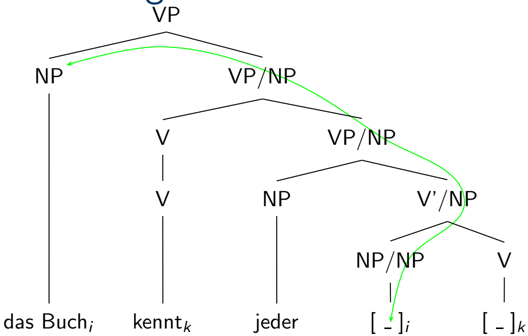
# Overview Fronting




- As in the example of head movement: Trace at “canonical” position

# Overview Fronting




- As in the example of head movement: Trace at "canonical" position
- percolation of information in the tree

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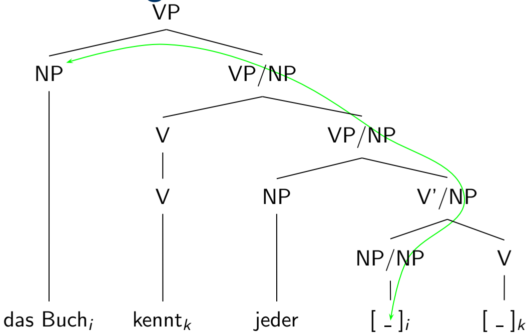


- As in the example of head movement: Trace at "canonical" position
- percolation of information in the tree
- constituent movement is not local, verb movement is
  two different features for modelling (SLASH vs. DSL)

# Properties of the Analysis

- percolation of non-local information

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- percolation of non-local information
- structure sharing
- Information is simultaneously present at every node in the extraction path.
- Nodes in the middle of an unbounded dependency may access this information. (Bouma et al., 2001: Irish, Chamorro, Palauan, Icelandic, Kikuyu, Ewe, Thompson Salish, Moore, French, Spanish, and Yiddish)

# Differenciation into Local and Nonlocal Information

- Differenciation between information that is locally relevant (LOCAL) and information that plays a role in nonlocal dependencies (NONLOCAL)

$$\begin{bmatrix} \text{PHON} & \textit{list of phoneme strings} \\ \text{LOC} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{head} \\ \text{SUBCAT} & \textit{list of synsem objects} \\ \textit{cat} & \end{bmatrix} \\ \text{CONT} & \textit{cont} \\ \textit{loc} & \end{bmatrix} \\ \text{NONLOC} & \textit{nonloc} \\ \textit{sign} & \end{bmatrix}$$

# Data Structure for Nonlocal Information

- NONLOC value has internal structure:

$$\begin{bmatrix} \textsc{que} & \textit{list of npros} \\ & \\ & \\ \textit{nonloc} & \end{bmatrix}$$

- QUE: list of indices of question words (interrogative clauses)

# Data Structure for Nonlocal Information

- NONLOC value has internal structure:

$$\begin{bmatrix} \text{QUE} & \textit{list of npros} \\ \text{REL} & \textit{list of indices} \\ & \\ \textit{nonloc} & \end{bmatrix}$$

- QUE: list of indices of question words (interrogative clauses)
- REL: list of indices of relative pronouns (relative clauses)

# Data Structure for Nonlocal Information

- NONLOC value has internal structure:

$$\begin{bmatrix} \text{QUE} & \textit{list of npros} \\ \text{REL} & \textit{list of indices} \\ \text{SLASH} & \textit{list of local structures} \\ \textit{nonloc} & \end{bmatrix}$$

- QUE: list of indices of question words (interrogative clauses)
- REL: list of indices of relative pronouns (relative clauses)
- SLASH: list of *local* objects (Vorfeldbesetzung, relative clauses)

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- QUE: list of indices of question words (interrogative clauses)
- REL: list of indices of relative pronouns (relative clauses)
- SLASH: list of *local* objects (Vorfeldbesetzung, relative clauses)
- We focus on SLASH and ignore the others.

# A Trace for the Accusative Object of *kennen* ('know')

$$\begin{bmatrix} \text{PHON} & \langle\rangle \\ \text{LOC} & \boxed{1} \begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix}\text{CAS} & \textit{acc}\\ \textit{noun} & \end{bmatrix} \\ \text{SUBCAT} & \langle\rangle \end{bmatrix}\end{bmatrix} \\ \text{NONLOC} & \begin{bmatrix}\text{SLASH} & \langle \boxed{1} \rangle\end{bmatrix} \\ \textit{word} & \end{bmatrix}$$

# A Trace for the Accusative Object of *kennen* ('know')

$$\left[\begin{array}{ll}
\text{PHON} & \langle\rangle \\
\text{LOC} & \boxed{1}\left[\text{CAT}\left[\begin{array}{ll}\text{HEAD} & \left[\begin{array}{l}\text{CAS } \textit{acc} \\ \textit{noun}\end{array}\right] \\ \text{SUBCAT} & \langle\rangle\end{array}\right]\right] \\
\text{NONLOC} & \left[\text{SLASH } \langle \boxed{1} \rangle\right] \\
\textit{word} &
\end{array}\right]$$

- The trace does not contribute a phonology.

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- The trace does not contribute a phonology.
- The trace has the local properties that *kennen* requires.

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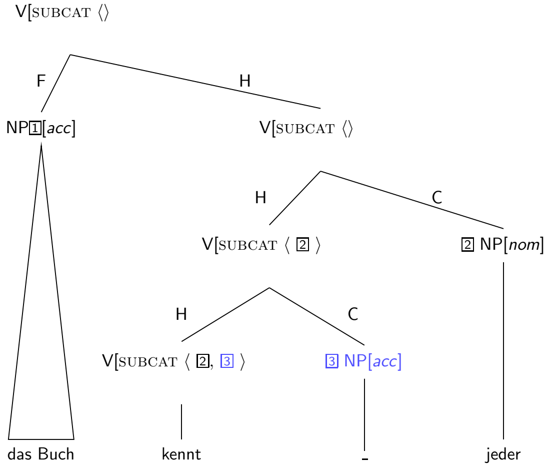
- The trace does not contribute a phonology.
- The trace has the local properties that *kennen* requires.
- These are also represented under SLASH.

# Percolation of Nonlocal Information (simplified → wrong verb position!)



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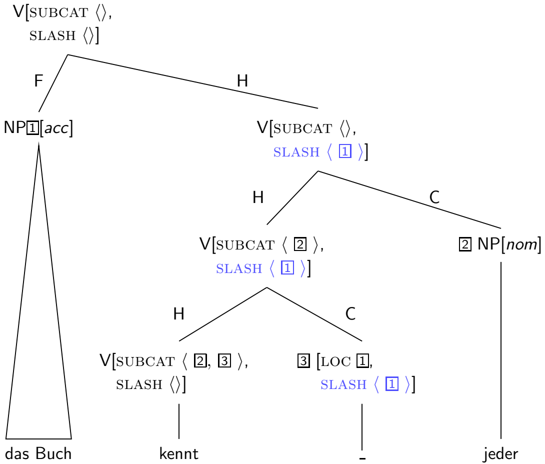

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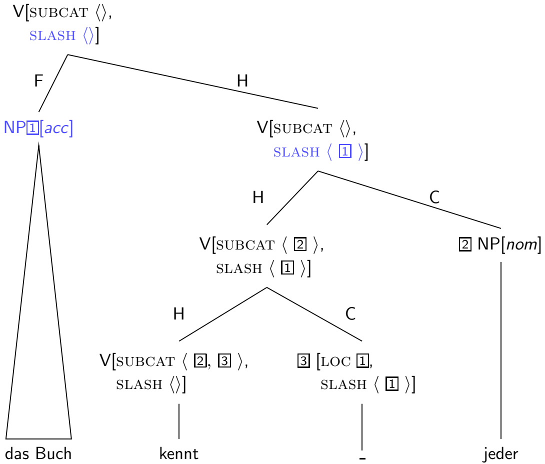

# The Head Filler Schema (Simplified)

*head-filler-structure* $\rightarrow$

$$\begin{bmatrix} \text{NONLOC}|\text{SLASH} & \langle\rangle \\ \text{HEAD-DTR} & \begin{bmatrix} \text{LOC}|\text{CAT} & \begin{bmatrix} \text{HEAD} & \begin{bmatrix} \text{VFORM} & \textit{fin} \\ \text{INITIAL} & + \\ \textit{verb} & \end{bmatrix} \\ \text{SUBCAT} & \langle\rangle \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

- The head daughter is a finite clause with a verb in final position (INITIAL+)

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- The head daughter is a finite clause with a verb in final position (INITIAL+) and an element in SLASH
- LOCAL value of the non-head daughter is identical to the element in SLASH

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$$
\left[\begin{array}{ll}
\text{NONLOC}|\text{SLASH} & \langle\rangle \\
\text{HEAD-DTR} & \left[\begin{array}{ll} \text{LOC}|\text{CAT} & \left[\begin{array}{ll} \text{HEAD} & \left[\begin{array}{ll}\text{VFORM} & \textit{fin}\\ \text{INITIAL} & + \\ \textit{verb} & \end{array}\right] \\ \text{SUBCAT} & \langle\rangle \end{array}\right] \\ \text{NONLOC}|\text{SLASH} & \langle \boxed{1} \rangle \end{array}\right] \\
\text{NON-HEAD-DTRS} & \left\langle \left[\begin{array}{ll} \text{LOC} & \boxed{1} \\ \text{NONLOC}|\text{SLASH} & \langle\rangle \end{array}\right] \right\rangle
\end{array}\right]
$$

- The head daughter is a finite clause with a verb in final position (INITIAL+) and an element in SLASH
- LOCAL value of the non-head daughter is identical to the element in SLASH
- nothing can be extracted from the non-head daughter

# The Extraction Trace

$$\begin{bmatrix} \text{PHON} & \langle\rangle \\ \text{LOC} & \boxed{1} \\ \text{NONLOC} & \begin{bmatrix} \text{SLASH} & \langle \boxed{1} \rangle \end{bmatrix} \\ \textit{word} & \end{bmatrix}$$

- The trace used as argument was specific, but we can generalize over all traces.

