



Syntax & Semantics WS2019/2020

Lecture 10: Lexical Functional Grammar I (Feature Descriptions)

25/11/2019, Christian Bentz



Overview

Section 1: Recap of Lecture 8 (GPSG)

Section 2: Untyped Feature Descriptions

- Notational Conventions

- Glossing and Feature Descriptions

- Syncretism and Disjunction

- Embedding

- Lists

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- Type Hierarchies

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Comments on Exercises of Tutorial Week 4

- ▶ I've explicitly added a note in exercise 1a) now that the rewrite rules *defined in lecture 6 should be used* (I've also added two more verb rules in Lecture 6). Within X-bar theory, the idea is to define a fixed set of rules that can be applied to analyze sentences in a given language. PSGs are generally more flexible.
- ▶ 1b) *Why is there a noun phrase in the solution and not an adjective phrase?* - Both is possible. You could also rewrite NP into AP and NP and then AP into Adv and A. More generally, the only constraint given here is the binarization constraint, and the rules of headedness, i.e. a noun cannot be headed by an adjective. Otherwise, rules are flexible. Hence, there are different trees that can be a correct solution.
- ▶ It is 13 unary branches in the X-bar tree, not 12.

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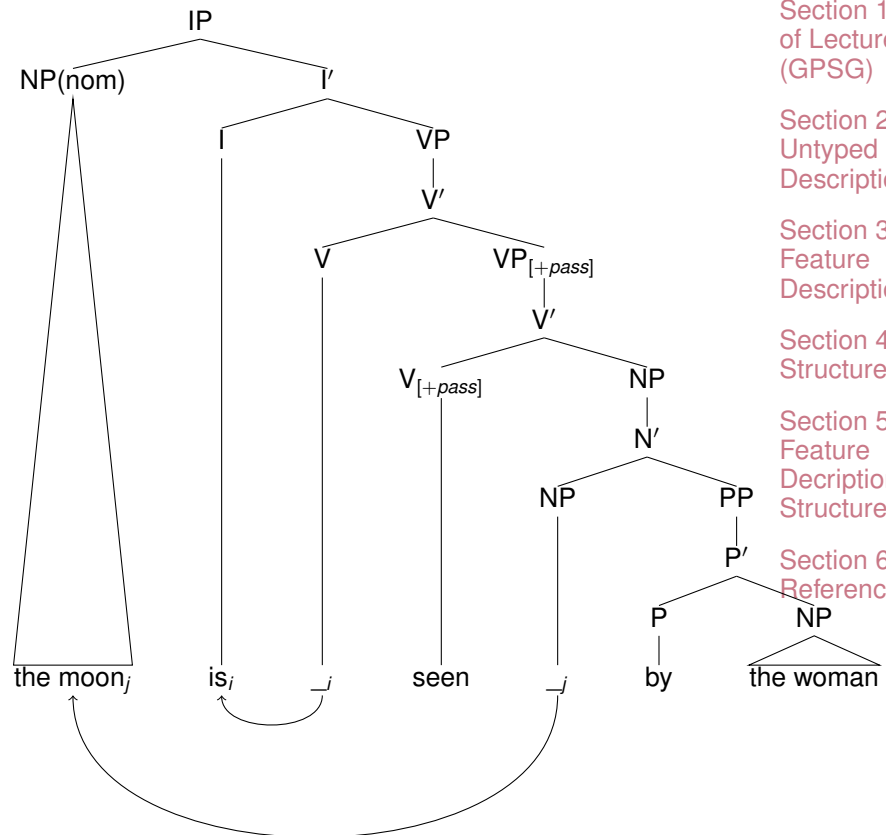
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Comments on Exercises of Tutorial Week 4

Why is the object of the active phrase considered to move into subject position in the passive transformation, while the original subject in an optional *by*-phrase is not considered the outcome of movement?

- In fact, according to Lasnik (2017, p. 12) the original transformational account in *Syntactic Structures* assumed that the subject NP moves to the end of the sentence building the *by*-phrase in passivization. However, it was later noticed that there are *by*-phrases of the same meaning that can occur without passivization (e.g. *the destruction of Rome by the barbarians*). As a consequence, in later accounts of GB, the *by*-phrase is seen as an adjunct to the verb phrase just like other prepositional phrases. Hence, it is considered to be in the adjunct position already in D-structure, and does not need to move there in S-structure. See also the examples of passive D-structure and S-structure in Black (1999, p. 31).



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Section 1: Recap of Lecture 8 (GPSG)



Non-Terminal Symbols with Features

In GPSG this is worked out more precisely, such that each non-terminal symbol can be defined by a set of feature value pairs of the form $\langle \textit{feature}, \textit{feature-value} \rangle$. For instance, a non-terminal symbol with feature values like NP(3,sg,nom) could be rendered as in (1):

$$\begin{aligned} & \{ \langle \textit{CAT}, \textit{N} \rangle, \\ & \quad \langle \textit{BAR}, 2 \rangle, \\ & \quad \langle \textit{PER}, 3 \rangle, \\ & \quad \langle \textit{NUM}, \textit{SG} \rangle, \\ & \quad \langle \textit{CASE}, \textit{NOM} \rangle \} \end{aligned} \tag{1}$$

Note: The NP is here replaced by the X-bar theoretic representation, i.e. $\overline{\overline{N}}$, which is then indicated by $\langle \textit{BAR}, 2 \rangle$.

