EBERHARD KARLS
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Faculty of Philosophy
General Linguistics

Syntax & Semantics WS2019/2020

Lecture 4: Dependency Grammar (DG)

04/11/2019, Christian Bentz

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Section 1: Recap of Lecture 3

Determining the Head

The head of a phrase is the element that provides the "grammatical scaffolding":

(1) _ _-ta **yanu-n**
_.NOM.SG _-ACC cook-PRS.3SG
"_ cooks _."

Imagine we only hear/read "... yanun", and the rest of the information of the sentence is lost. We can still determine from this partial information that there has to be a *cooker* and a *cooked*,[1] that the cooker has to be *third person singular*, and that the cooked has to be marked for *accusative case*. In a sense, from *yanun* we can predict the occurrence of *-ta*.

[1] I make the assumption here that *yanun* is not used with a single participant like in "he cooks" in English.

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Valence according to Tesnière

> *"Nous avons vu qu'il y avait de 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.*

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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

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Section 2: Historical Notes

Historical Perspective

"Dependency Grammar (DG) is the oldest framework described in this book. According to Hudson (2019), the basic assumptions made today in Dependency Grammar were already present in the work of the Hungarian Sámuel Brassai in 1873 (see Imrényi 2013), the Russian Aleksej Dmitrievsky in 1877 and the German Franz Kern (1884). The most influential version of DG was developed by the French linguist Lucien Tesnière (1893–1954)."

Müller (2019). Grammatical theory, p. 365.

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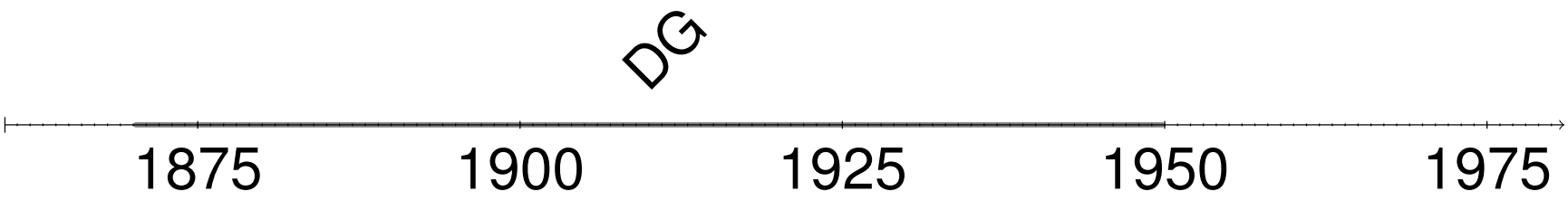

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Some Notes about Dependency Grammar

- It is more wide-spread in Central Europe and (particularly Germany) than in the English-speaking world. Maybe due to late translation of the work by Tesniére into English?
- It is often preferred over constiutent-based analyses by researchers working on languages with highly flexible word order (see next slide), since it deals with dependency relations rather than linearization of constituents.
- Often also first choice for computational analyses, since dependencies are relatively easy to handle, and many dependency annotated corpora exist (e.g. Universal Dependencies in more than 50 languages).[2]

[2] https://universaldependencies.org/

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Constituency and Dependencies

"The syntactic structure here [example of Thalanyji case-tagging below] is most elegantly represented via a dependency formalism (supplemented with appropriate morphological features) rather than a constituency one."

Evans & Levinson (2009). The myth of language universals, p. 441.

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(2) Kupuju-lu **kaparla-nha** yanga-lkin **wartirra-ku-nha**
child-ERG dog-ACC chase-PRES woman-DAT-ACC
"The child chases the woman's dog."

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Analyzed Languages[3]

Danish, English, **Esperanto**, **Estonian**, Faroese, **Finnish**, French, German, Irish, **Japanese**, Latin, **Mandarin Chinese**, Norwegian, Old Icelandic, Portuguese, Russian, Spanish, **Swahili**

According to Müller (2019). Grammatical theory, p. 367.