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- The trace used as argument was specific, but we can generalize over all traces.
- We do not have to specify the LOCAL value of the trace since the verb specifies the LOCAL value of its arguments.

## Why Prefer the Constraint-Based Analysis to the Movement-Based Alternative?

- Detailed, empirically adequate accounts

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- Partial identity between filler and gap
- Coordinate Structure Constraint and Across-the-Board Exceptions

# Cross-Linguistic Data: Extraction Path Sensitivity

- Irish complementizer selection (McCloskey 1978, 1989)
- French ‘stylistic’ inversion (Kayne and Pollock 1978).
- Spanish ‘stylistic’ inversion (Torrego 1984)
- Kikuyu downstep suppression (Clements 1984, Zaenen 1983)
- Chamorro verb agreement (Chung 1982, 1995)
- Yiddish inversion (Diesing 1990)
- Icelandic expletives (Zaenen 1983)
- Adyghe ‘*wh*-agreement’ (Polinsky 2007)

# Irish

(15) a.

| | | | | | |
|---|---|---|---|---|---|
| Shíl | mé | goN | mbeadh | sé | ann. |
| thought | I | COMP | would-be | he | there |

'I thought that he would be there.'

b.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dúirt | mé | gurL | shíl | mé | goN | mbeadh | sé | ann. |
| said | I | goN.PAST | thought | I | COMP | would-be | he | there |

'I said that I thought that he would be there.'

c.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| an | fear | aL | shíl | mé | aL | bheadh | | ann |
| the | man | COMP | thought | I | COMP | would-be | __ | there |

'the man that I thought would be there'

d.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| an | fear | aL | dúirt | mé | aL | shíl | mé | aL | bheadh | | ann |
| the | man | COMP | said | I | COMP | thought | I | COMP | would-be | __ | there |

'the man that I said I thought would be there'

e.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| an | fear | aL | shíl | | goN | mbeadh | sé | ann |
| [the | man]$_j$ | COMP | thought | __ | COMP | would-be | he$_j$ | there |

'[the man]$_j$ that thought he$_j$ would be there'

f.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| an | fear | aL | dúirt | sé | aL | shíl | | goN | mbeadh | sé | ann |
| the | man | COMP | said | he | COMP | thought | __ | COMP | would-be | he | there |

'the man that he said thought he would be there'

# The Irish Complementizers

- No extraction:

$$\begin{bmatrix} \text{PHON} \ \langle \textit{goN} \rangle \\ \text{LOC}|\text{CAT} \begin{bmatrix} \text{HEAD} & \textit{prt} \\ \text{SUBCAT} & \left\langle \begin{bmatrix} \text{LOC}|\text{CAT}|\text{HEAD TYPEVERB} \\ \text{NONLOC}|\text{SLASH} \ \langle\rangle \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix}$$

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- Extraction:

$$\begin{bmatrix} \text{PHON} \ \langle \ \textit{aL} \ \rangle \\ \text{LOC}|\text{CAT} \begin{bmatrix} \text{HEAD} & \textit{prt} \\ \text{SUBCAT} & \left\langle \begin{bmatrix} \text{LOC}|\text{CAT}|\text{HEAD} \ \textit{verb} \\ \text{NONLOC}|\text{SLASH} \ \langle \ \text{X} \ \rangle \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix}$$

# Filler-Gap Mismatches

(16) a. You can rely on Dominique’s help.

b. Dominique’s help, you can rely on __ .

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b. Dominique's help, you can rely on __ .

c. * You can rely on that they will help you.

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How can movement turn an NP into a CP?

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How can movement turn an NP into a CP?

Certain Filler-Gap constructions involve constraints of partial identity, not total identity.

# Coordinate Structure Constraint and ATB Exceptions – I

(17) a. * Which dignitaries do you think
[[Sandy photographed the castle] and [Chris visited __ ]]?

# Coordinate Structure Constraint and ATB Exceptions – I

(17) a. * Which dignitaries do you think [[Sandy photographed the castle] and [Chris visited __ ]]?

b. * Which dignitaries do you think [[Sandy photographed __ ] and [Chris visited the castle]]?

# Coordinate Structure Constraint and ATB Exceptions – I

(17) a. * Which dignitaries do you think
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b. * Which dignitaries do you think
[[Sandy photographed __ ] and [Chris visited the castle]]?

c. Which dignitaries do you think
[[Sandy photographed __ ] and [Chris visited __ ]]?

## The Movement-Based Analysis

(18) a. [$_S$ you think [$_{S'}$ [$_S$ Kim should help **who**$_i$ ]]

# The Movement-Based Analysis

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c. **who**$_i$ $[_S$ you think $[_{S'}$ **e**$_i$ $[_S$ Kim should help __ $_i$ ]]?

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c. **who**$_i$ [$_S$ you think [$_{S'}$ **e**$_i$ [$_S$ Kim should help __ $_i$ ]]?

d. **who**$_i$ [$_S$ do you think [$_{S'}$ **e**$_i$ [$_S$ Kim should help __ $_i$ ]]?

# Across-the-Board Movement?

(19) **who**$_i$ [$_S$ do you think
[$_{S'}$ **e**$_i$ [[$_S$ Kim likes __ $_i$ ] and [$_S$ Pat hates __ $_i$ ]]]]?

 

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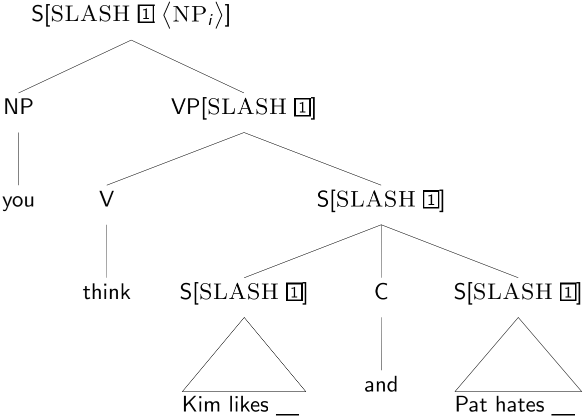
There is no uniform movement algorithm that allows across-the-board movement. (Gazdar, Pullum, Sag and Wasow, 1982)

# Across-the-Board Constraint

SLASH is among the features whose values are identified across conjuncts:



# Outline

- Motivation & Psychological Reality
- General Overview of the Framework
- Valency
- Head Argument Structures
- Semantics
- Hierarchical Organization of Knowledge
- Lexical Regularities
- Constituent Order
- Nonlocal Dependencies
- Comparison

# HPSG – The Frankenstein Theory

- Bob Carpenter (Mineur, 1995): HPSG is a Frankenstein Theory.
  Sewed together from various other theories. Influences:
  - GPSG (no surprise, authors overlap): nonlocal dependencies, ID/LP format
  - Categorial Grammar (valence, functor/argument relationships)
  - GB (parts of $\overline{\text{X}}$ Theory, parts of structural aspects)

# HPSG vs. Transformational Grammar

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  - Categories are feature sets
  - $\overline{\text{X}}$ Theory (not all aspects)
  - verb position in German (Grewendorf, 1988)

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  - extraction is percolation of information

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# HPSG vs. Transformational Grammar

- General differences:
  - lack of precision since the 80ies
    (intentionally: Chomsky, 1981, p. 2–3; Chomsky, 1990, p. 146)
  - for discussion of this point see
    Gazdar, Klein, Pullum and Sag, 1985, p. 6;
    Pullum, 1985, 1989; Kornai and Pullum, 1990, Pullum, 1991, p. 48
  - As a consequence: No large-scale consistent (implemented) fragments.
- HPSG is a Model Theoretic approach,
  while GB/Minimalism are generative-enumerative approaches.
  On differences see Pullum and Scholz, 2001.
  Note: There are Model Theoretic variants of GB. See for instance
  Rogers, 1998.

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- Conclusion:
  If such inferences regarding properties of particular languages,
  one has to assume (very specific!) innate linguistic knowledge.

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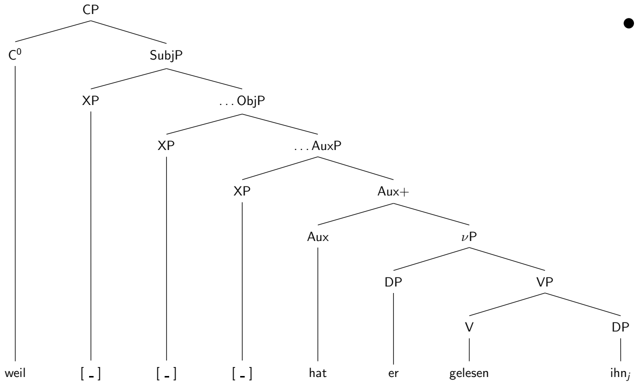


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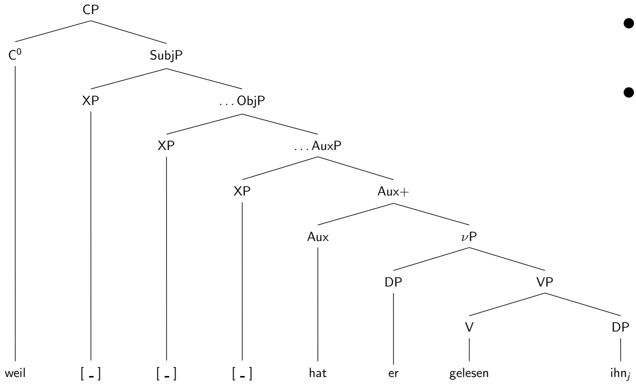


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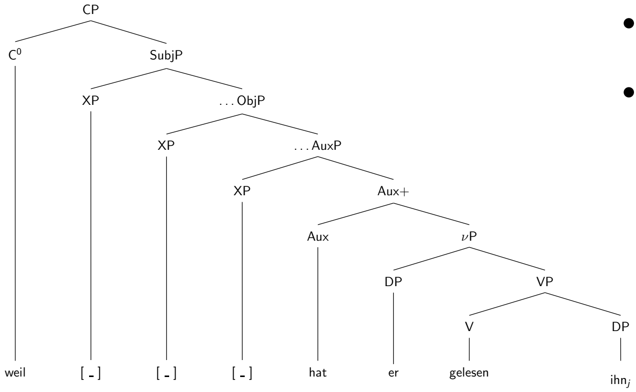