Müller (2019). Grammatical theory, p. 182.

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Lexical Subcategorization

Lexical subcategorization refers to matching *non-terminal* (*preterminal*) symbols, and the *rewrite rules* they are allowed to occur in. For verbs, for example, this means that an integer specifies which type of verb (in terms of valency) is allowed to occur in a particular rule. Take the rewrite rules below:

$$(1) \quad V2 \rightarrow V[1]$$

$$(2) \quad V2 \rightarrow V[2] N2$$

The integers in square brackets would then be found also in the lexical entry of particular verbs, e.g. in simplified form:

$$(3) \quad \langle \textit{weep}, [\mathbf{SUBCAT 1}], \dots \rangle$$

$$(4) \quad \langle \textit{devour}, [\mathbf{SUBCAT 2}], \dots \rangle$$

Gazdar et al. (1985). Generalized phrase structure grammar, p. 33-34.

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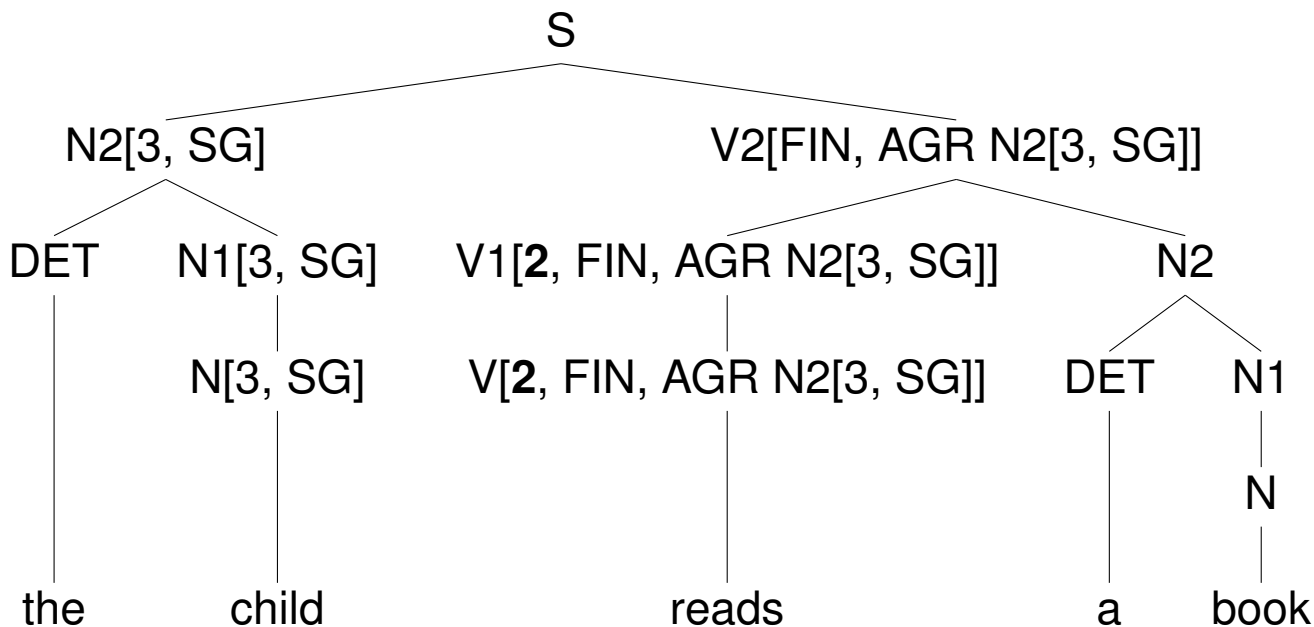
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Example of Full Declarative Sentence



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ID rules

- (5) $S \rightarrow N2[3, SG], V2[FIN, AGR N2[3, SG]]$
- (6) $N2[3, SG] \rightarrow DET, N1[3, SG]$
- (7) $V2[FIN, AGR N2[3, SG]] \rightarrow V1[2, FIN, AGR N2[3, SG]], N2$
- (8) $N2 \rightarrow DET N1$

LP rules

- (9) $N2 \prec V2$
- (10) $DET \prec N1$
- (11) $V1 \prec N2$



The Passive Metarule

The **passive metarule** is then formulated as follows:

$$\begin{array}{c} V2 \rightarrow W, N2 \\ \Downarrow \\ V2[PAS] \rightarrow W, (PP[by]) \end{array}$$

where W stands in for a multiset of symbols, i.e. could be replaced by whatever symbols are used to form the active sentence.

Gazdar et al. (2019), p. 59.

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Long-Distance Dependencies

“One of the main innovations of GPSG is its treatment of **long-distance dependencies as a sequence of local dependencies** [...] For this, the metarule [below] has to be used. This metarule removes an arbitrary category X from the set of categories on the right-hand side of the rule and represents it on the left-hand side with a slash (‘/’).”

$$\begin{array}{c}
 (12) \quad V2 \rightarrow W, X \\
 \quad \quad \quad \downarrow \\
 (13) \quad V2/X \rightarrow W
 \end{array}$$

Müller (2019). Grammatical theory, p. 195.