Language Families[4]

Artificial, Atlantic-Congo (Bantu), Indo-European, Japonic, Sino-Tibetan, Uralic

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[3] The non-Indo-European ones are marked in bold face. Note that these are the languages named by Müller. If we count the languages of the Universal Dependencies (UD) project as well, we have many more.

[4] According to Glottolog 4.0, https://glottolog.org/.

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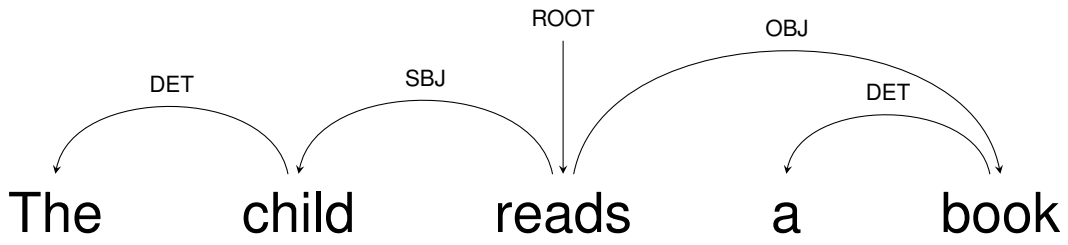
Section 3: Notational Conventions

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.[5]



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

[5] 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.

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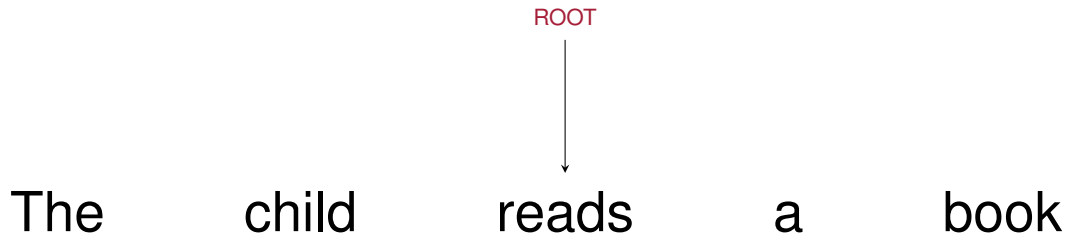
Notation: The Head/Root

The **root** of a sentence is the overall **head** of the maximal projection (i.e. a verb with all arguments filled). The root is indicated by a downwards arrow to the lexical item that represents it.



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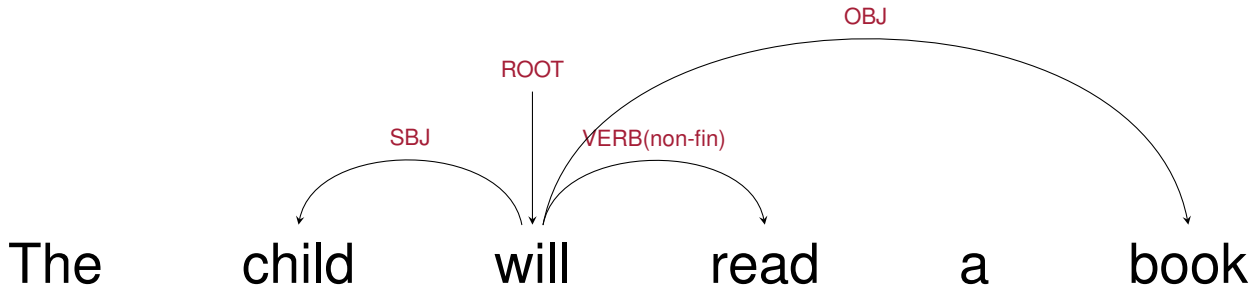
Notation: Auxiliary Verbs

When an **auxiliary verb** is used in a sentence, it is the finite verb (inflects for person and number). This is then considered the root of the sentence. The second verb form is then a non-finite verb (e.g. participle or infinitive), which depends on the auxiliary verb. Also, note that the arguments of the sentence (SBJ and OBJ) now depend on the auxiliary verb, rather than the non-finite verb. This is because agreement and case-assignment to the arguments is related to the inflected auxiliary rather than the non-finite verb form.[6]



[6] From a valency perspective it could be argued that the non-finite verb form determines the valency of the verb complex, rather than the auxiliary, but here morphosyntax is given precedence over semantics. For a discussion see also Müller (2019), p. 594-595.