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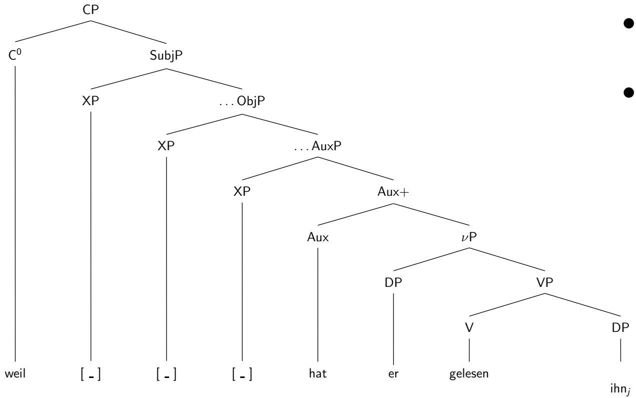


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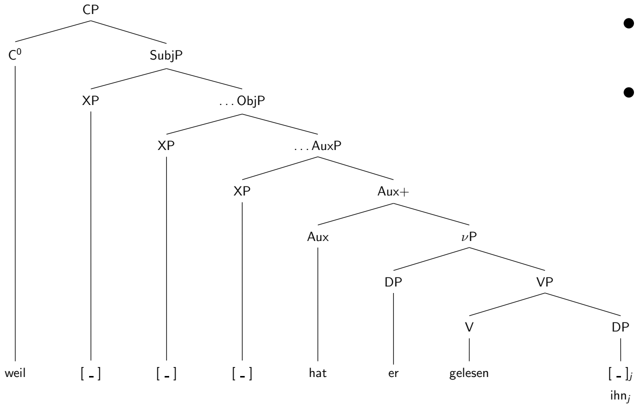


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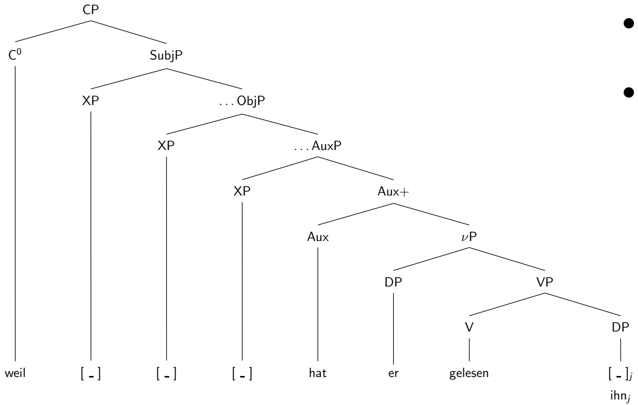


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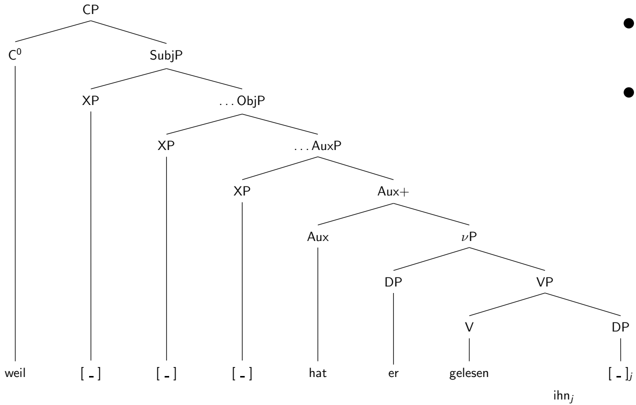


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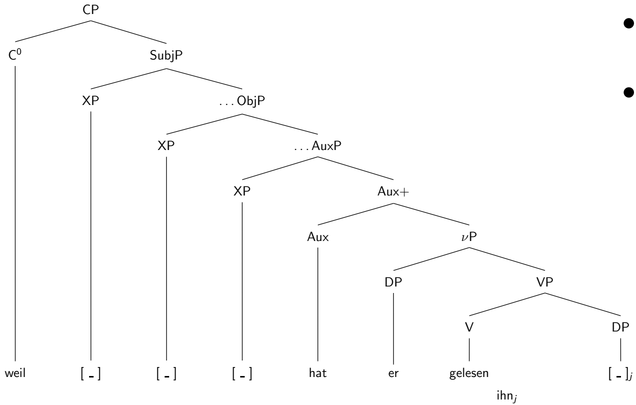


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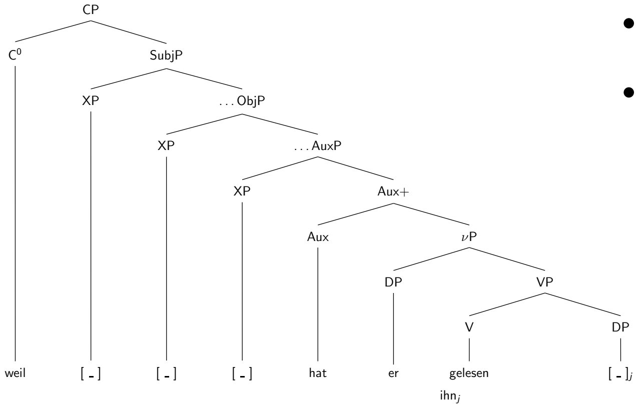


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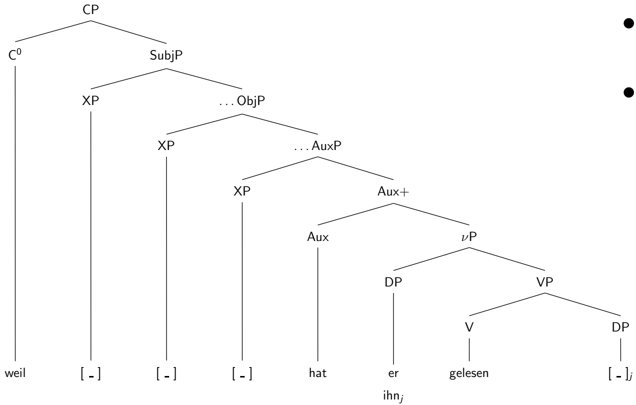


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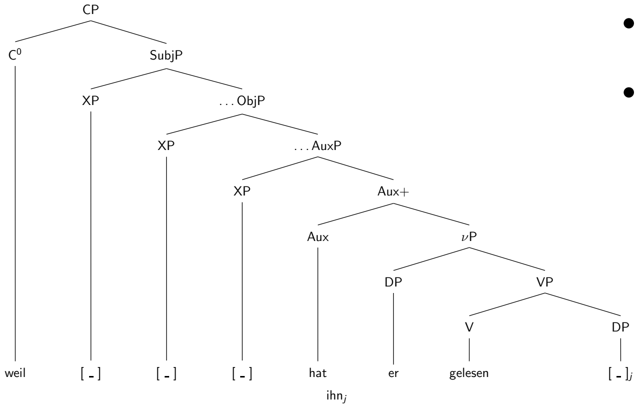


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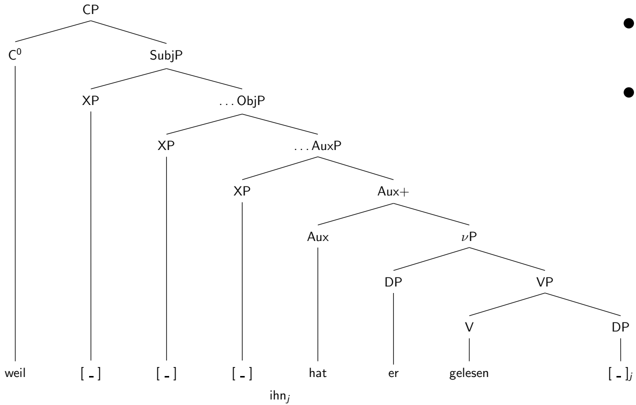


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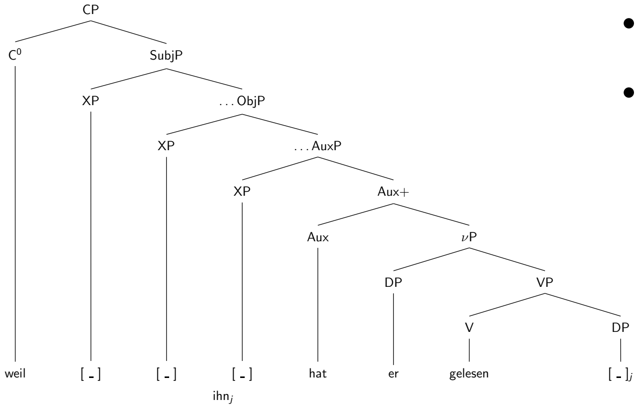


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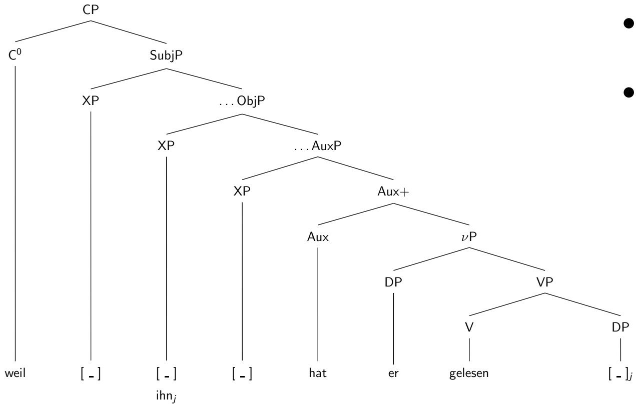


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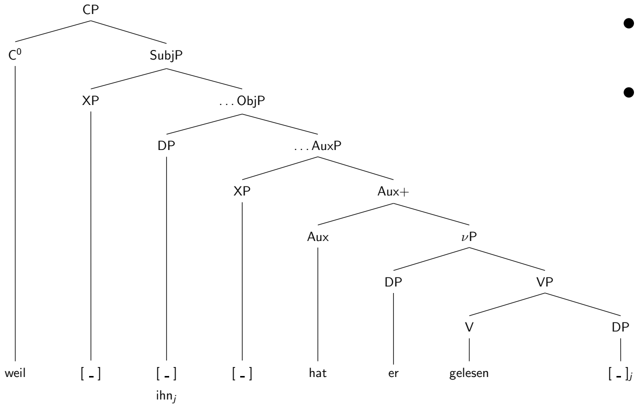