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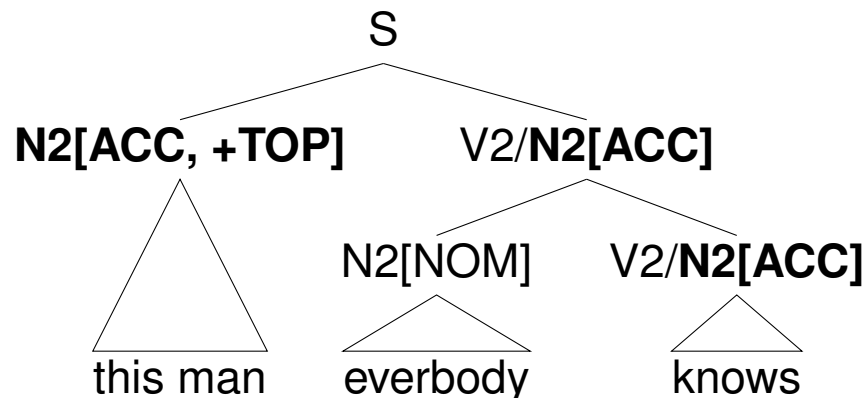
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Long-Distance Dependencies

This metarule allows for non-terminals being “percolated” up the tree to higher positions where they can then combine with other non-terminals. This helps to model long distance dependencies while maintaining the *context-freeness* of the rewrite rules. Also, note that this is a so-called *trace-less* analysis, as it is assumed that only the features move up the tree, rather than the words themselves.

Müller (2019). Grammatical theory, p. 198.



Note: The +TOP value is here needed to indicate that this is not the regular order of phrases in the language, but an order due to topicalization.

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Section 2: Untyped Feature Descriptions



Feature Descriptions

“In the previous chapter, we talked about sets of feature-value pairs, which can be used to describe linguistic objects. In this chapter, we will introduce feature descriptions which play a role in theories such as LFG, HPSG, Construction Grammar, versions of Categorical Grammar and TAG (and even some formalizations of Minimalist theories (Veenstra 1998)). This chapter will therefore lay some of the groundwork for the chapters to follow.”

Müller (2019). Grammatical theory, p. 206.

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Beware Terminological Confusion

“**Feature structures** are complex entities which can model properties of a linguistic object. Linguists mostly work with **feature descriptions** which describe *only parts of a given feature structure*.”

Müller (2019). Grammatical theory, p. 206.

Alternative terms for *feature structures*:

- ▶ feature-value structure
- ▶ attribute-value structure

Alternative terms for *feature descriptions*:

- ▶ attribute-value matrix (AVM)
- ▶ feature matrix

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Untyped Feature Descriptions

A typical example of **untyped feature descriptions** are matrices that contain inflectional information of a given word form. In this particular context, the *feature values* are often given without the *feature labels*, since there is little syncretism between feature values which could make them ambiguous.

Example from GB theory (Lecture 7):

drank: $\begin{bmatrix} +past \\ 3pers \\ +sg \end{bmatrix}$.

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Notational Conventions

However, to be maximally specific we will here use *upper case letters* for **feature labels**, and *lower case italics* for **feature values**, and always give both in the feature descriptions.

Example from Müller describing a person:

FIRSTNAME	<i>max</i>
LASTNAME	<i>meier</i>
DATE-OF-BIRTH	<i>10.10.1985</i>

Example from above for *drank*:

TENSE	<i>past</i>
PERSON	<i>3</i>
NUMBER	<i>sg</i>

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Glossing and Feature Descriptions

Note that the **glossings** we find in grammatical example sentences can be directly *translated into feature descriptions*. We therefore might assume that if there is a gloss, then this is relevant grammatical information that should go into a feature description, while if there is none, then the feature description is basically empty.

Ayacucho Quechua (quy, Quechuan)

- (14) wayna runa mikuy-ta yanu-n
 young man.NOM.SG food-ACC cook-PRS.3SG
 “The young man cooks the food.”

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Example

Glossing:

(15) wayna runa mikuy-ta yanu-n
 young man.NOM.SG food-ACC.SG cook-PRS.3SG
 “The young man cooks the food.”

Feature Description:

wayna: []	runa: [CASE <i>nom</i> NUMBER <i>sg</i>]	mikuy-ta: [CASE <i>acc</i> NUMBER <i>sg</i>]	yanu-n: [NUMBER <i>sg</i> PERSON <i>3</i> TENSE <i>prs</i>]
--------------	---	---	---

Note: Henceforth, we will order the feature-value pairs alphabetically inside the matrix from top to bottom.

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Empty Morphemes

In some theories of morphology, **empty morphemes** are posited (in parallel to empty slots in a tree structure as discussed in the lecture on GB) whenever there is no overt morphological marker for a grammatical function which *in theory* should be there. This could be represented by a feature label without value in the feature description matrix...

runa-∅-ta
man-∅-ACC

$$\begin{bmatrix} \text{NUMBER} & _ \\ \text{CASE} & \text{acc} \end{bmatrix}$$

mikuy-kuna-ta
man-PL-ACC

$$\begin{bmatrix} \text{NUMBER} & \text{pl} \\ \text{CASE} & \text{acc} \end{bmatrix}$$

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Empty Morphemes

... However, empty features are not considered in feature descriptions. As an alternative, we might assume that the lack of a marker means that all *theoretically possible* grammatical functions are possible, except the one that is not explicitly marked. For Ayacucho Quechua, there is an overt plural marker, but no overt singular marker. Hence, whenever the plural marker is lacking, singular is assumed as the NUMBER value.

runa-ta
man-ACC.SG

$$\left[\begin{array}{ll} \text{NUMBER} & sg \\ \text{CASE} & acc \end{array} \right]$$

mikuy-kuna-ta
man-PL-ACC

$$\left[\begin{array}{ll} \text{NUMBER} & pl \\ \text{CASE} & acc \end{array} \right]$$

Note: in the glossing, this is then often represented by using a dot (ACC.SG), which according to the Leipzig glossing rules indicates that a marker (i.e. -ta) is assigned both singular number and accusative case. Another option would be to just drop the SG glossing.

