



Syntax & Semantics WiSe 2020/2021

Lecture 8: Intermediate Summary I (Syntax)



Overview

Q & As Tutorial Week 3

Basic Concepts

- Constituency, POS, Heads, Valency, Grammatical Functions
- A Note on Combinatoriality

Dependency Grammar

- Representational Format
- Syntactic Phenomena (Verb Position, Passive, Coordination)
- Crossing Dependencies
- Relevance of Basic Concepts

Phrase Structure Grammar

- Basic Definitions
- Morphological Features
- Syntactic Phenomena (Passive)
- Relevance of Basic Concepts

DG and PSG Comparison



Q&As Tutorial Week 3

Are the terms “crossings” and “crossing dependencies” equivalent? They could be used to refer to different concepts, namely, the former to the number of crossings, and the latter to the subset of dependency arrows which cross with one or several other arrows. In the first case, is it possible that we have more crossings than dependency arrows? Isn't this an issue?

I used them interchangeably in the exercise sheets to refer to the *number of crossings in the dependency arrows*. I have clarified this now in the new version of the exercises and solutions. As to the last point: I currently don't see why this would be an issue.

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Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison



“Crossings” vs. “Crossing Dependencies”

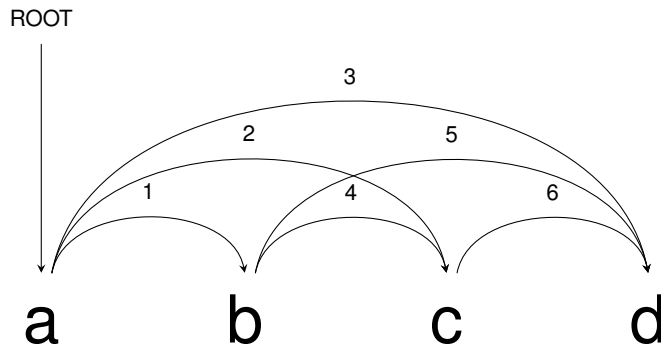
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Week 3

Basic Concepts

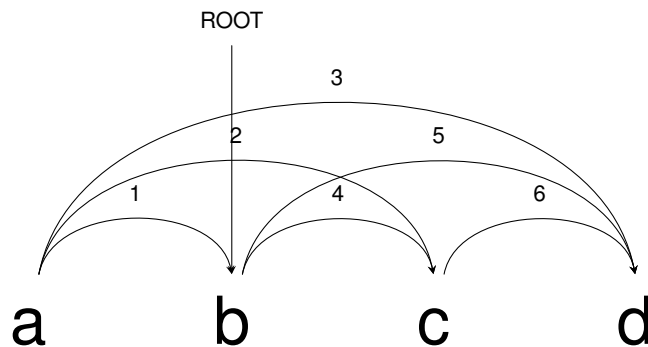
Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison



crossings: 1
crossing dependencies: 2 (i.e.
dependency 2 and dependency 5).



crossings: 3
crossing dependencies: 4 (i.e. 2, 5,
3, and root).



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In the Swiss German example sentence (and respective English translation), why do we not draw the subject arrows from “hälfe” and “aanstriche” to “chind” and “Hans” respectively?

This is a fair point. Looking at the respective dependency relations given in the Universal Dependencies corpora of English, we should indeed draw these arrows. I've added them in the dependency analyses on the next slide. Note that this also changes the average dependency lengths and the number of crossings (for Swiss German).

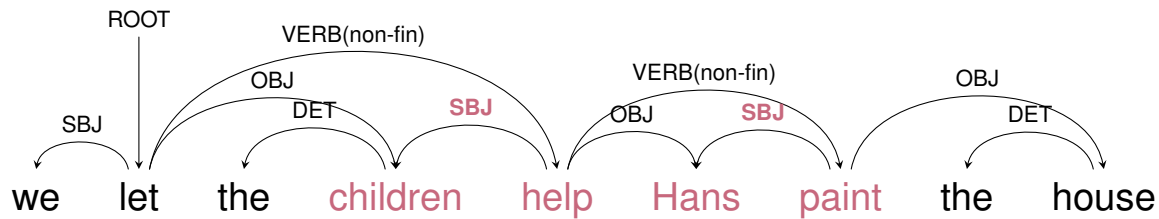
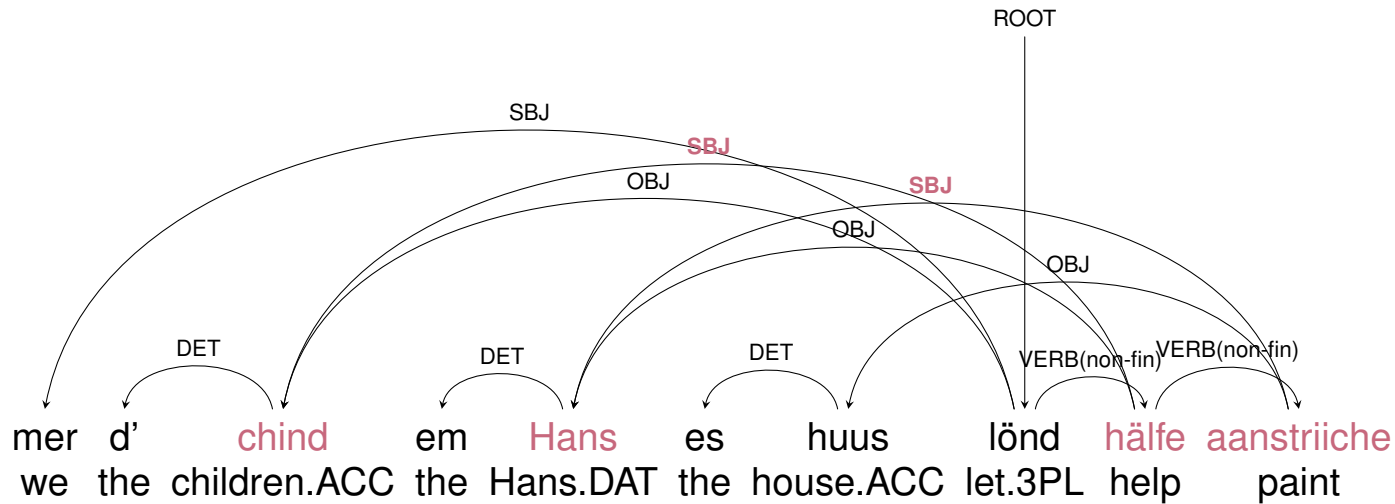
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Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison





Basic Concepts



Basic Concepts

- ▶ **Constituency** (Lecture 2)
- ▶ **Parts of Speech** (Lecture 2)
- ▶ **Headedness** (Lecture 3)
- ▶ **Valency** (Lecture 3)
- ▶ **Grammatical Functions** (Lecture 3)
- ▶ **Combinatoriality** (Lecture 1)

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Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison



Definition: Constituents

Both the **basic elements/units** of a sentence – often orthographic words – as well as **combinations of those**, i.e. **phrases**, count as constituents.