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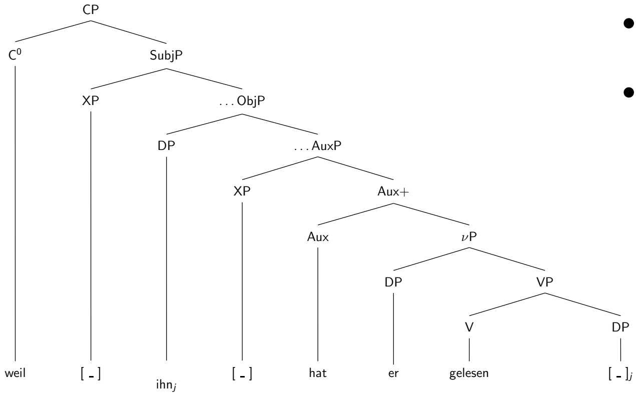


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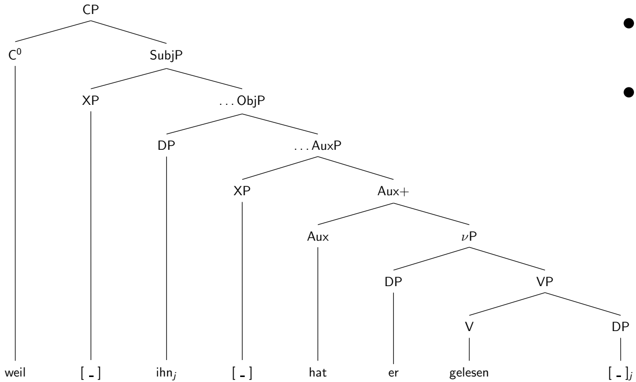


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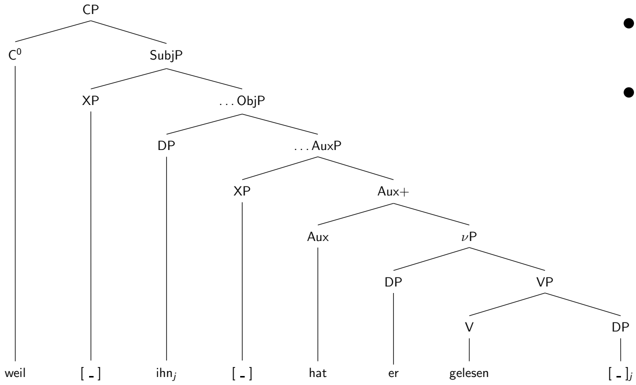


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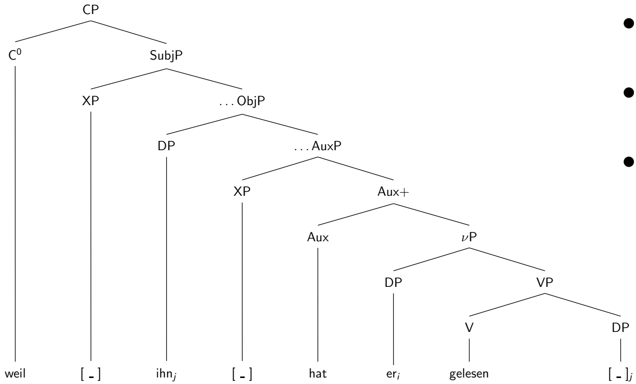


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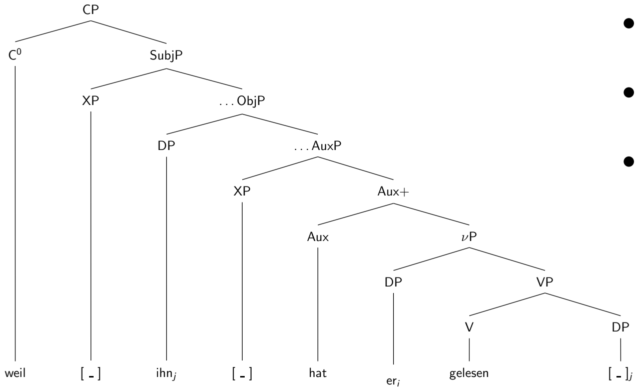


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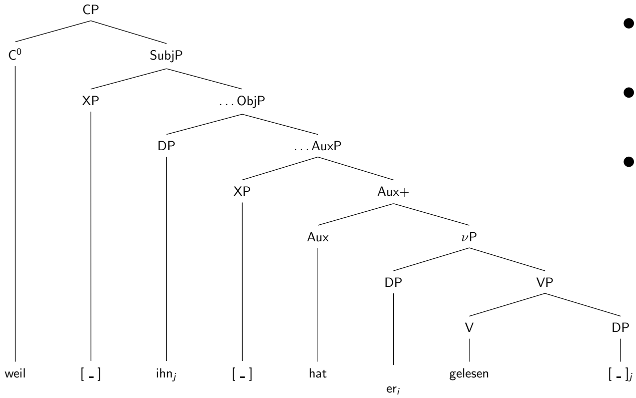


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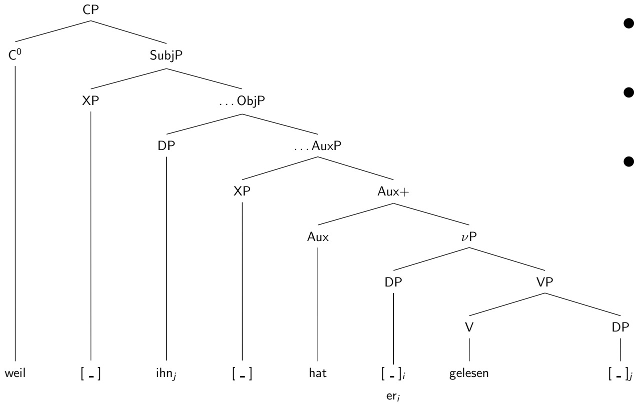


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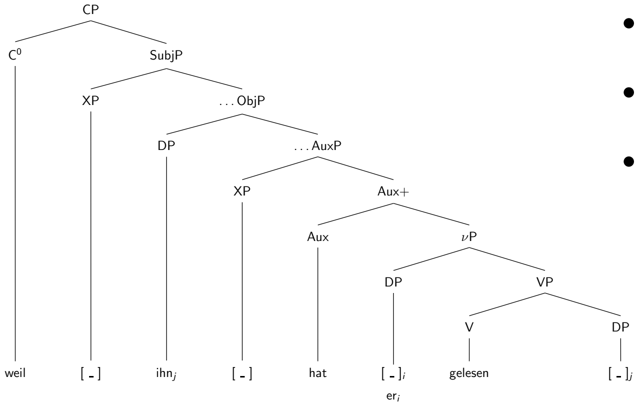


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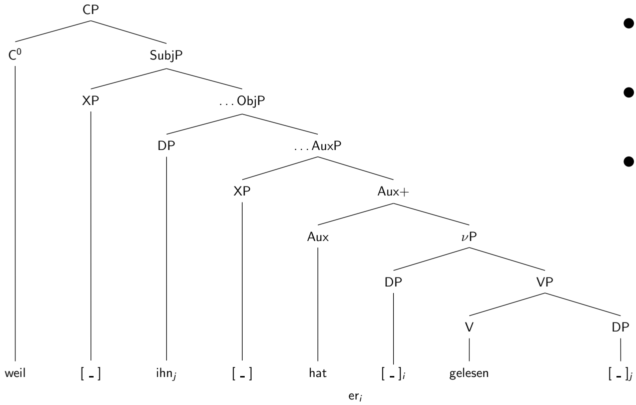


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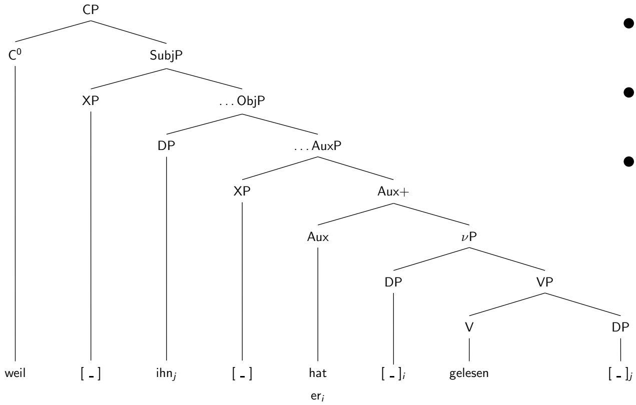


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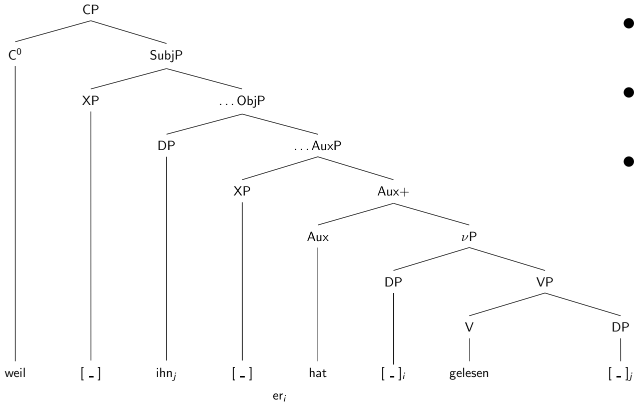


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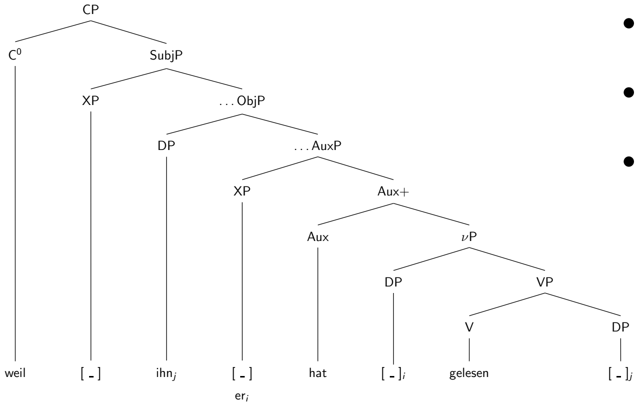