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Syncretism

A problem related to empty morphemes is so-called **syncretism** of word forms. We can construe inflectional paradigms by assuming certain theoretical features like CASE, NUMBER, GENDER, etc. The theoretical grids can then be filled by the actual word forms used for these grammatical feature combinations. However, the set of different word types rarely matches these grids exactly in the sense that each cell would be filled by a different word type. We talk about a form being *syncretic* if it fills different cells.

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Paradigm for *Frau* 'woman':

	NOM	ACC	DAT	GEN
SG	Frau	Frau	Frau	Frau
PL	Frauen	Frauen	Frauen	Frauen

Paradigm for *Mann* 'man':

	NOM	ACC	DAT	GEN
SG	Mann	Mann	Mann	Mannes
PL	Männer	Männer	Männern	Männer



Syncretism and Disjunction

In feature descriptions, **each word form gets a separate description**. If there is syncretism across a whole feature (i.e. all forms for the values of CASE are the same), then the feature can be dropped. If there is only partial syncretism, then it is indicated by using disjunction, i.e. the ‘or’ symbol \vee .

Word form: *Frau*

[NUMBER *sg*]

Word form:
Frauen

[NUMBER *pl*]

Word form: *Mann*

[CASE *nom* \vee *acc* \vee *dat*
NUMBER *sg*]

Word form: *Mannes*

[CASE *gen*
NUMBER *sg*]

Word form: *Männer*

[CASE *nom* \vee *acc* \vee *gen*
NUMBER *pl*]

Word form: *Männern*

[CASE *dat*
NUMBER *pl*]

Note: we could also take grammatical gender into account to the effect that GENDER would always be *fem* for *Frau* and *Frauen*, and *masc* for *Mann* and *Männer*. Similarly, PERSON features could be included, i.e. the value would be 3 in all cases.

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Disjunction: Alternative Notation

Instead of working with disjunctions inside the feature descriptions, we could also consider to have separate feature descriptions and then apply disjunctions to these.

Word form: *Mann*

$$\left[\begin{array}{ll} \text{CASE} & \textit{nom} \\ \text{NUMBER} & \textit{sg} \end{array} \right] \vee \left[\begin{array}{ll} \text{CASE} & \textit{acc} \\ \text{NUMBER} & \textit{sg} \end{array} \right] \vee \left[\begin{array}{ll} \text{CASE} & \textit{dat} \\ \text{NUMBER} & \textit{sg} \end{array} \right]$$

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Embedding

One feature description might be embedded in another feature description, as in the example below from Müller (2019), p. 206.

FIRSTNAME	<i>max</i>										
LASTNAME	<i>meier</i>										
DATE-OF-BIRTH	<i>10.10.1985</i>										
FATHER	<table style="border-collapse: collapse; margin-left: 20px;"> <tr> <td style="border-left: 1px solid black; border-right: 1px solid black; padding: 5px;">FIRSTNAME</td> <td style="padding: 5px;">peter</td> </tr> <tr> <td style="border-left: 1px solid black; border-right: 1px solid black; padding: 5px;">LASTNAME</td> <td style="padding: 5px;">meier</td> </tr> <tr> <td style="border-left: 1px solid black; border-right: 1px solid black; padding: 5px;">DATE-OF-BIRTH</td> <td style="padding: 5px;">10.05.1960</td> </tr> <tr> <td style="border-left: 1px solid black; border-right: 1px solid black; padding: 5px;">FATHER</td> <td style="padding: 5px;">...</td> </tr> <tr> <td style="border-left: 1px solid black; border-right: 1px solid black; padding: 5px;">MOTHER</td> <td style="padding: 5px;">...</td> </tr> </table>	FIRSTNAME	peter	LASTNAME	meier	DATE-OF-BIRTH	10.05.1960	FATHER	...	MOTHER	...
FIRSTNAME	peter										
LASTNAME	meier										
DATE-OF-BIRTH	10.05.1960										
FATHER	...										
MOTHER	...										
MOTHER	...										

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Paths

“In feature descriptions, a *path* is a sequence of features which immediately follow each other. The *value of a path* is the feature description at the end of the path. Therefore, the value of FATHER|DATE-OF-BIRTH is *10.05.1960*.”

Müller (2019), p. 206.

FIRSTNAME	<i>max</i>										
LASTNAME	<i>meier</i>										
DATE-OF-BIRTH	<i>10.10.1985</i>										
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Embedding: Linguistic Example

A linguistic example of embeddings of feature descriptions is *derivational morphology*, which can create a new word form out of a word form that functions as a stem for derivational affixes.