Most basic constituents:

[Kim] [sees] [a] [big] [tree]

Higher level constituents:

[big[tree]], [a[big[tree]]], etc.

Müller (2019). Grammatical theory, p. 7.

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Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison



Tests for Constituency

▶ Substitution Test

he knows [the man] → he knows [a woman] ✓

▶ Pronominalization Test

he knows [the man] → he knows [him] ✓

▶ Question Formation Test

Whom does he know? – [The man]. ✓

▶ Permutation Test

he knows [the man] → [the man] he knows ✓

he knows [the man] → he [the man] knows ✗

▶ Fronting Test

he knows [the man] → [the man] he knows ✓

▶ Coordination Test

he knows [the man] → he knows [the man] and [the woman] ✓



Problems with Constituency Tests

“It would be ideal if the tests presented here delivered clear-cut results in every case, as the empirical basis on which syntactic theories are built would thereby become much clearer. Unfortunately, this is not the case. There are in fact a number of problems with constituent tests, [...]”

Müller (2019). Grammatical theory, p. 11.

Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison



Definition: Parts of Speech

Parts of Speech are classes of words that each lexical item is assigned to according to its *morphosyntactic* properties. According to Müller (2019: 18) the basic POS are *Verb*, *Noun*, *Adjective*, *Adverb*, *Prepositions*.

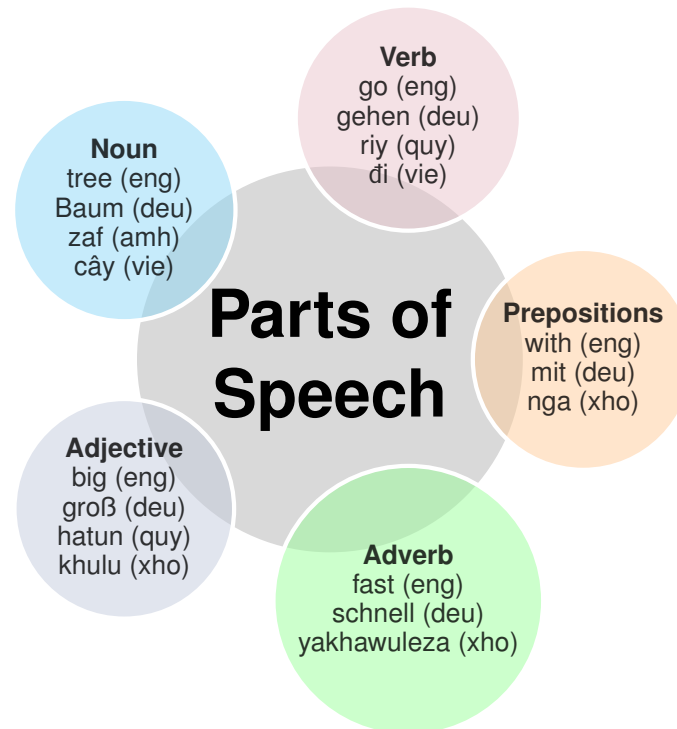
Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

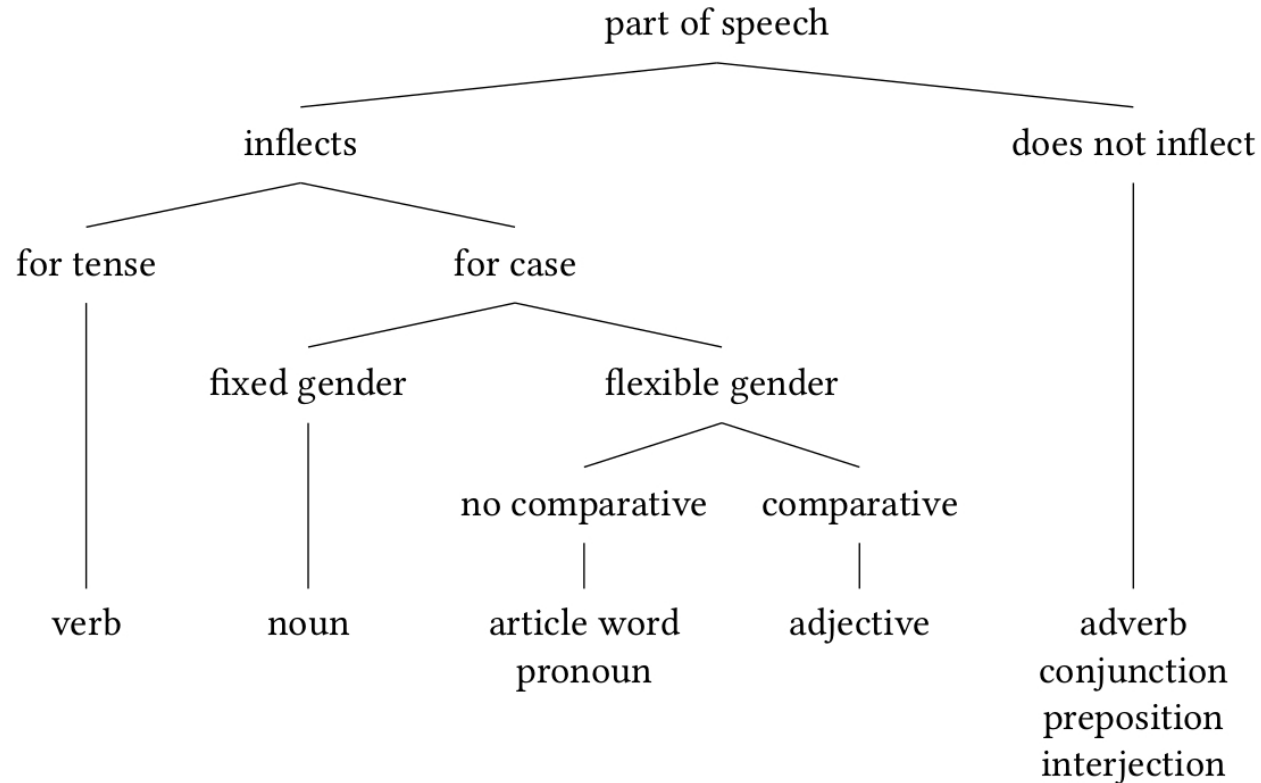
Phrase Structure
Grammar

DG and PSG
Comparison





Decision Tree



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Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison

Müller (2019). Grammatical theory, p. 24.

Based on Duden Grammar by Eisenberg et al. (2005).



Controversy: languages without adjectives?

“In Mandarin, both verbs and ‘adjectives’ can be marked for aspectual categories, either by aspectual suffixes like *-le* (perfective), *-guo* (experiential), and *-zhe* (durative), or by ‘reduplication’ (‘delimitative’). (I tentatively adopt the position of regarding aspectual markers as (morphological) suffixes rather than (syntactic) particles. [...]”

Sackmann (1996), p. 262.

Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison

Mandarin Chinese (cmn, Sino-Tibetan)

(1) zhèige xuéshēng shuì-**le** [...]

this student sleep-**PERF** [...]

“This student has slept [...].”

(2) zhèige xuéshēng nǚlì-**le** [...]

this student diligent-**PERF** [...]