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Notation: Dependents

Dependents are the arguments of the head that have to be filled, as well as further adjuncts. In the example below, these are the *subject* and *object* of the transitive clause. The arrow runs from the head to the respective dependent. The label on the arrow gives the type of argument that is filled by the dependent.

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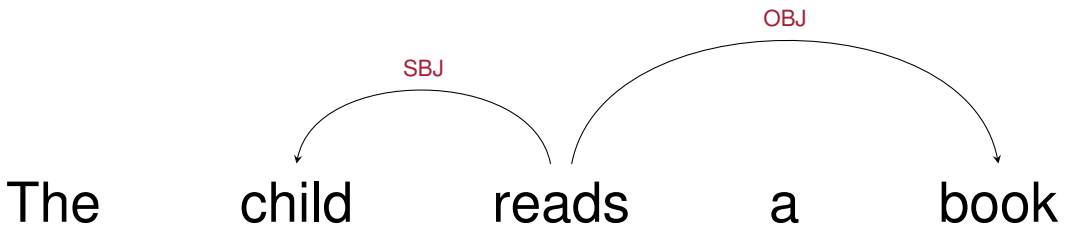

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Notation: Determiners

Determiners are here considered to *depend on the noun-(phrase)* they modify, rather than the other way around. That is, the dependency arrow runs from the noun(-phrase) to the determiner.

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Notation: Adjuncts

Remember from Lecture 3 that **adjuncts** are typically *adjectives* (ADJ), *adverbs* (ADV) or *prepositional phrases* (PREP). They depend on the respective head of the phrase. Below is a modified version of the example by Müller to illustrate this.

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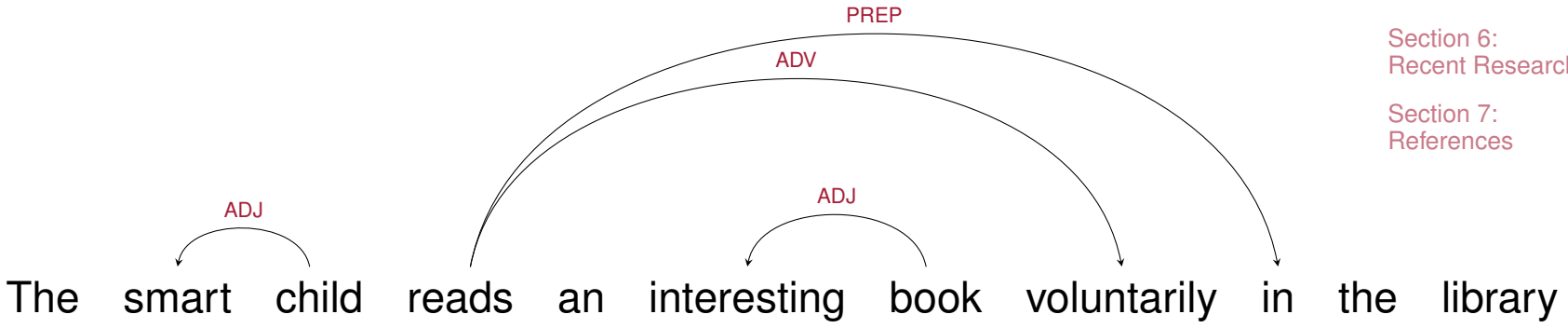