Word form: *help*

$$\left[\text{POS } \textit{noun} \vee \textit{verb} \right]$$

Word form: *helpful*

$$\left[\begin{array}{l} \text{POS } \textit{adj} \\ \text{STEM } \left[\text{POS } \textit{noun} \vee \textit{verb} \right] \end{array} \right]$$

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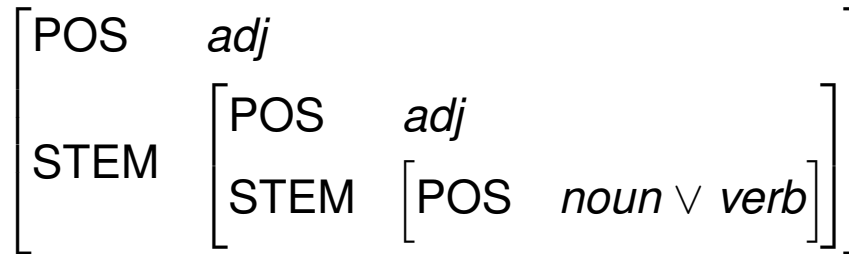
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Embedding: Linguistic Example

A linguistic example of embeddings of feature descriptions is *derivational morphology*, which can create a new word form out of a word form that functions as a stem for derivational affixes.

Word form: *unhelpful*



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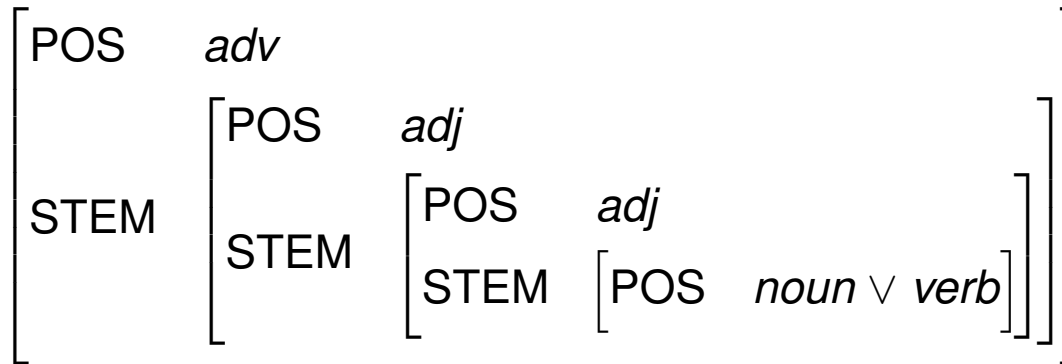
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Embedding: Linguistic Example

A linguistic example of embeddings of feature descriptions is *derivational morphology*, which can create a new word form out of a word form that functions as a stem for derivational affixes.

Word form: *unhelpfully*



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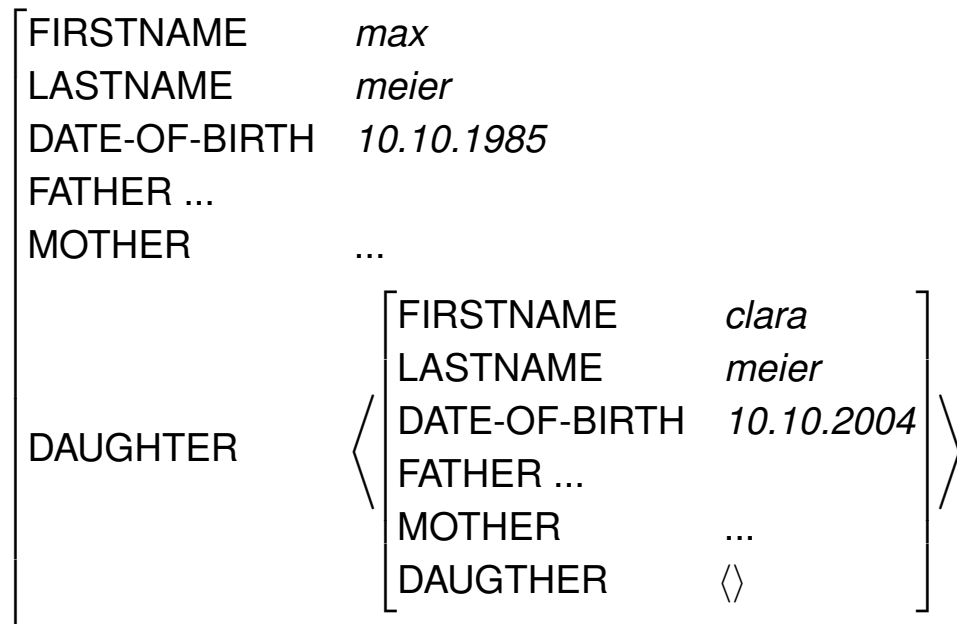
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Lists

In some cases, it is not just a single value that a feature can take, but rather several values. Therefore, we can use a **list of feature values** as in the example below from Müller (2019), p. 207. Note that a list is *different from disjunction*, since the former is essentially an ‘and’ statement, whereas the latter is an ‘or’ statement.



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Lists: Linguistic Examples

Going beyond the word level, we might want to capture the feature description, for example, of whole phrases such as *the green house*. In this particular example, we assume a HEAD feature for *house*, and a list of feature descriptions for the *complements* (COMPS).¹

phrase: *the green house*

$$\left[\begin{array}{l} \text{HEAD} \left[\begin{array}{ll} \text{POS} & \textit{noun} \\ \text{CASE} & \textit{nom} \vee \textit{acc} \vee \textit{dat} \\ \text{NUMBER} & \textit{sg} \end{array} \right] \\ \text{COMPS} \left\langle \left[\text{POS} \ \textit{det} \right], \left[\text{POS} \ \textit{adj} \right] \right\rangle \end{array} \right]$$

¹This is similar to what we will see in Head-Driven Phrase Structure Grammar, though in HPSG the article would be considered a specifier rather than a complement.