“This student has been diligent [...].”



Mandarin Chinese ‘adjectives’

Note: If we accept *-le* as a suffix marking perfective aspect, then we would class *nǔlì-le* “diligent-PERF” as verb on the decision tree, since it inflects for tense/aspect.

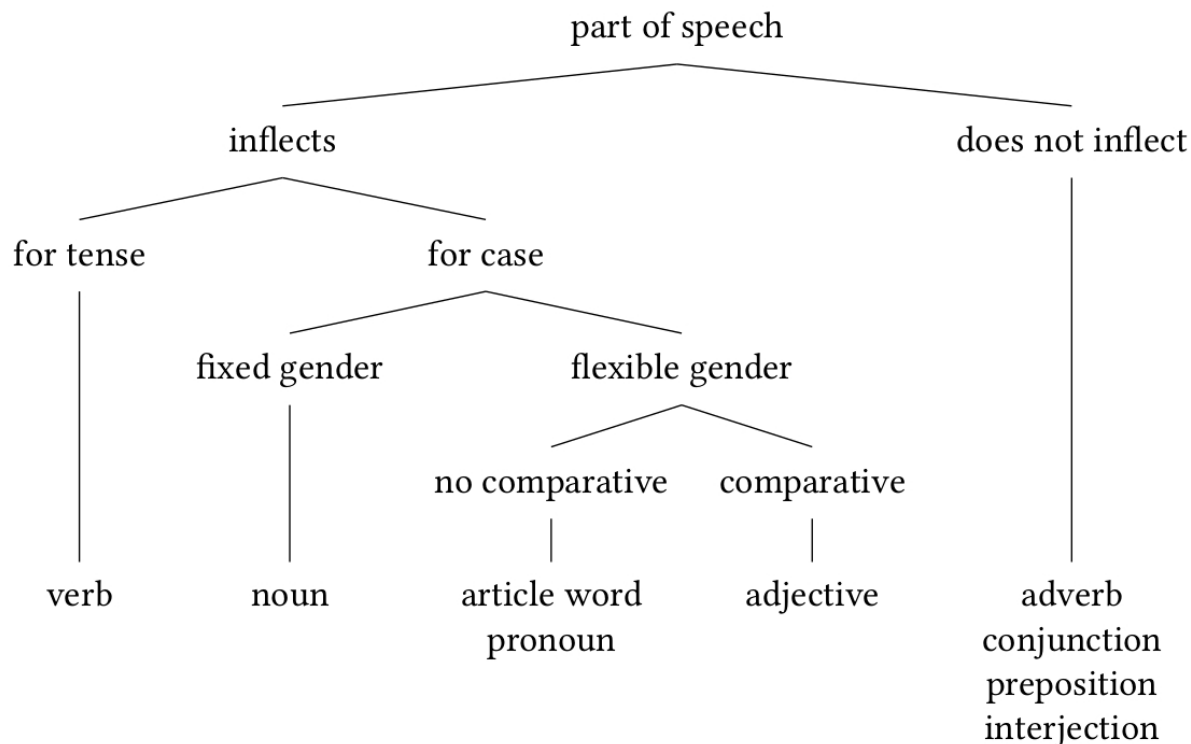
Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison





Definition: Head

“The **head** of a constituent/phrase is the element which determines the *most important properties* of the constituent/phrase. At the same time, the head also determines the *composition of the phrase*. That is, the head requires certain other elements to be present in the phrase.”

Müller (2019). Grammatical theory, p. 28.

Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison

Examples:

- (3) This man *dreams* in his sleep.
- (4) this *man*
- (5) *in* his sleep
- (6) his *sleep*

The heads are here indicated in *italics*.



Overview: Heads and Phrase Types

Example	Head	Phrase Type
she knows the man	knows (V)	VP
he is smart	smart (A)	AP
smart woman	woman (N)	NP
the woman	woman (N)	NP
the man's cat	cat (N)	NP
very beautiful	beautiful (A)	AP
very quickly	quickly (Adv)	AdvP
in the library	in (P)	PP

Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison



Valence according to Tesnière

“Nous avons vu qu’il y avait des verbes sans actant, des verbes à un actant, des verbes à deux actants et des verbes à trois actants.”

Tesnière (1959). Éléments de syntaxe structurale, p. 238.

Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison

	Verb	V	V	V	V
				/ \	/ \
	Arguments	—	A	A A	A A A
Sentence Type:		impersonal sentence	intransitive sentence	transitive sentence	ditransitive sentence
Valency:		avalent (0)	monovalent (1), one-place predicate	bivalent (2), two-place predicate	trivalent (3), three-place predicate

Note: Müller states that the pronouns in expletives (e.g. *it rains*) should be considered obligatory arguments of the verb, while Tesnière explicitly calls them “sans actant”.



Subject and Object

“In some theories, grammatical functions such as **subject** and **object** form part of the formal description of language (see Chapter 7 on Lexical Functional Grammar, for example). [...] it is by no means a trivial matter to arrive at a definition of the word subject which can be used cross-linguistically.”

Müller (2019). Grammatical theory, p. 35.

Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison



Valence and Grammatical Functions

“If we can be clear about what we want to view as a subject, then the definition of *object* is no longer difficult: objects are all other arguments whose form is directly determined by a given head. [...] it is commonplace to talk of *direct objects* and *indirect objects*. The direct object gets its name from the fact that – unlike the indirect object – the referent of a direct object is directly affected by the action denoted by the verb.”

Müller (2019), p. 38.

Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison

	Verb	V	V	V	V
				/ \	/ \
	Arguments	—	A	A A	A A A
Gramm. Functions:		None or SUBJ	SUBJ	SUBJ, OBJ	SUBJ, DOBJ, IOBJ
Valency:		avalent (0)	monovalent (1)	bivalent (2)	trivalent (3)

Notation: DOBJ (direct object), IOBJ (indirect object)



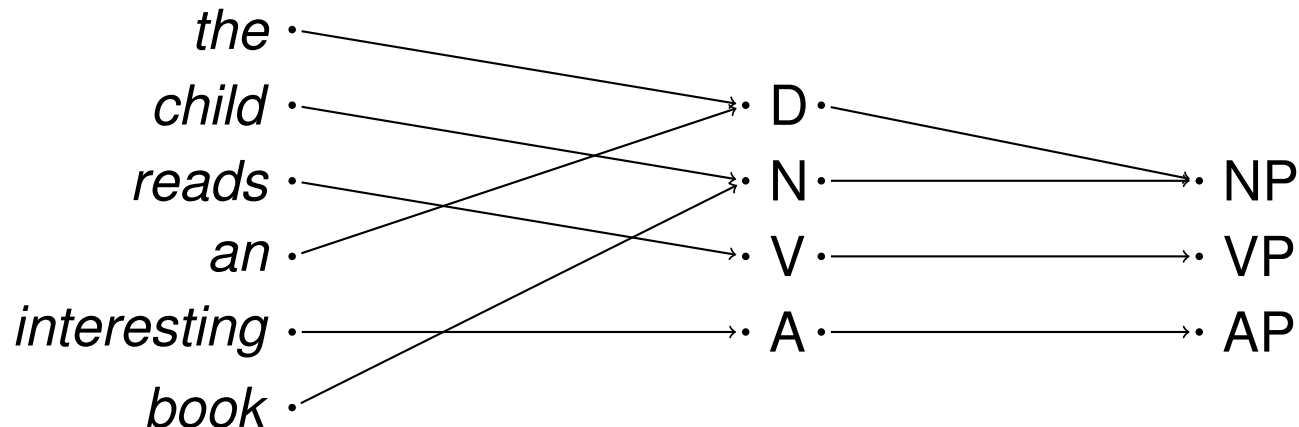
A Note on Combinatoriality in Syntax

(7) Words: the child reads an interesting book

POS: D N V D A N

Phrases: [NP [VP [NP [AP]]]]