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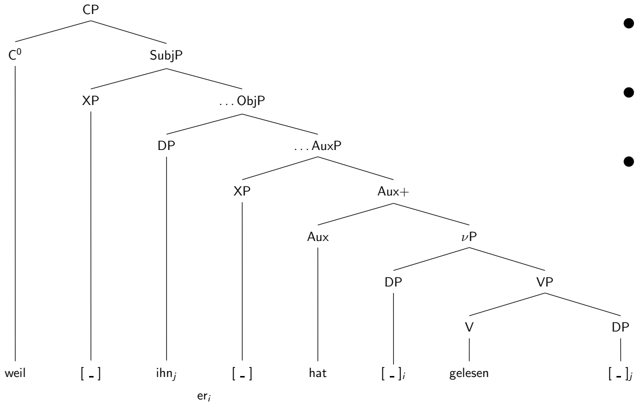


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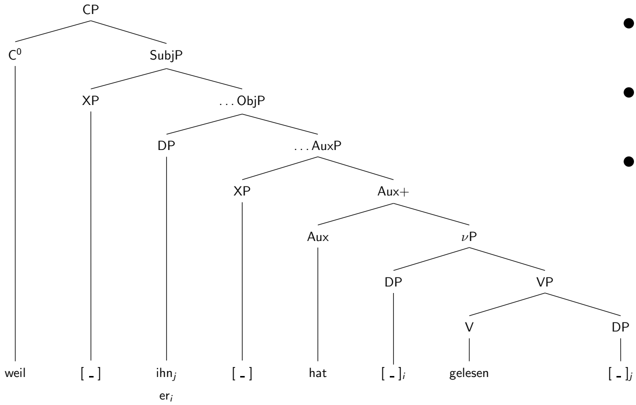


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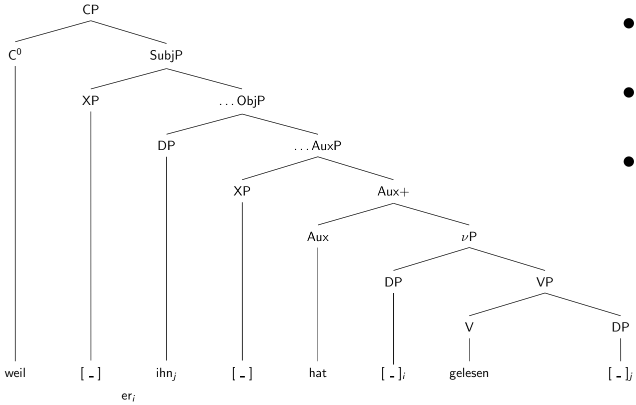


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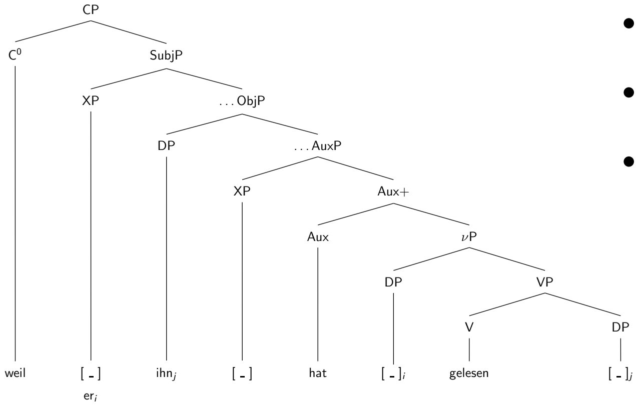


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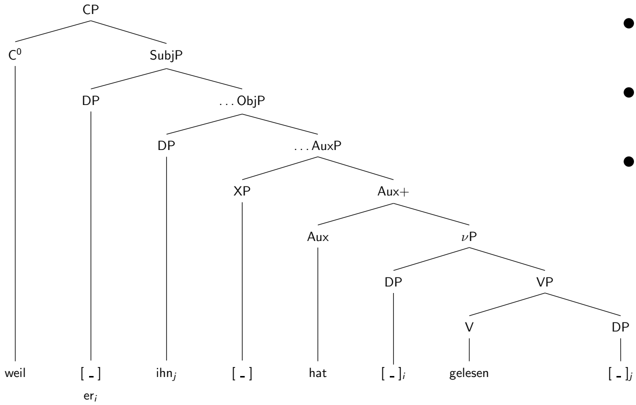


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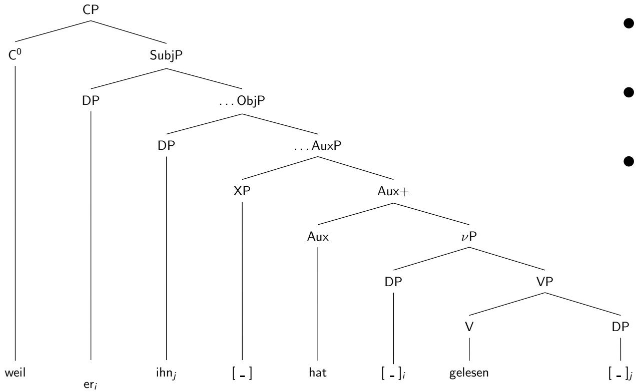


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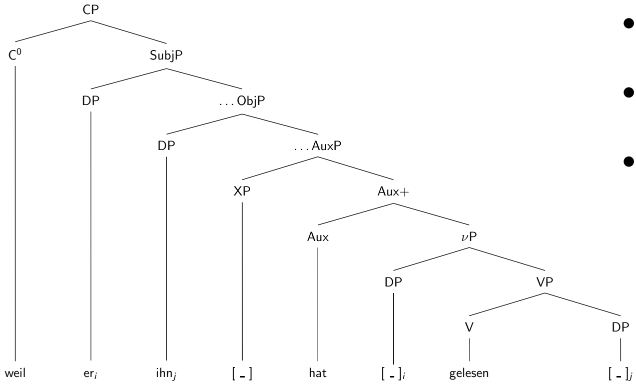


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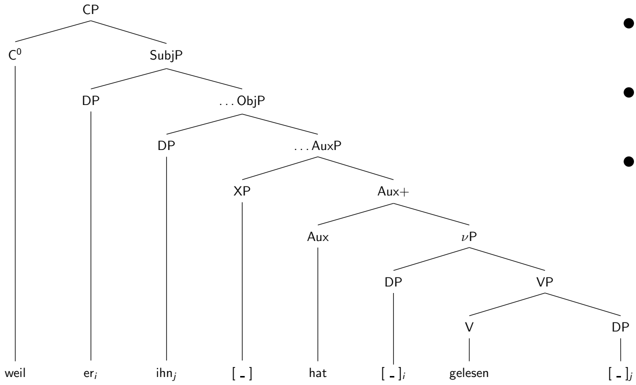


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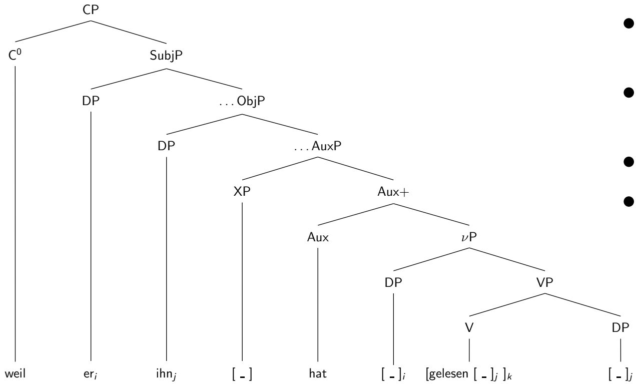


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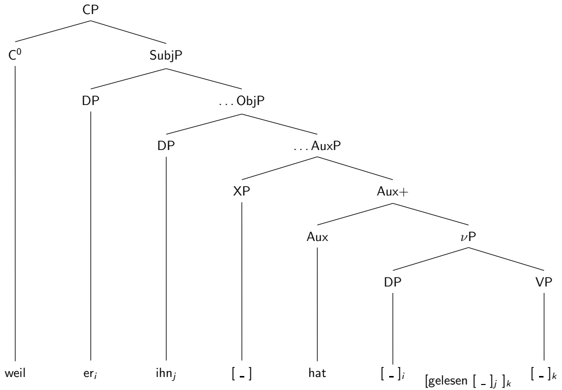


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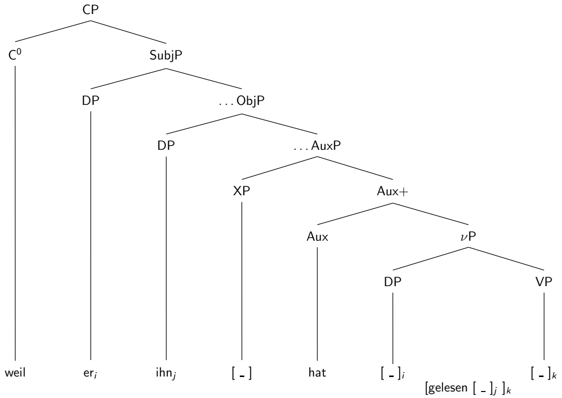


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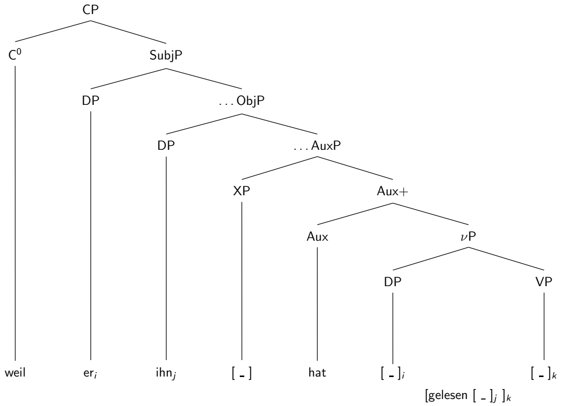