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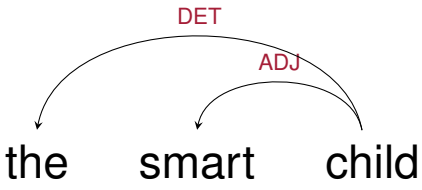
Notation: Adjuncts (Adjectives)

Adjectives depend on nouns or noun-phrases. If we deal with a noun-phrase that also contains a determiner, than both the determiner and the adjective depend on the noun (see example in Müller (2019), p. 396).[7]



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[7] There are alternative analyses where the noun depends on the adjective, and the determiner on the noun. However, since we have defined before that adjectives depend on nouns, this option is ruled out here.

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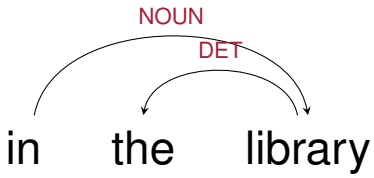
Notation: Adjuncts (Prepositional Phrases)

In a prepositional phrase, the noun depends on the preposition, and the other elements, e.g. adjectives and determiners, depend on the noun (see also example in Müller (2019), p. 397).



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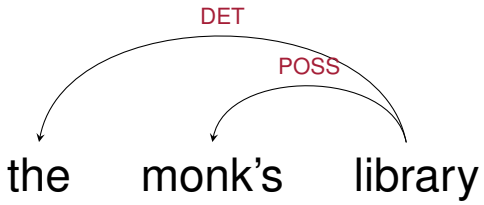
Notation: Adjuncts (Possessor Phrases)

In **possessor phrases**, the possessee noun is the head of the phrase, and the possessor hence depends on it. We here mark this with an arrow labeled with POSS.



Note: For simplicity, we here assume that the genitive *'s* is an inflection rather than a possessive clitic.

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Summary: The Full Example

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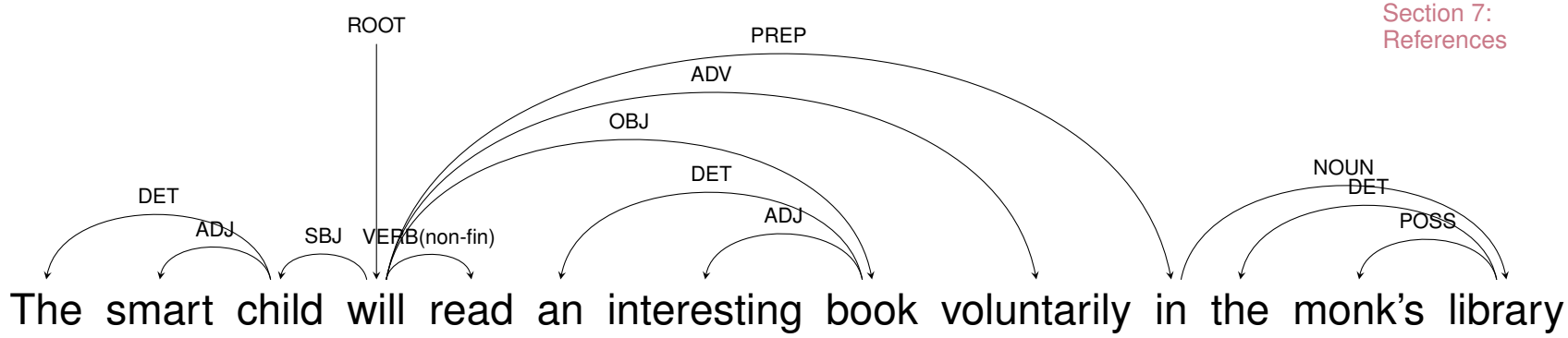

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Notation Glossary

ADJ: adjective
ADV: adverb
COMPL: complementizer (i.e. *that*)
DET: determiner[1]
DOBJ: direct object[2]
IOBJ: indirect object[2]
NOUN: noun[3]
OBJ: object
PART: particle
PREP: preposition
POSS: possessor noun
ROOT: head[4]
SBJ: subject
VERB(non-fin): non-finite (infinitive) verb[5]
VERB(fin): finite verb [6]

[1]Definite and indefinite.
[2]Applicable only in ditransitive sentences.
[3]For simplicity, we also include pronouns and proper names here.
[4]Head of the overall sentence.
[5]Applicable if there is another, finite verb form in the sentence, i.e. an auxiliary.
[6]Required in complementizer-constructions.