Mapping from words to (unique) POS to (unique) Phrases:



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Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison



Combinatorial Possibilities

Words

with replacement:

$$n^{\text{words}} = 6^6 = 46656$$

without replacement:

$$n^{\text{words}} = 6! = 720$$

the child reads an interesting book
book the child reads an interesting
interesting book the child reads an
an interesting book the child reads
reads an interesting book the child
child reads an interesting book the
an child reads the interesting book
book an child reads the interesting
interesting book an child reads the
the interesting book an child reads
reads the interesting book an child
child reads the interesting book an
etc.

POS

with replacement:

$$n^{\text{POS}} = 4^4 = 256$$

without replacement:

$$n^{\text{POS}} = 4! = 24$$

D N V A
A D N V
V A D N
N V A D
D V N A
A D V N
N A D V
V N A D
etc.

Phrases

with replacement:

$$n^{\text{phrases}} = 3^3 = 27$$

without replacement:

$$n^{\text{phrases}} = 3! = 6$$

NP VP AP
AP NP VP
VP AP NP
VP NP AP
AP VP NP
NP AP VP

Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison



Combinatoriality: Important Take-Home-Message

The possibilities of combining words to strings of words, i.e. phrases and sentences, quickly explode into an unmanagable number. Mapping them to more general categories, like POS and phrases, helps to reduce the combinatorial possibilities. Further constraints on the order of these categories further reduces the possible set of sentences.

However: In order to do this, we need to define what POS and phrases, i.e. constituents are.

Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison



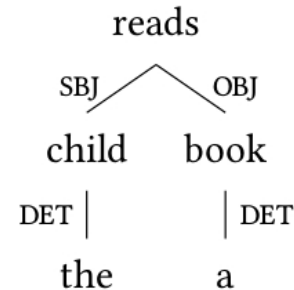
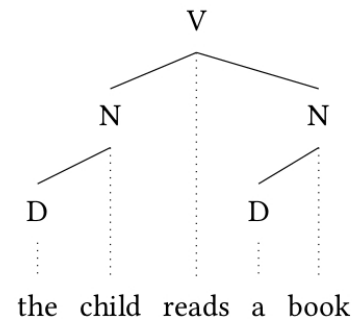
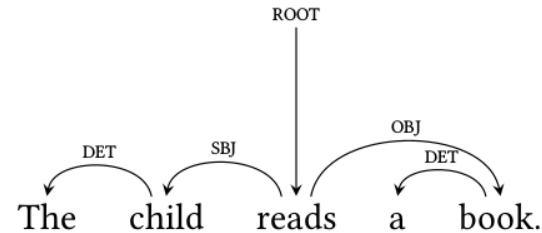
Dependency Grammar



The Representational Format

There are (at least) *three different* ways of illustrating a dependency grammar analysis of a given phrase/sentence (see Müller 2019, p. 268-269). We here generally follow the approach by Hudson (2007), namely, illustrating dependencies by curved arrows from the head to the dependent.

Note: There is an online tool at www.spacy.io that automatically generates lemmas, POS, etc. for sentences of a set of languages (English, German, French, etc.). This can also be used to generate dependency graphs.



Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison

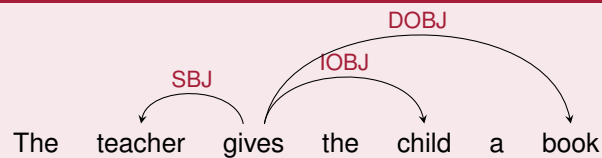
Adopted from Müller (2019). Grammatical theory, p. 369.



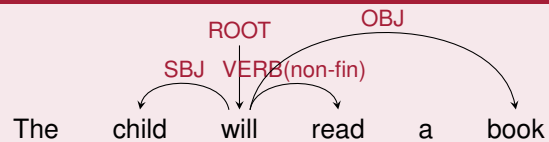
Main Verbs (Transitive)



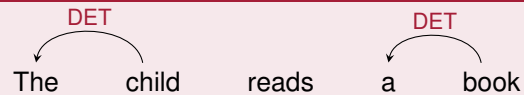
Main Verbs (Ditransitive)



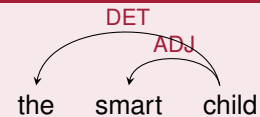
Auxiliary Verbs



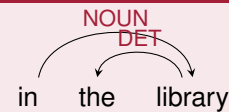
Determiners



Adjectives



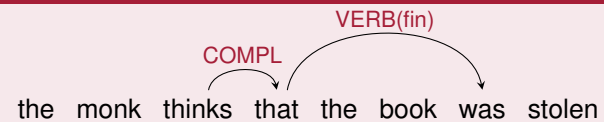
Prepositional Phrases



Possessor Phrases



Complementizer Phrases



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Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison

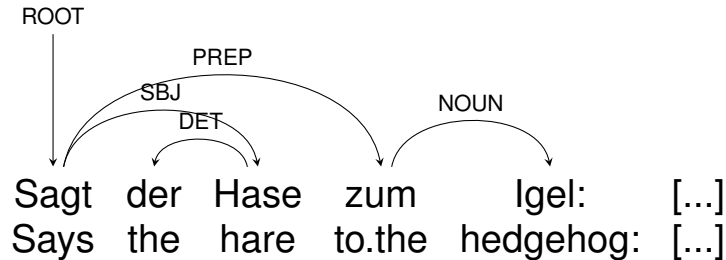


Verb Position

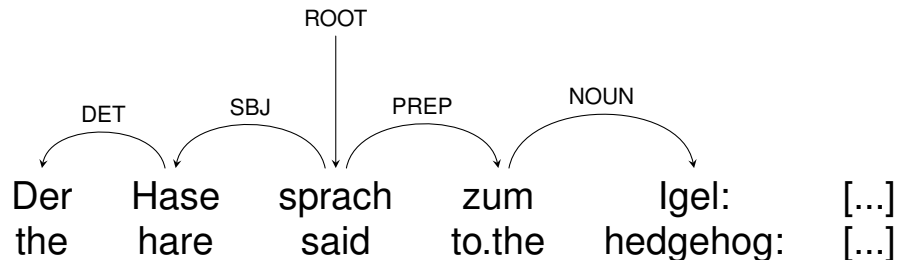
“In many Dependency Grammar publications on German, linearization issues are not dealt with and authors just focus on the dependency relations between a verb and its arguments are basically the same in verb-initial and verb-final sentences [...] only the position of the verb is different [...].”