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Section 3: Typed Feature Descriptions



Types

Another way of thinking about **typed feature descriptions** is that the type determines the template of feature labels that can (but do not have to be) filled with values.

Müller (2019), p. 208.

Feature structure of the type *person*:

<i>person</i>	
FIRSTNAME	<i>firstname</i>
LASTNAME	<i>lastname</i>
DATE-OF-BIRTH	<i>date</i>
GENDER	<i>gender</i>
FATHER	<i>person</i>
MOTHER	<i>person</i>
CHILDREN	<i>list of person</i>

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Types & Atomic Types (Values)

Note that both the *type* and the *feature values* are written in lower case italics. This is not a coincidence, since feature values are also types, though without any further features subcategorized under them. They are hence called **atomic types**.

Feature structure of the type *person*:

<i>person</i>	
FIRSTNAME	<i>firstname</i>
LASTNAME	<i>lastname</i>
DATE-OF-BIRTH	<i>date</i>
GENDER	<i>gender</i>
FATHER	<i>person</i>
MOTHER	<i>person</i>
CHILDREN	<i>list of person</i>

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Typed Feature Descriptions: Linguistic Example

When we deal, for instance, with *word forms* in our linguistic analyses, we might define a feature structure for the type *word*. Note, however, that the content of this structure is dependent on the theory we adopt, and the particular language we analyze.

Possible feature structure of the type *word*:

<i>word</i>	
ASPECT	<i>aspect</i>
BOUNDEDNESS	<i>boundedness</i>
CASE	<i>case</i>
GENDER	<i>gender</i>
MOOD	<i>mood</i>
NUMBER	<i>number</i>
PERSON	<i>person</i>
POS	<i>pos</i>
TENSE	<i>tense</i>
etc.	

Note: BOUNDEDNESS is here introduced to distinguish between *morphemes* and *words*, morphemes are *bound*, words are *unbound* (according to the traditional definition.)

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Important Question

Should we deal with differences between parts-of-speech at the level of *types* or at the level of *features*? – We will here take POS as separate types with their own feature structures.

Feature structure of the type *word*:

<i>word</i>	
ASPECT	<i>aspect</i>
BOUNDEDNESS	<i>boundedness</i>
CASE	<i>case</i>
GENDER	<i>gender</i>
MOOD	<i>mood</i>
NUMBER	<i>number</i>
PERSON	<i>person</i>
POS	<i>pos</i>
TENSE	<i>tense</i>
etc.	

Feature structure of the type *noun*:

<i>noun</i>	
BOUNDEDNESS	<i>boundedness</i>
CASE	<i>case</i>
GENDER	<i>gender</i>
NUMBER	<i>number</i>
PERSON	<i>person</i>
etc.	

Feature structure of the type *verb*:

<i>verb</i>	
ASPECT	<i>aspect</i>
BOUNDEDNESS	<i>boundedness</i>
MOOD	<i>mood</i>
NUMBER	<i>number</i>
PERSON	<i>person</i>
TENSE	<i>tense</i>
etc.	

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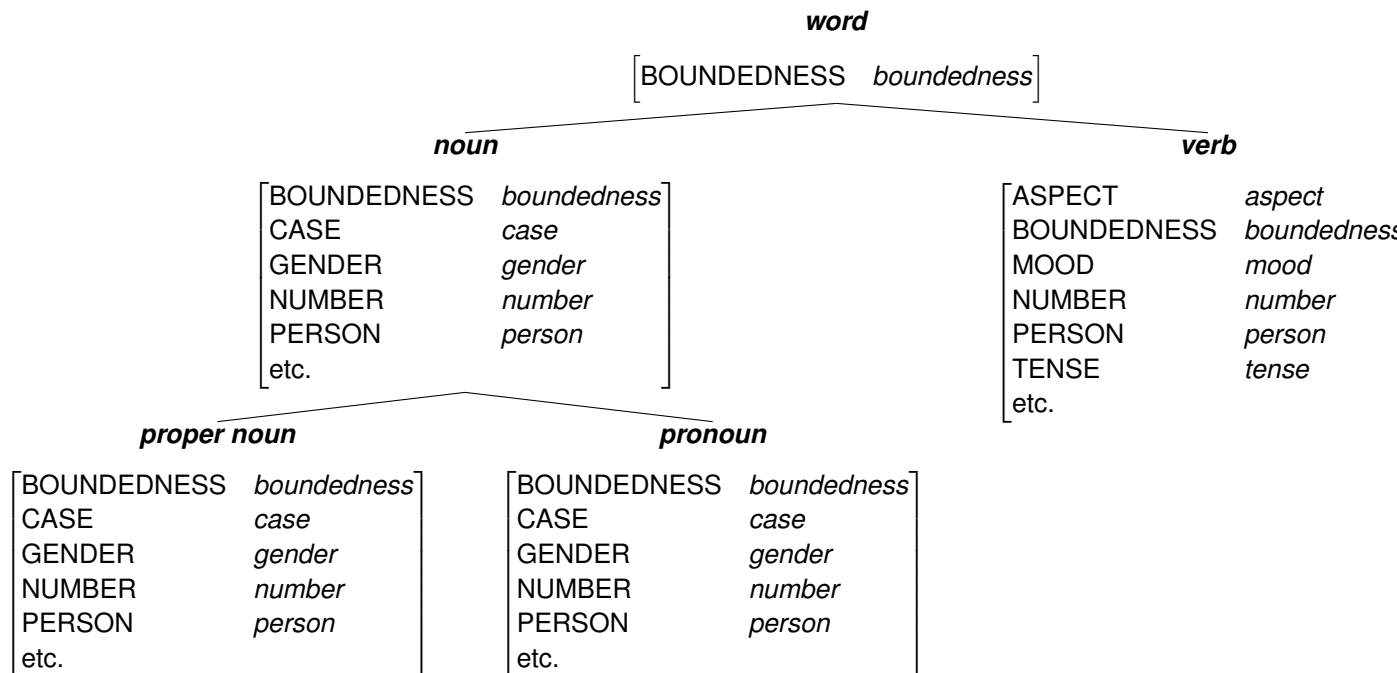
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Note: In fact, if we decide to deal with POS at the level of types, then the type *word* would not have to contain all the POS specific features anymore, but just the BOUNDEDNESS feature. See type hierarchy on the next slide.