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Section 4: Syntactic Phenomena

Verb position

"In many Dependency Grammar publications on German, linearization issues are not dealt with and authors just focus on the dependency relations. 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, but the dependency relations are the same, as it should be."

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

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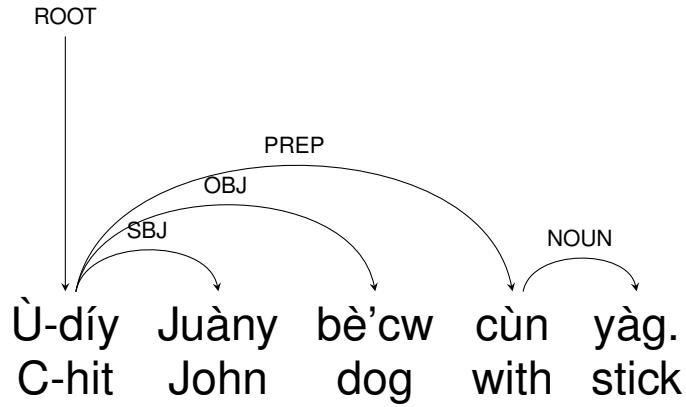
Verb position (Initial)

In **head-initial** languages, the dependencies – at least of the arguments – mostly project *forwards* (i.e. from left to right).

Zapotec (???, Otomanguean)[8]



"John hit the dog with the stick."

Adopted from Hudson (2007), p. 174.

[8]There are many different "Zapotec" languages, all with their own ISO codes. This is an example of where the language information is highly underspecified.

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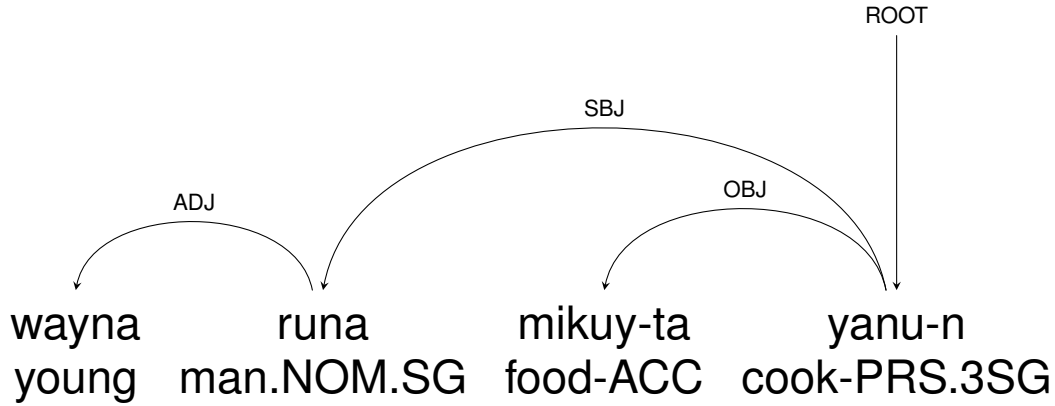
Verb position (Final)

In **head-final** languages, the dependencies – at least of the arguments – mostly project *backwards* (i.e. from right to left).

Ayacucho Quechua (quy, Quechuan)



“The young man cooks the food.”