Müller (2019). Grammatical theory, p. 375.

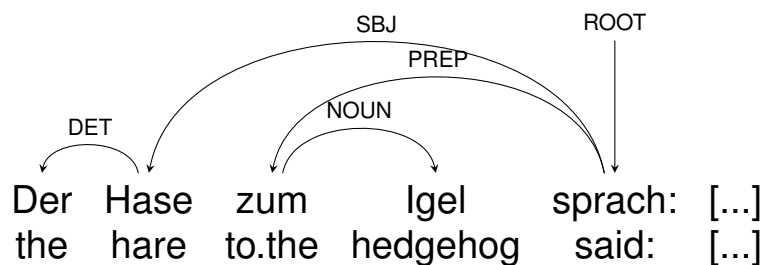
Initial



Medial



Final



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Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison



The Passive

In a **passive construction**, the object of the corresponding *active sentence* becomes the subject. If we want to further license case assignments (e.g. nominative to the subject of the active sentence and the subject of the passive sentence, while accusative to the object of the active sentence) then we have to invoke further lexical rules (see Müller (2019), pp. 373).

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Week 3

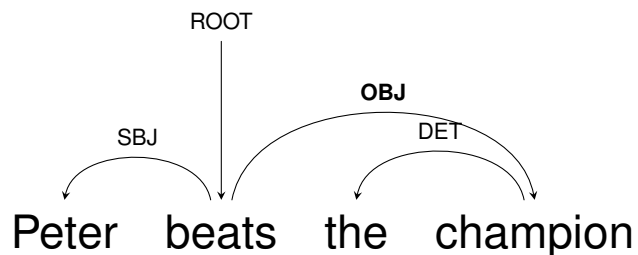
Basic Concepts

Dependency
Grammar

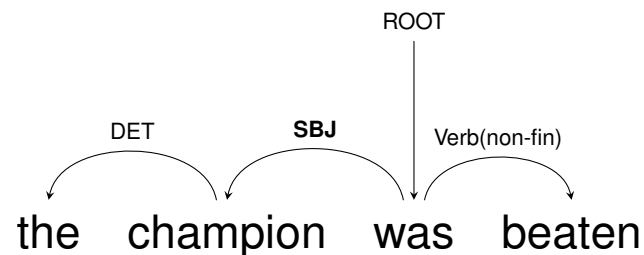
Phrase Structure
Grammar

DG and PSG
Comparison

Active:



Passive:





Coordination

There are different ways to model **coordination** in a dependency grammar framework (see discussion in Müller 2019, p. 384). We here follow one of the proposals, which considers the conjunction (i.e. *and*) as the head of the conjoined noun phrases.

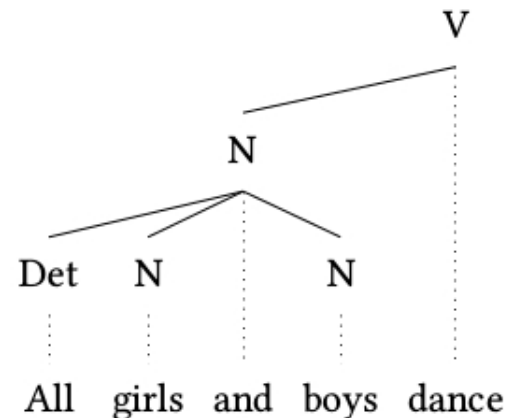
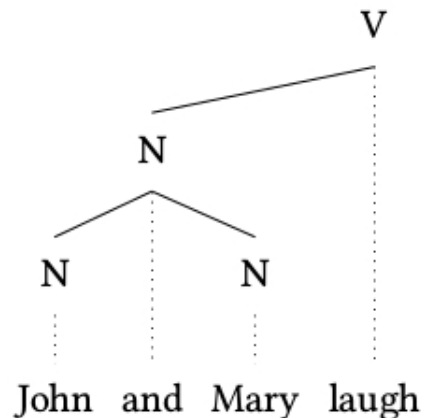
Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison

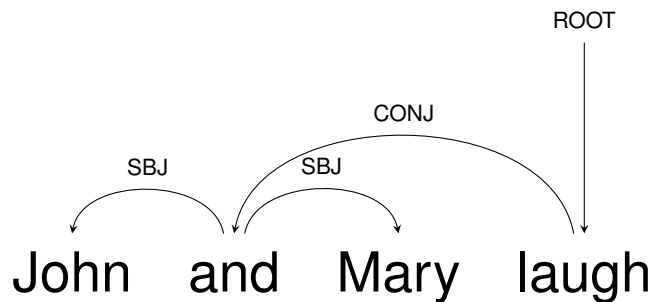


Müller (2019), p. 385.



Translation into Current Notation

Proper nouns:



Notes: We here need two SUBJ arrows, since both proper nouns are subjects of the sentence. In the case of noun phrases with determiners (Müller considers *all* a determiner here), the determiner also depends on the conjunction.

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Week 3

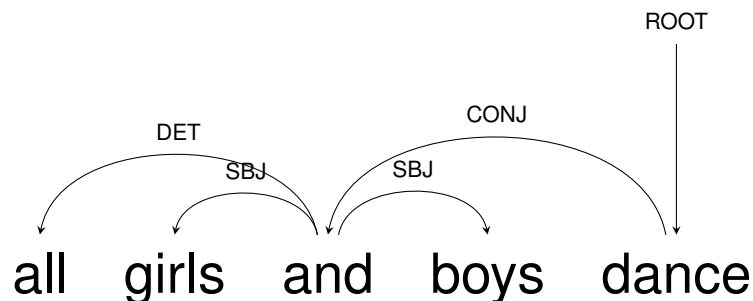
Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison

Noun phrases:





Crossing Dependencies

In certain syntactic constructions (and languages), dependencies might cross. Such constructions are referred to as *non-projective*. This is often seen as dispreferred from a processing and learning perspective, though there is no reason a priori why dependencies should not cross.

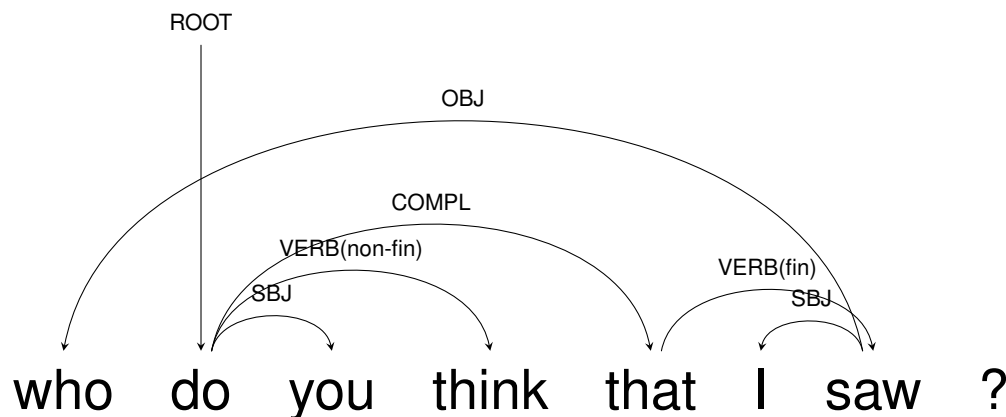
Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison



See the German equivalent in Müller (2019), p. 379.