Type Hierarchies

Type hierarchies display the hierarchical relationships between different types, i.e. it displays which type is a *subordinate* or *superordinate* of which other type.



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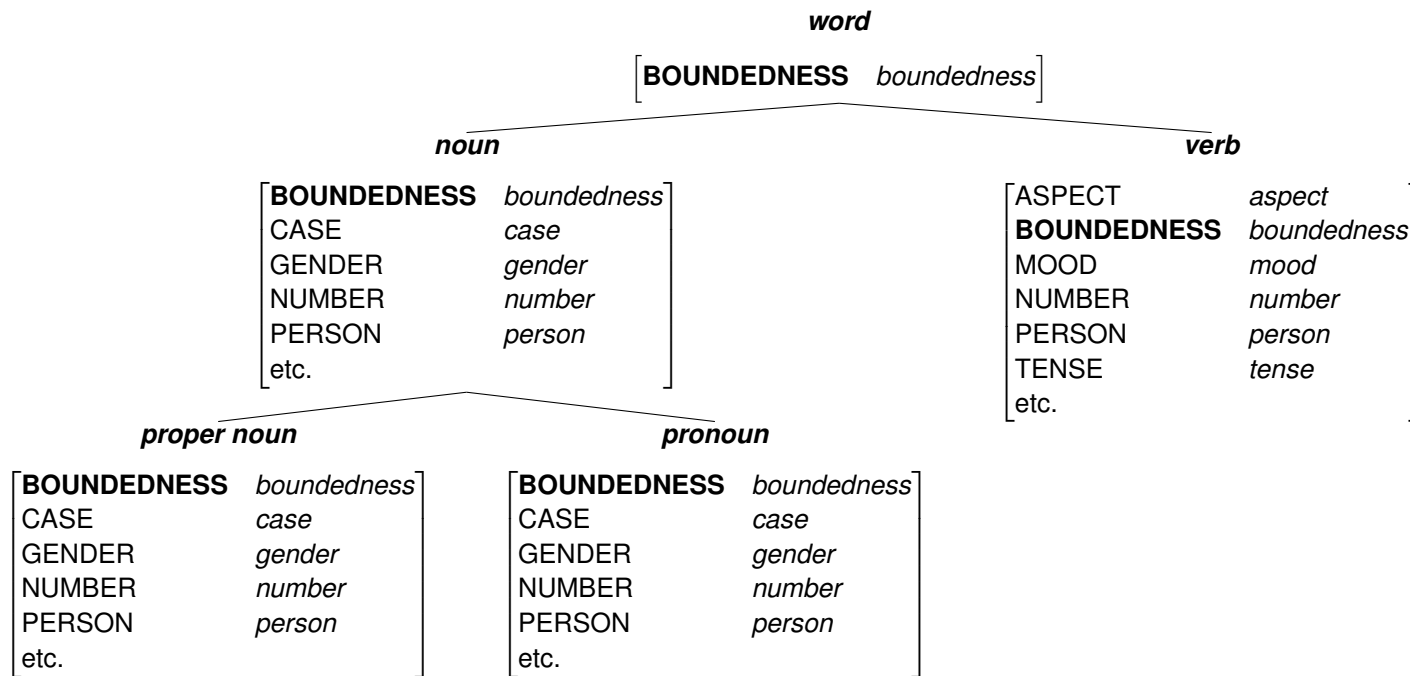
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Inheritance

Subordinate types “**inherit**” the features of their superordinate types. E.g. the feature BOUNDEDNESS is *multiply inherited* to all the subordinate types in this tree. It is the feature that all words share.