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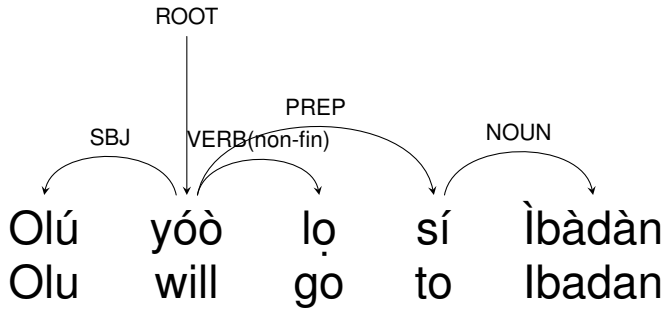
Verb position (Medial)

In **head-medial** languages, the dependencies – at least of the arguments – project *in both directions*.

Yoruba (yor, Atlantic-Congo)



“Olu will go to Ibadan.”

Adopted from Adesola (2006), p. 7.

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Linearization

The fact that dependency grammars do often not require particular rules for the *linearization* of words,[9] is the reason for why they are seen as particularly appropriate for languages with discontinuous constituents (or even no constituency at all?). Remember the example by Evans & Levinson (2009) in Lecture 2.

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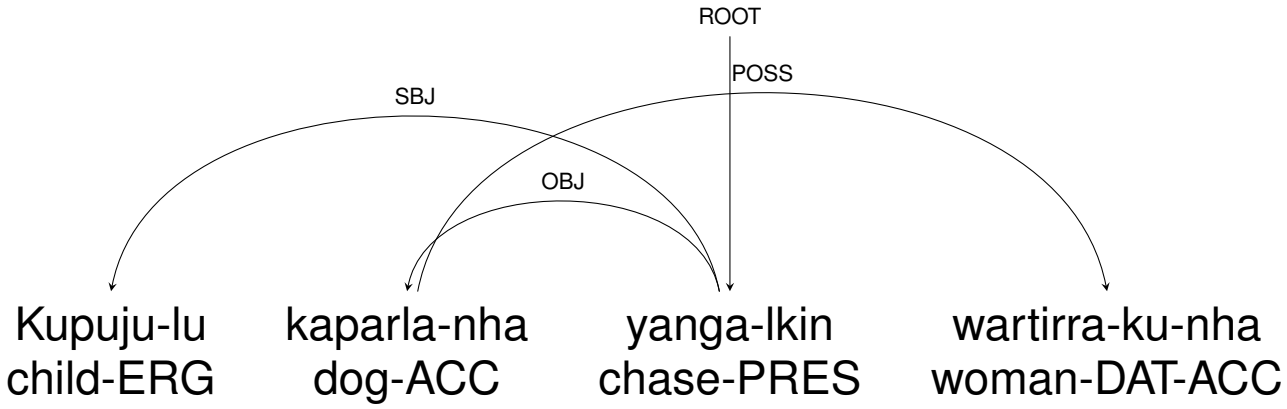
Thalanyji (?, Pama-Nyungan(?))



[9] Though see the discussion in Müller (2019), pp. 371, for dependency grammar accounts that additionally formulate such rules.

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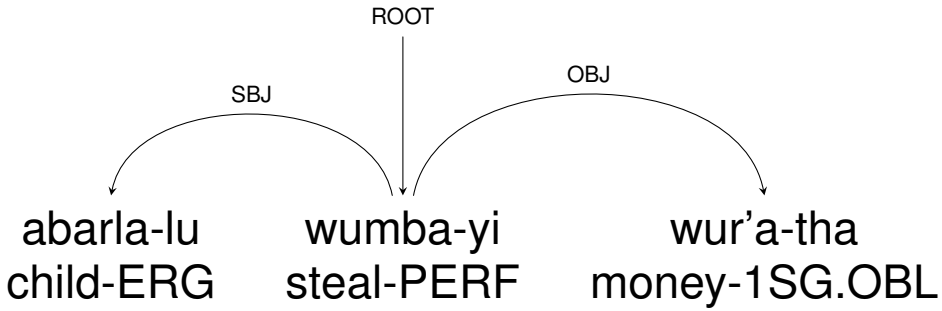
Linearization: Free Word Order

If a language has **completely free word order**, then linearization might not be required by the syntactic framework. All orders are grammatical and hence "licensed". See the permutation examples below.