- All languages are SVO underlyingly.
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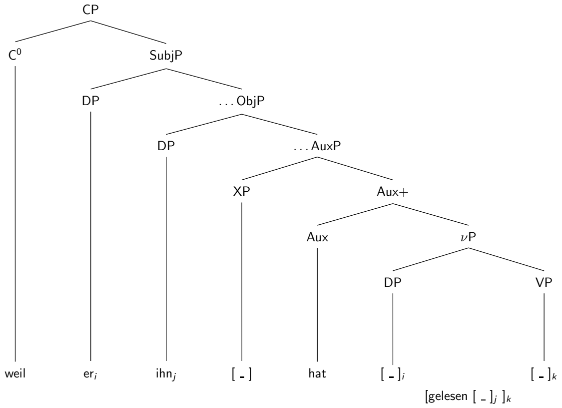


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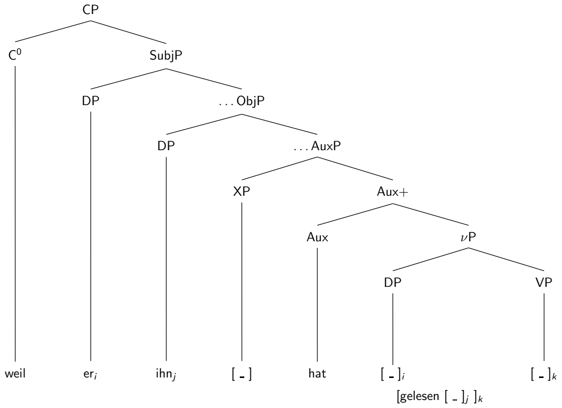


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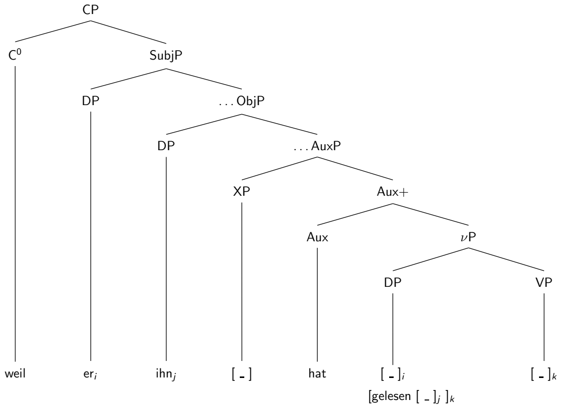


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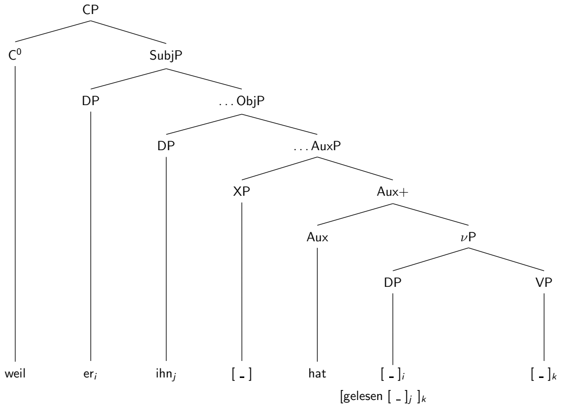


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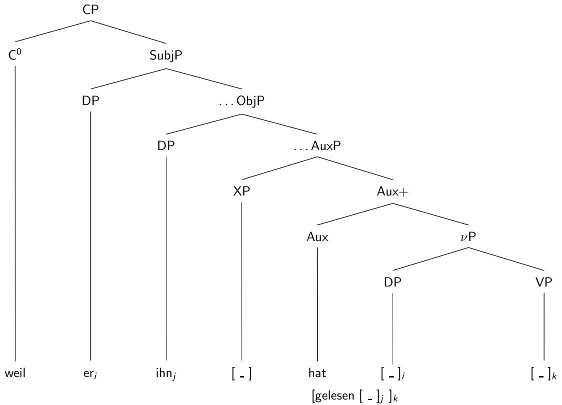


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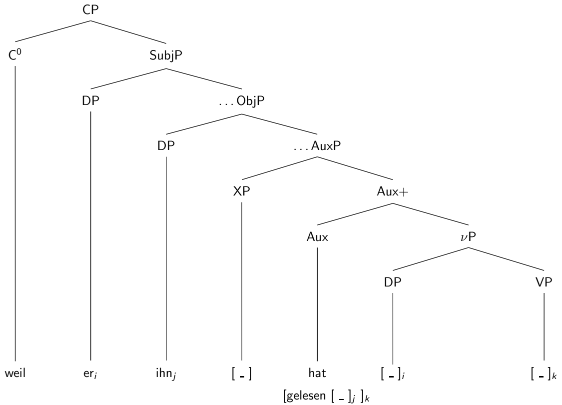


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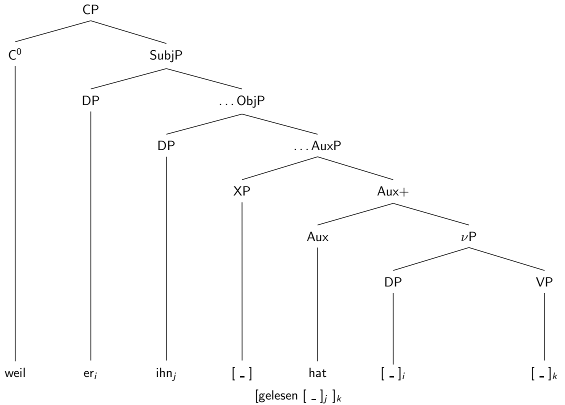


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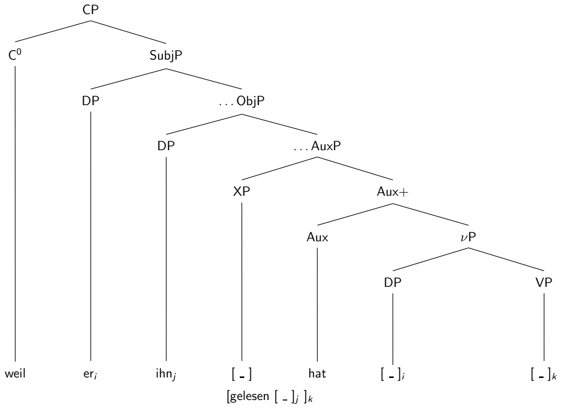


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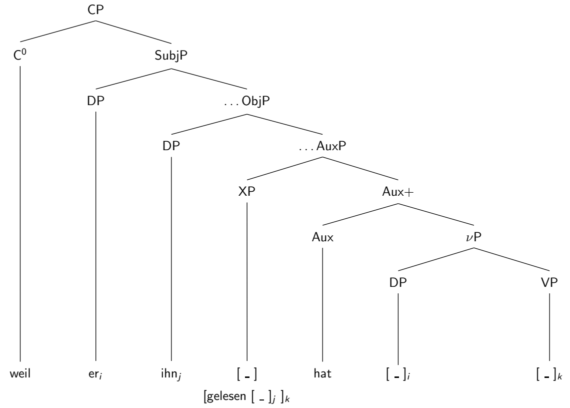


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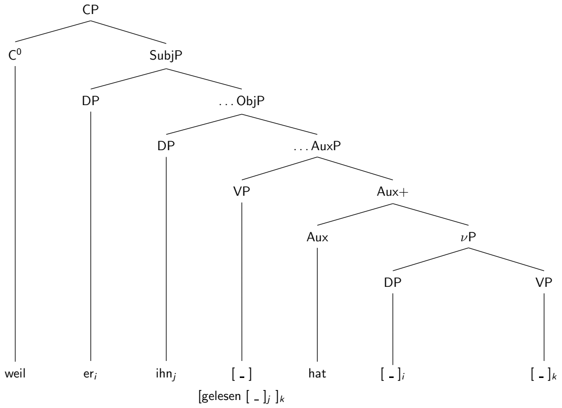


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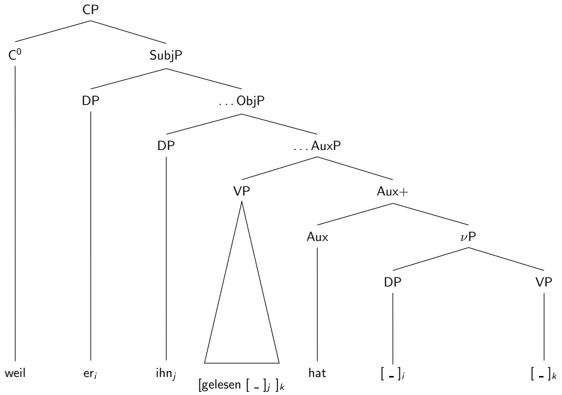


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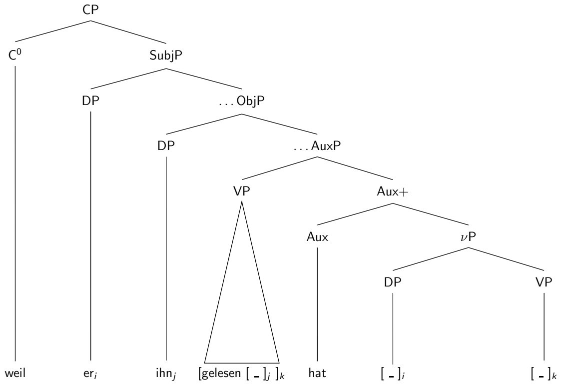


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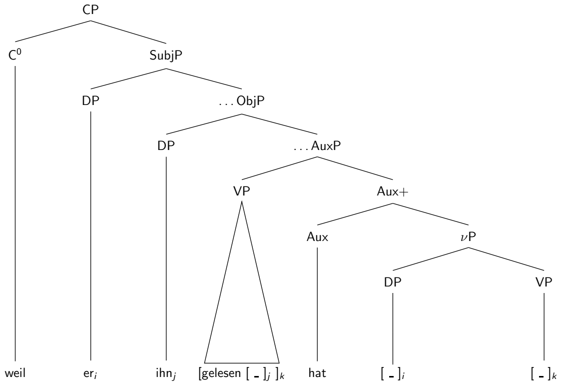


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- The object is moved out of the VP.
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- There are further empty heads (Cinque, 1999).