Crossing Dependencies

In fact, some researchers propose to try and analyze dependencies in a way to avoid crossing dependencies.

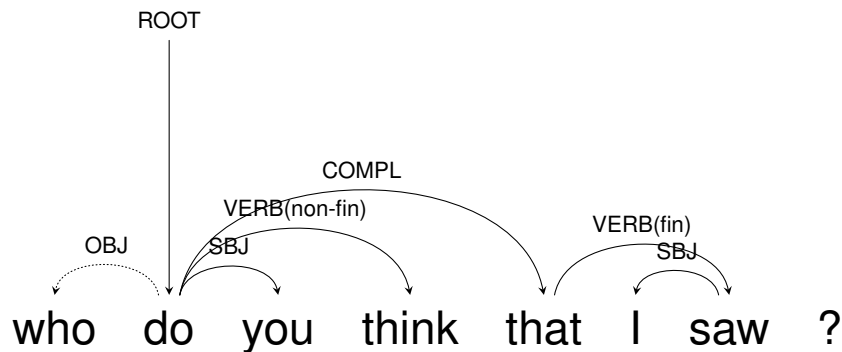
Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison



See the German equivalent in Müller (2019), p. 380.

Note: In this particular case, we remove the long-distance dependency from *saw* to *who*, and rather conceptualize *who* as the object of the main clause (i.e. the auxiliary verb *do*). However, this raises another interesting problem: the verb of the complementizer clause *I saw* is then considered monovalent (i.e. doesn't have an object), which clearly contradicts the general valency assumption of the verb *see*. This kind of problem nicely illustrates the trade-offs and contradictions we sometimes face in syntactic analyses.



Dependency Grammar: Relevance of Basic Concepts

- ▶ Constituency ✗
- ▶ POS ✓
- ▶ Heads ✓
- ▶ Valency ✓¹
- ▶ Grammatical Functions (✓)²

Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison

¹In order to assign SBJ, OBJ, DOBJ and IOBJ arrows, we need to understand the valency relations. But note that the distinction between arguments and adjuncts is irrelevant (there needs to be an arrow from head to the complement, regardless of whether it is an argument or an adjunct.)

²In our version of DG we indicated grammatical functions on dependency arrows (i.e. SBJ, OBJ), but since agreement and case assignment are not explicitly modelled, these functions are secondary.



Phrase Structure Grammar



Grammar in Formal Language Theory

A **grammar** \mathcal{G} in formal language theory is then a quadruple consisting of the set of terminal symbols, non-terminal symbols, a starting symbol S , and a set of rewrite rules R :

$$\langle T, NT, S, R \rangle^3 \quad (1)$$

Jäger and Rogers (2012). Formal language theory: refining the Chomsky hierarchy.
Partee et al. (1990). Mathematical methods in linguistics.

Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison

³S is a “distinguished member” of NT.



Language in Formal Language Theory

“The set of all strings that \mathcal{G} can generate is called the language of \mathcal{G} , and is notated $L(\mathcal{G})$.”

Jäger and Rogers (2012). Formal language theory: refining the Chomsky hierarchy, p. 1957

We thus have a language defined as

$$L(\mathcal{G}) = \{(w_1), (w_2), \dots (w_n), (w_1, w_2), \dots (w_1, \dots w_m)\}, \quad (2)$$

where w_i is a terminal symbol, i.e. word in our case, n is the overall number of terminal symbols, i.e. the cardinality $|T|$; and m is the maximum length of strings (could be ∞). Note that each string here has to be licensed by the rewrite rules.

Note: $L(\mathcal{G})$ has to be a multiset, since the same strings can occur multiple times.

Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison

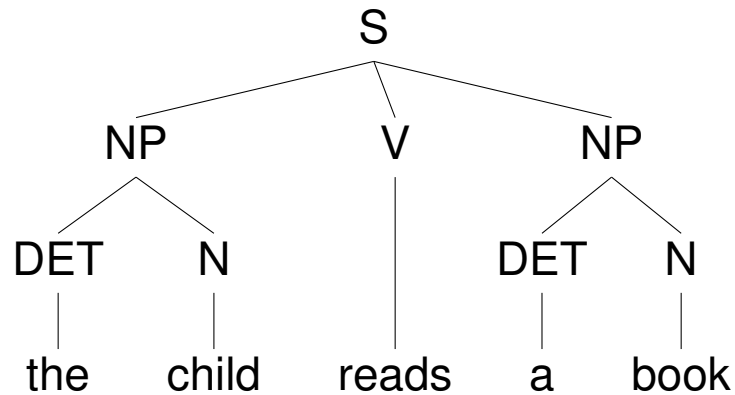


Rewrite	Rule	Terminals	
S	—	$T = \{a, book, child, reads, the\}$	Q & As Tutorial Week 3
NP V NP	6	Non-Terminals	Basic Concepts
DET N V NP	7	$NT = \{DET, N, NP, V\}$	Dependency Grammar
DET N V DET N	7	R (Terminals)	Phrase Structure Grammar
DET N reads DET N	5	1. DET → the	DG and PSG Comparison
the N reads DET N	1	2. DET → a	
the child reads DET N	3	3. N → child	
the child reads a N	2	4. N → book	
the child reads a book	4	5. V → reads	
		R (Non-Terminals)	
		6. S → NP V NP	
		7. NP → DET N	

Note: The horizontal line indicates the point where rules exclusively defined with non-terminals ($R(NT)$) end, and rules involving terminals ($R(T)$) start. While the order of application of non-terminal rules is often important, the order of the application of terminal rules is irrelevant.



Bracket Notation



Rewrite Notation

S
 NP V NP
 DET N V NP
 DET N V DET N

DET N reads DET N
 the N reads DET N
 the child reads DET N
 the child reads a N
 the child reads a book

Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison

[S [NP [DET [the]][N [child]]][V [reads]][NP [DET [a]][N [book]]]]⁴

⁴Note: The *Bracket Notation* is yet another equivalent way to visualize the same structure. In fact, the latex code generating this slide takes the bracket notation as input to generate the above tree. There is also an online tool at ironcreek.net/syntaxtree to generate trees based on bracket notation input.