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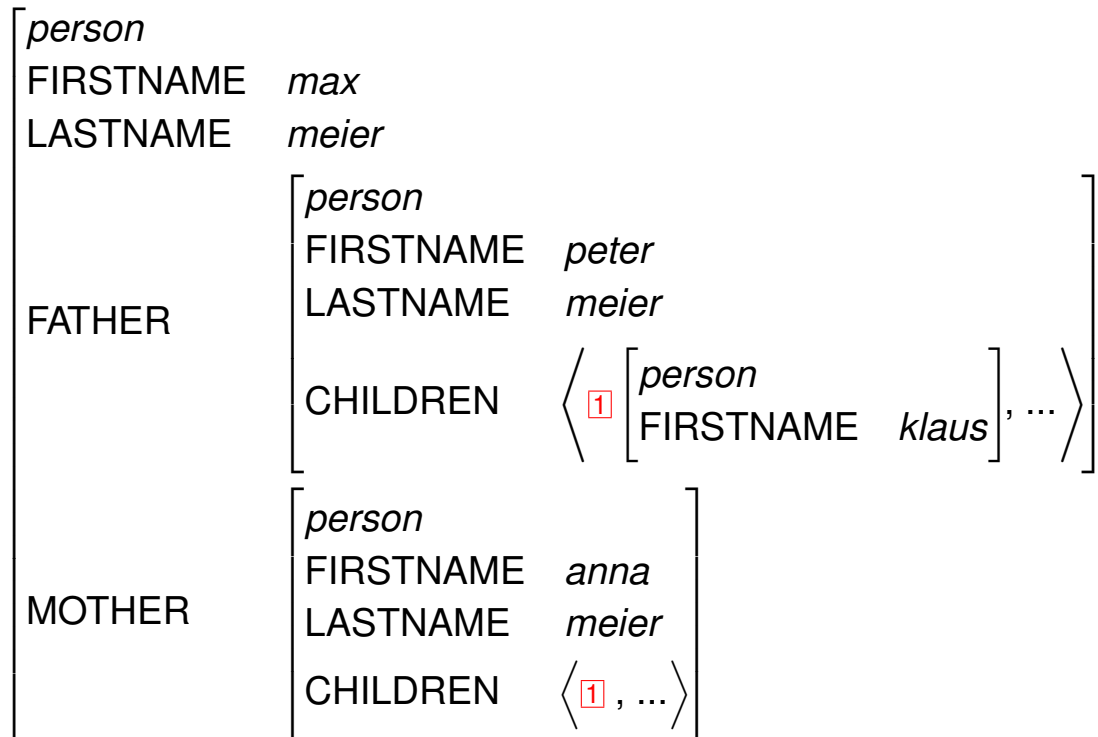
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Structure Sharing

Structure sharing can be used to indicate that an *identical feature structure* is used in different parts of the feature description.

Müller (2019), p. 211.



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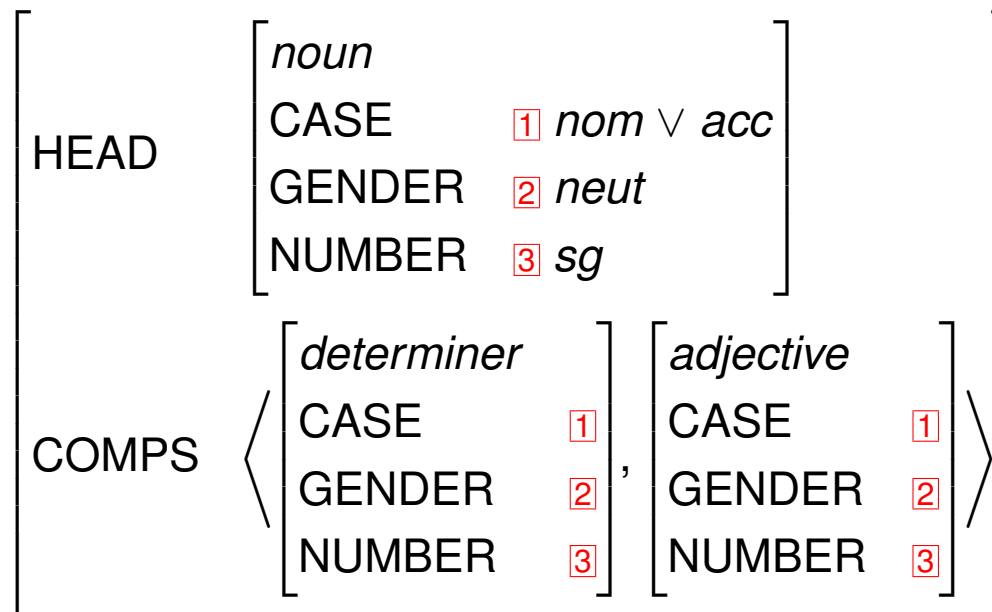
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Structure Sharing: Linguistic Example

A linguistic example of structure sharing is **agreement**. In the example below, between determiner, adjective and noun in German.

phrase: *das grüne Haus*



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Section 5: Feature Descriptions and Structures



Difference: Feature Descriptions and Structures

“If we return to the example with people from the previous sections, we can capture the difference between a **model [feature structure]** and a **[feature] description** as follows: if we have a model of people that includes first name, last name, date of birth, gender and hair color, then it follows that every object we model also has a birthday. We can, however, decide to omit these details from our descriptions if they do not play a role for stating constraints or formulating searches.”

Müller (2019), p. 217.

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Feature structure

assumed for the word *Frau*:

<i>noun</i>	
CASE	<i>case</i>
GENDER	<i>gender</i>
NUMBER	<i>number</i>
PERSON	<i>person</i>
etc.	

Feature description

assumed for the word *Frau*:

<i>noun</i>	
GENDER	<i>fem</i>
NUMBER	<i>sg</i>
etc.	



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References

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Lasnik, Howard (2017). *Case, Passives, and Government*. Unpublished manuscript.

Müller, Stefan. 2019. *Grammatical theory: From transformational grammar to constraint-based approaches. Third revised and extended edition. Volume I*. Berlin: Language Science Press.

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Thank You.

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