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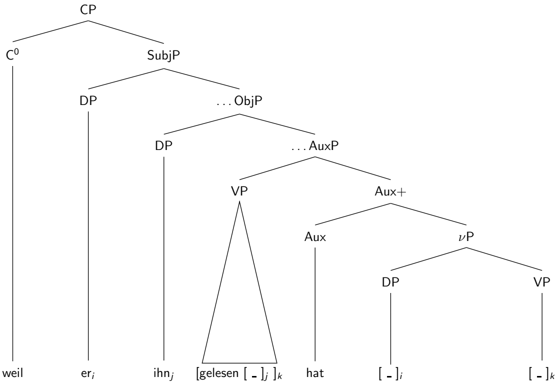


- All languages are SVO underlyingly.
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- There are further empty heads (Cinque, 1999).
- Innateness has to be assumed.

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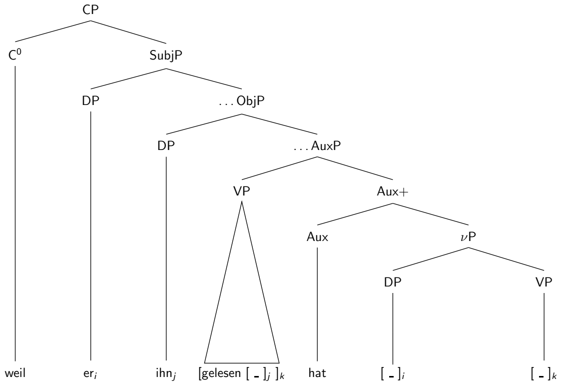


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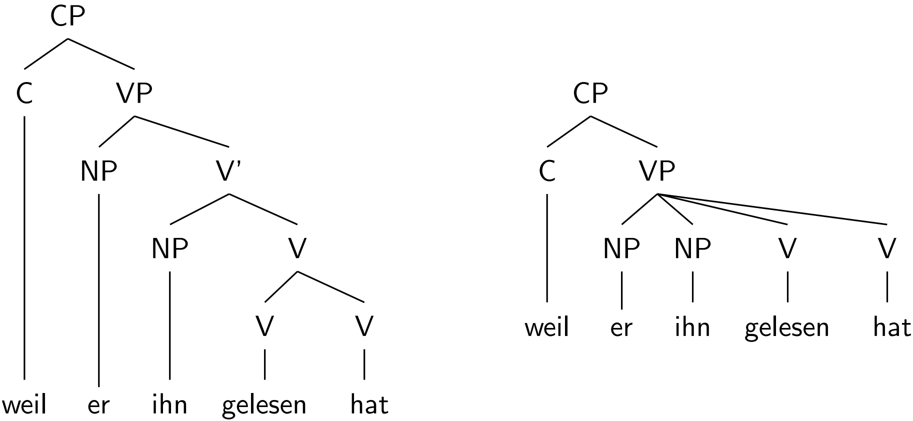
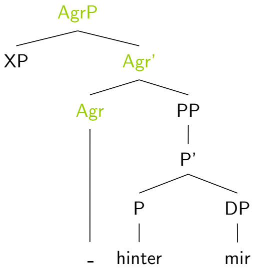
# German is German (GB Variants, CG, LFG, HPSG, . . . )



# English, German, . . . are Hungarian




- Hornstein, Nunes and Grohmann (2005, p. 124): agreement head for the checking of case features

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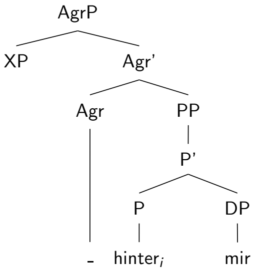


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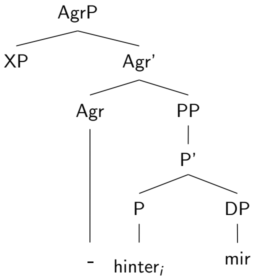


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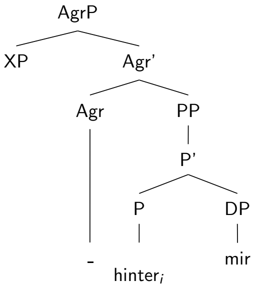


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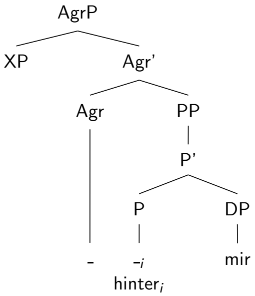


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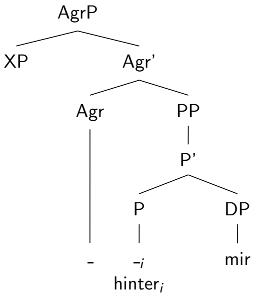


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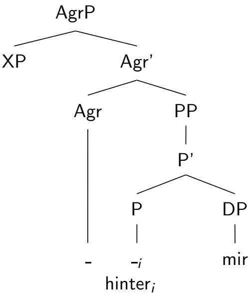


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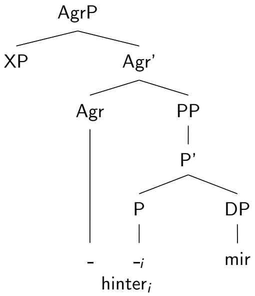


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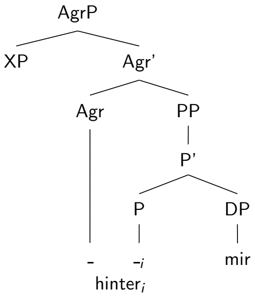


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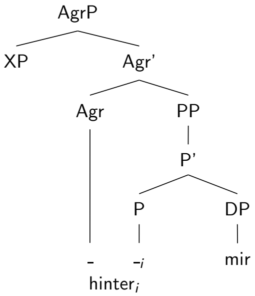


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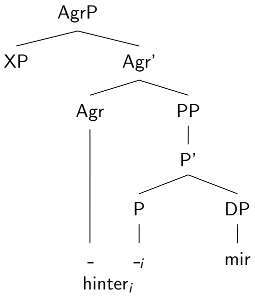


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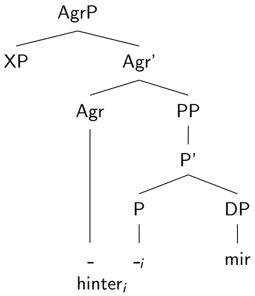


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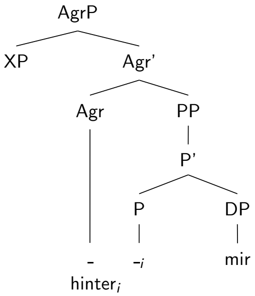


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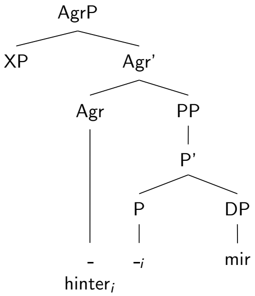


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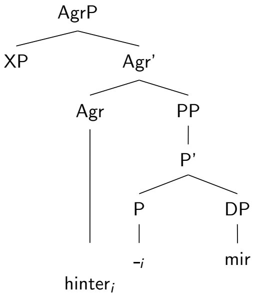


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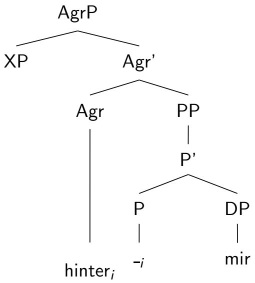


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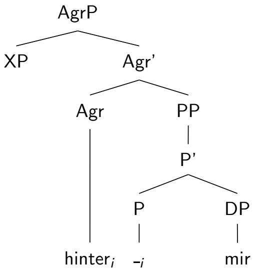


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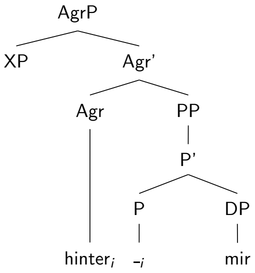


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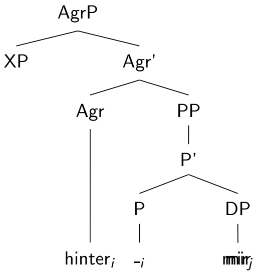


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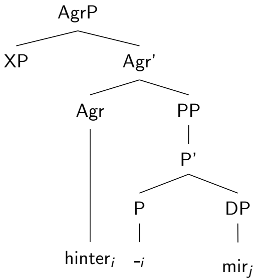


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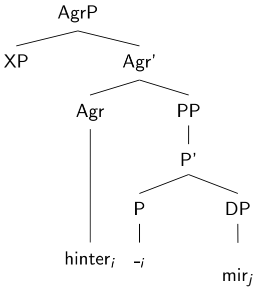


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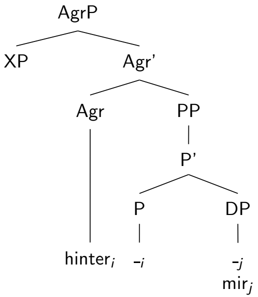


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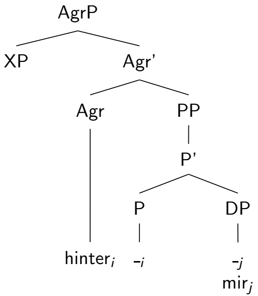


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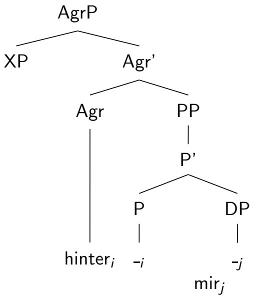


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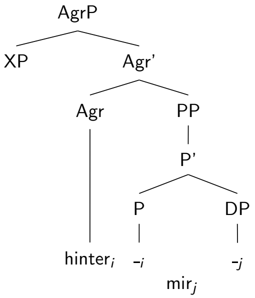


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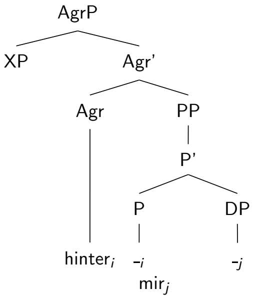