Morphological Features

Rewrite Notation

S
 NP(PL) VP(PL)
 NP(PL) V(PL) NP(SG)
 DET(PL) N(PL) V(PL) NP(SG)
 DET(PL) N(PL) V(PL) DET(SG) N(SG)

DET(PL) N(PL) read DET(SG) N(SG)
 the N(PL) read DET(SG) N(SG)
 the children read DET(SG) N(SG)
 the children read a N(SG)
 the children read a book

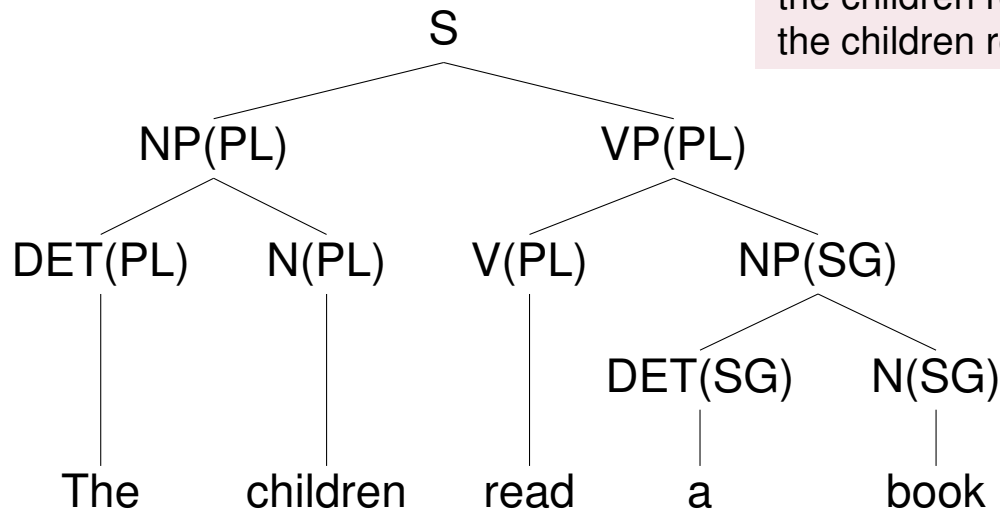
Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison





Problem: Implementing Morphological Features

Given productive agreement systems for gender, number, and case, it quickly becomes a formidable task to implement morphological features into a PSG. See below the examples for the word *zuri* “good” in Swahili.⁵

$A(SG, CL1) \rightarrow$ **m**zuri
 $A(SG, CL2) \rightarrow$ **m**zuri
 $A(SG, CL3) \rightarrow$ **k**izuri
 $A(SG, CL4) \rightarrow$ zuri
 $A(SG, CL5) \rightarrow$ **n**zuri
 $A(PL, CL1) \rightarrow$ **w**azuri
 $A(PL, CL2) \rightarrow$ **m**izuri
 $A(PL, CL3) \rightarrow$ **v**izuri
 $A(PL, CL4) \rightarrow$ **m**azuri
 $A(PL, CL5) \rightarrow$ **n**zuri

⁵This is based on my reading of the noun class system (CL) as defined by Mpiranya (2015), p. 22.



The Passive

In a **passive construction**, the object of the corresponding *active sentence* becomes the subject.

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Week 3

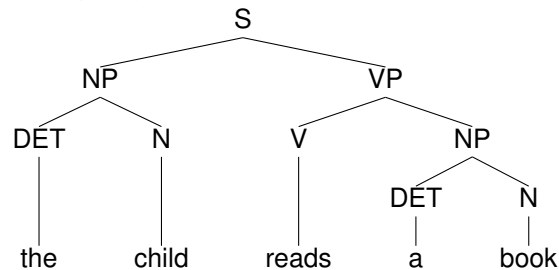
Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison

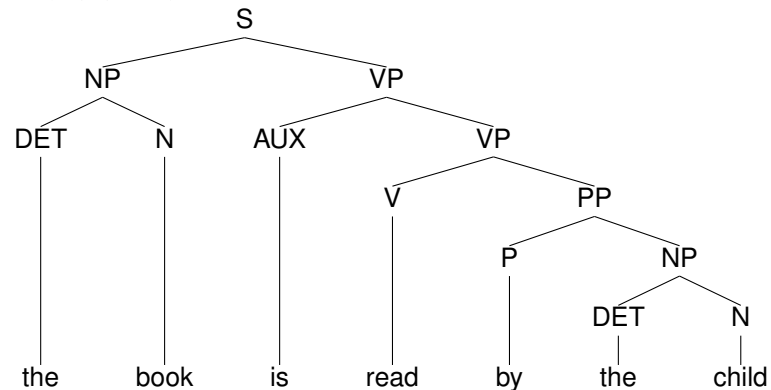
Active:



R (non-terminals)

1. $S \rightarrow NP VP$
2. $VP \rightarrow V NP$
3. $NP \rightarrow DET N$

Passive:



R (non-terminals)

1. $S \rightarrow NP VP$
2. $VP \rightarrow AUX VP$
3. $VP \rightarrow V PP$
4. $PP \rightarrow P NP$
5. $NP \rightarrow DET N$



Passive Transformations

Passive constructions are handled in some syntactic frameworks (e.g. Government and Binding) with the same underlying deep structure as **active constructions**. Note that this is an important deviation from traditional PSGs. In a traditional PSG you would have to formulate different phrase structure rules for active and passive sentences.

Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison

Early example of a transformational rule going back to Chomsky (1957):

$$NP_1 V_2 NP_3 \rightarrow NP_3 [AUX \text{ be}] V_2 en [PP [P \text{ by}] NP_1]$$

John sees Mary \rightarrow Mary [AUX is] seen [PP [P by] John]

Müller (2019). Grammatical theory, p. 85.



Phrase Structure Grammar: Relevance of Basic Concepts

- ▶ Constituency ✓
- ▶ POS ✓
- ▶ Heads ✓
- ▶ Valency (✓)⁶
- ▶ Grammatical Functions ✗

Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison

⁶Valency indirectly plays a role for classical phrase structure rules since it determines how many non-terminals need to be specified on the right side of VP rules. However, the core distinction between arguments and adjuncts is irrelevant.



DG and PSG Comparison



Comparison: DG and PSG

- ▶ **Linearization (word order)** is highly relevant in PSGs but only marginally in DG.

Note that in later versions of PSG, such as Generalized Phrase Structure Grammar (GPSG), ordering constraints can also be relaxed via the difference between *immediate dominance rules* and *linear precedence rules* (e.g. $NP \rightarrow NP VP$ versus $NP \rightarrow NP, VP$).

- ▶ Apart from linearization a **projective DG analysis** of a sentence can be brought into perfect correspondence with a **lexicalized PSG analysis**, i.e. if we use the same POS for both DG and PSG, and if we have PSG rules that always contain the head as a lexical element.

Q & As Tutorial
Week 3

Basic Concepts

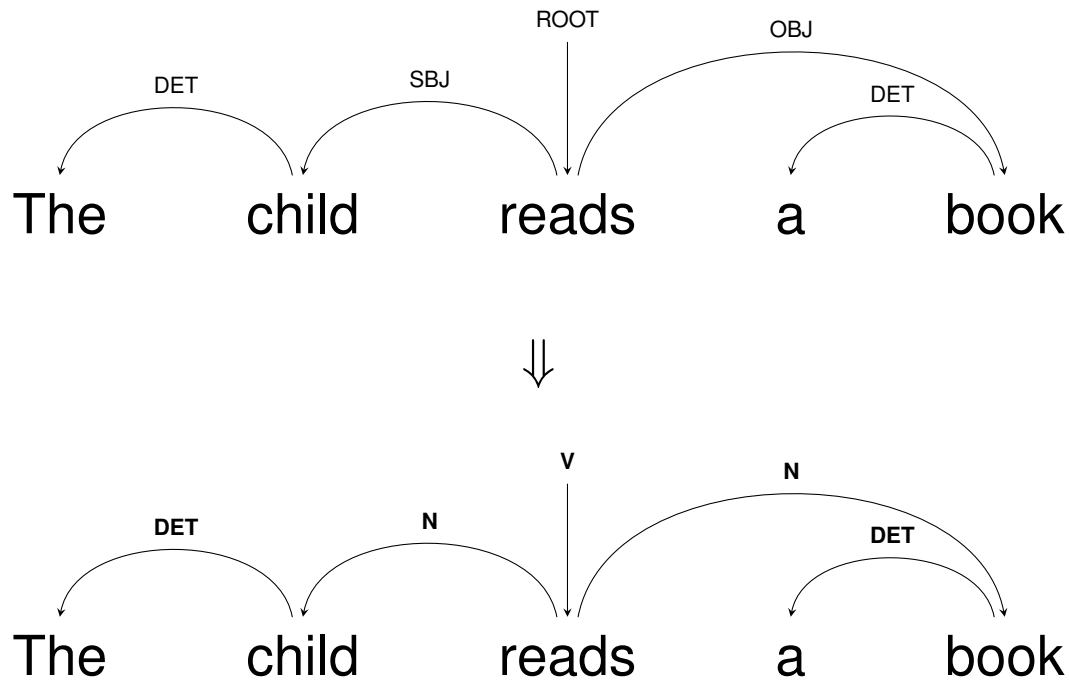
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Grammar

Phrase Structure
Grammar

DG and PSG
Comparison



Example: Translation of POS



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Week 3

Basic Concepts

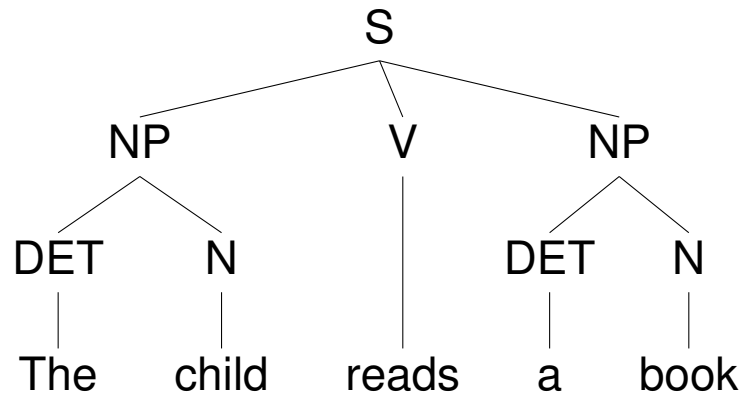
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Grammar

Phrase Structure
Grammar

DG and PSG
Comparison



Example: Lexicalization of PSG Rules



Rewrite Notation

S
 NP V NP
 DET N V NP
 DET N V DET N

 DET N reads DET N
 the N reads DET N
 the child reads DET N
 the child reads a N
 the child reads a book

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Week 3

Basic Concepts

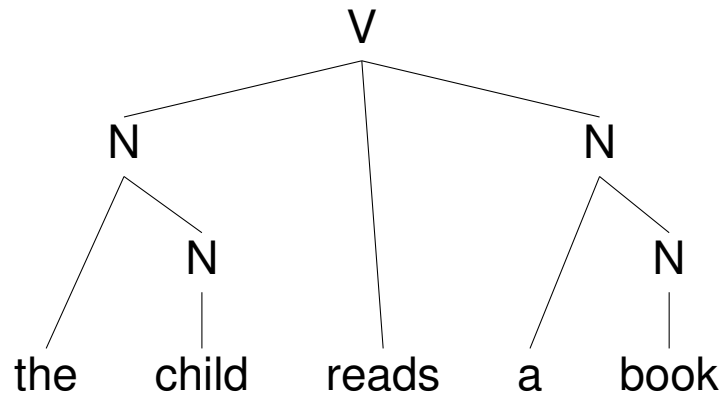
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Grammar

Phrase Structure
Grammar

DG and PSG
Comparison



Example: Lexicalization of PSG Rules



Note: By requiring that each rewrite rule has a lexical element on the right side, we essentially “push” the rewritings below the horizontal line, i.e. we have a *flat tree structure*.

Rewrite Notation

V

N reads N

the N reads a N

the child reads a N

the child reads a book

Rewrite Rules

V → N reads N

N → the N

N → a N

N → book

N → child

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Week 3

Basic Concepts

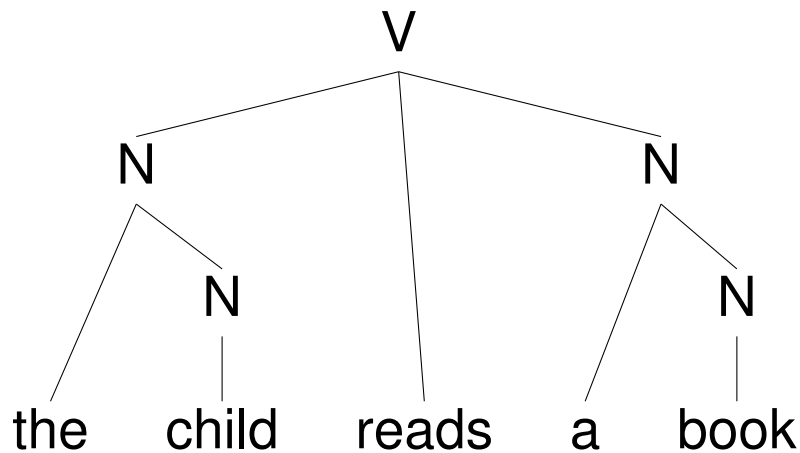
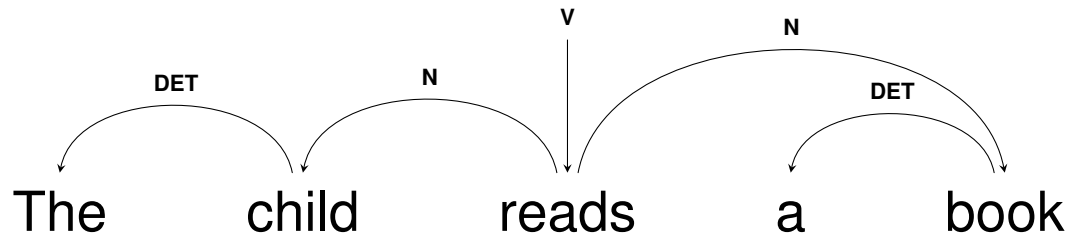
Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison



Result: DG to PSG Translation



Q & As Tutorial
Week 3

Basic Concepts

Dependency
Grammar

Phrase Structure
Grammar

DG and PSG
Comparison



Thank You.

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