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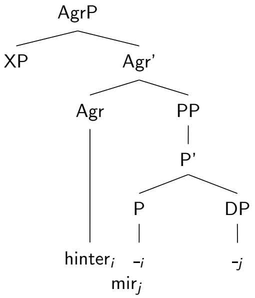


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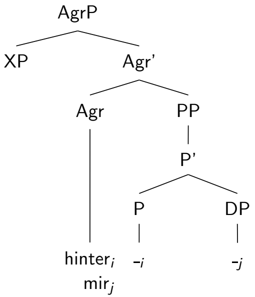


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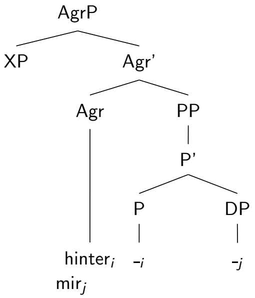


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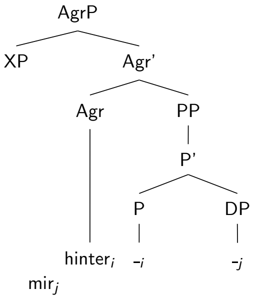


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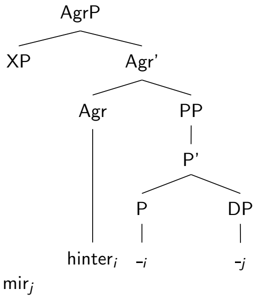


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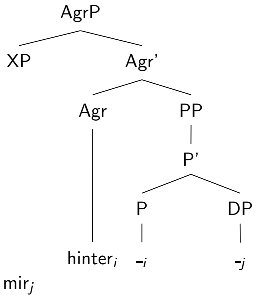


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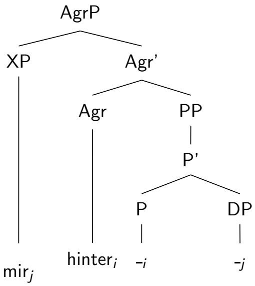


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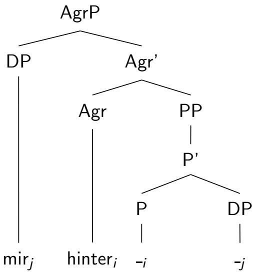


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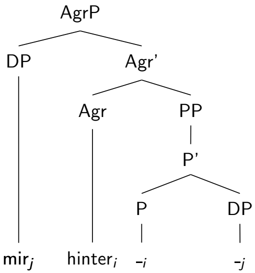


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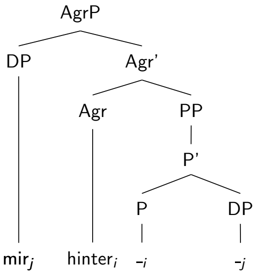


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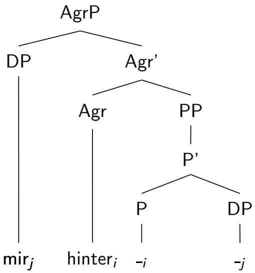


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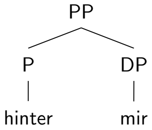


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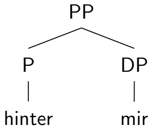


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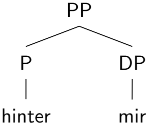


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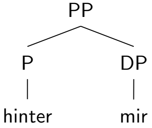


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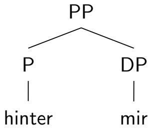


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- Truly minimal!
- Question: What constitutes an explanation? Where and how is complexity of language represented?

# Sociological Differences

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- The way arguments work differs dramatically.
- Avoid empty elements!
  This should be a strategy for every linguistic theory (Occam's Razor)!

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- Often OT papers do not give their assumptions about the underlying grammar.
- Factorial typology is attractive,
  but requires the assumption of domain specific innate knowledge about language.
- OT is often misunderstood to provide a way to deal with gradedness.
  Gradedness can be and has been introduced into HPSG implementations (as in OT-LFG).

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- There are subtle differences between types and macros
  (for instance type inference).

# Two Levels of Description: c-structure and f-structure

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  Examples:
  - Complementizer (word) and initial verb (LR).
  - Adjective (word) and relative clause (phrase)
- Crosslinguistically oriented work in LFG usually focuses on f-structures,
  c-structures are often not made explicit.
  In implementations they vary widely.

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- Introduced and motivated for HPSG:
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- So HPSG is the only free linguistic theory.

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- Additional rules are needed in CG,
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- It does not make sense for all structures to assume a head (functor).
  See for instance Constructionist work by Jackendoff (2008) and Jacobs (2008).

# HPSG vs. CxG: Constructionist Aspects

HPSG and CxG are close friends:

- Many of the insights of CxG regarding idiosyncrasies and similar points are taken over into other frameworks.
  HPSG: Sag, 1997
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  HPSG: Sag, 1997
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  Simpler Syntax: Culicover and Jackendoff, 2005
- So all of these frameworks can be regarded as constructional approaches to language (Goldberg).

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- Language acquisition facts are not a proof that we need phrasal analyses: Müller, In Preparationa

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- Sociological remark:
  Most Construction Grammar papers are not about grammar.

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# Constituent Order: Binary vs. Flat Structures

- We used binary branching structures in Class 1.

  *head-argument-phrase* $\rightarrow$

  $$\begin{bmatrix} \text{CAT}|\text{SUBCAT}\ \boxed{A} \\ \text{HEAD-DTR}|\text{CAT}|\text{SUBCAT}\ \boxed{A} \oplus \langle\ \boxed{1}\ \rangle \\ \text{NON-HEAD-DTRS}\ \langle\ \boxed{1}\ \rangle \end{bmatrix}$$

  We will argue for binary branching structures for German shortly.

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- However, binary branching is not the only option.
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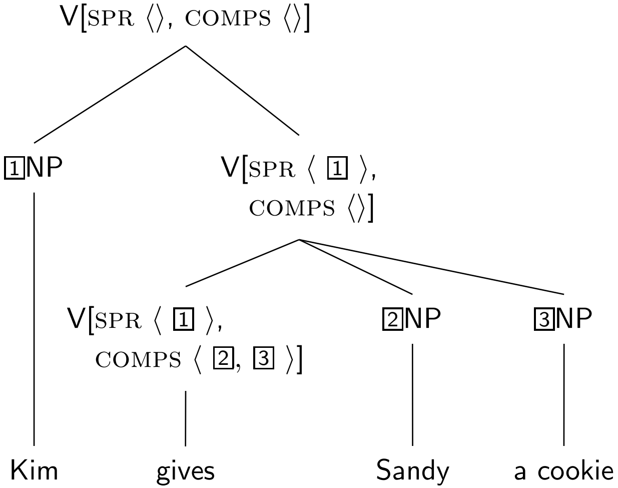
- The subject is represented separately
  (as the value of the feature SPECIFIER).
  The other arguments are represented under COMPS.
- Elements in COMPS are combined with their head in one go.

# Constituent Order: Binary vs. Flat Structures

- The following head argument schema licenses VPs, that is, projections of a head that include the head and all its arguments except the specifier.
  *head-complement-phrase* $\rightarrow$

$$\begin{bmatrix} \text{CAT}|\text{COMPS}\ \langle\rangle \\ \text{HEAD-DTR}|\text{CAT}|\text{COMPS}\ \boxed{A} \\ \text{NON-HEAD-DTRS}\ \boxed{A} \end{bmatrix}$$

# The English Clause



# Argument-Structure/Valency Mappings: English

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- A list valued feature ARGUMENT-STRUCTURE is used for the representation of arguments independent of their function as subject or complement.
- English: The subject is VP-external, both for finite and nonfinite verbs.
- All arguments but the subject are mapped from ARG-ST to COMPS:

  *gives*:

$$\begin{bmatrix} \text{SPR} & \langle \boxed{1} \rangle \\ \text{COMPS} & \boxed{A} \\ \text{ARG-ST} & \left\langle \boxed{1}\text{NP}[\textit{nom}] \right\rangle \oplus \boxed{A} \left\langle \text{NP}[\textit{acc}],\ \text{NP}[\textit{acc}] \right\rangle \end{bmatrix}$$

  Linking is done with reference to ARG-ST.

# Argument-Structure/Valency Mappings: German

- German: no distinction between subject and other arguments for finite verbs.
  (In GB terms: The subject is VP-internal.
  Much discussed topic: Haider, 1982; Grewendorf, 1983; Kratzer, 1984; Webelhuth, 1985; Sternefeld, 1985; Scherpenisse, 1986; Fanselow, 1987; Grewendorf, 1988; Dürscheid, 1989; Webelhuth, 1990; Oppenrieder, 1991; Wilder, 1991; Haider, 1993; Grewendorf, 1993; Frey, 1993; Lenerz, 1994; Meinunger, 2000)

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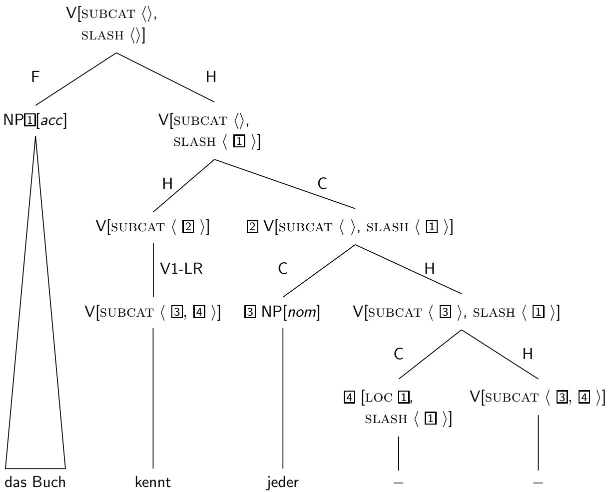
- All arguments are mapped from ARG-ST to COMPS:
  *gibt* (*gives*, finite Form):

$$\begin{bmatrix} \text{SPR} & \langle\rangle \\ \text{COMPS} & \boxed{A} \\ \text{ARG-ST} & \boxed{A}\left\langle \text{NP}[\textit{nom}],\ \text{NP}[\textit{acc}],\ \text{NP}[\textit{dat}] \right\rangle \end{bmatrix}$$

# Extraction and Verb Movement



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