Nhanda (nha, Pama-Nyungan)



"The child stole my money."

Adopted from Velupillai (2012), p. 282.

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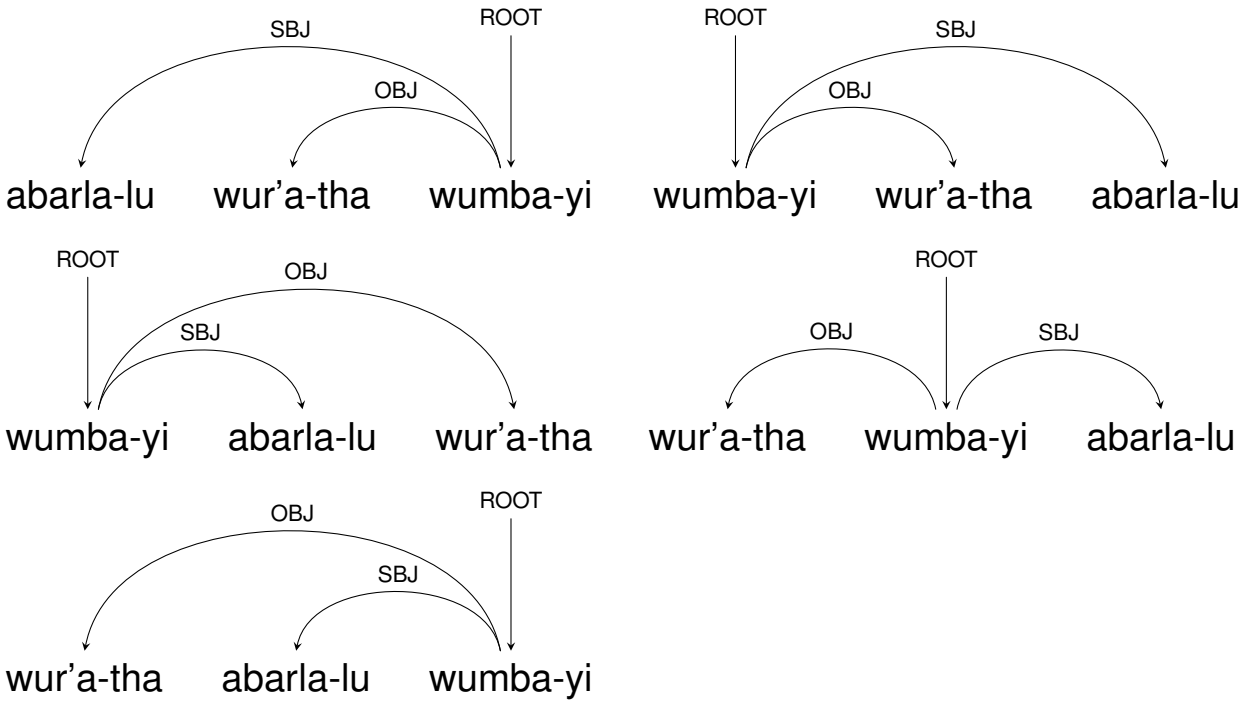
Free Permutation:



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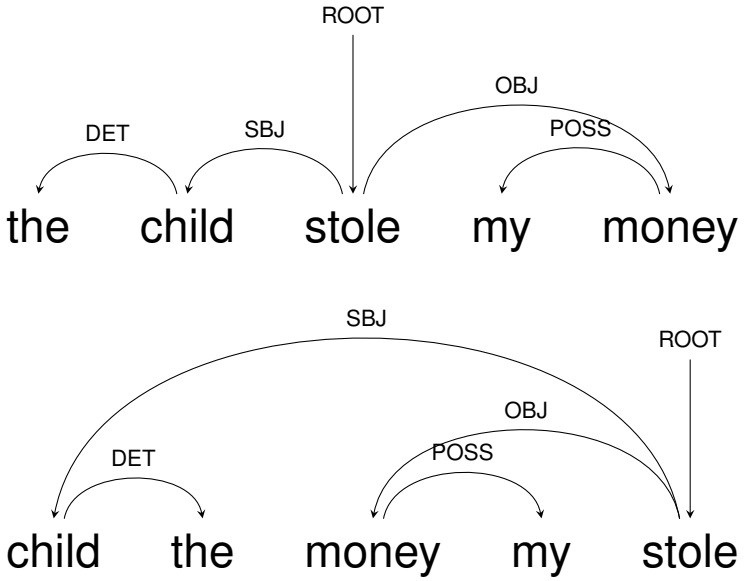
Linearization: Fixed Word Order

If a language has **fixed word order**, however, then the lack of linearization constraints licenses ungrammatical sentences.



Note that both of these sentences (and all other permutations) are licensed by a dependency grammar that does not specify linearization constraints.

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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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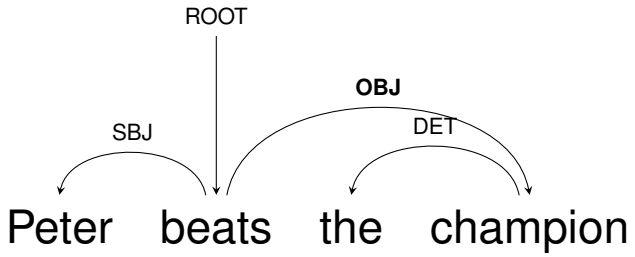
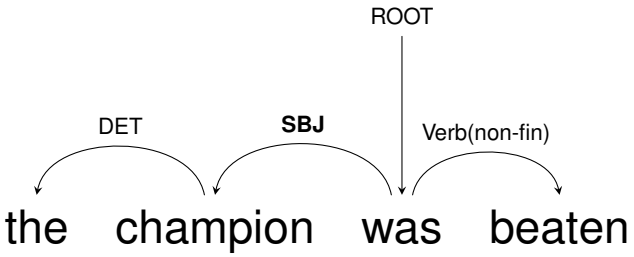
Active:



Passive:



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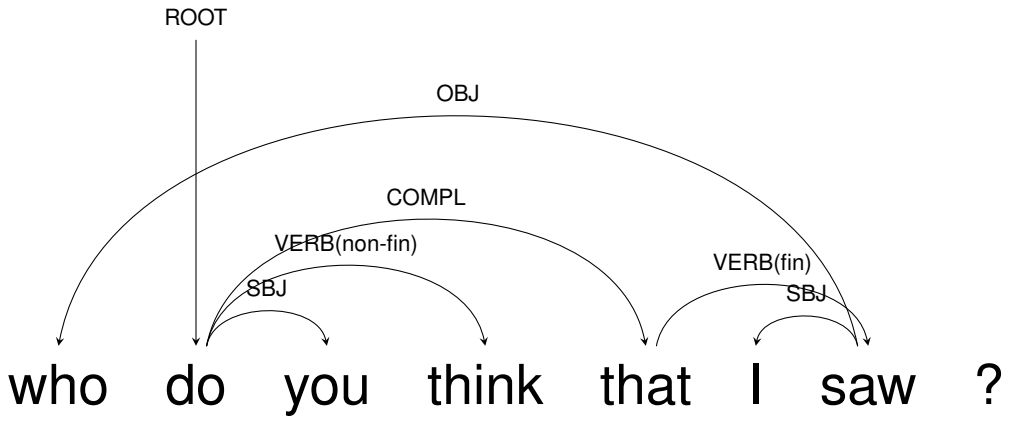
Crossing Dependencies

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.



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

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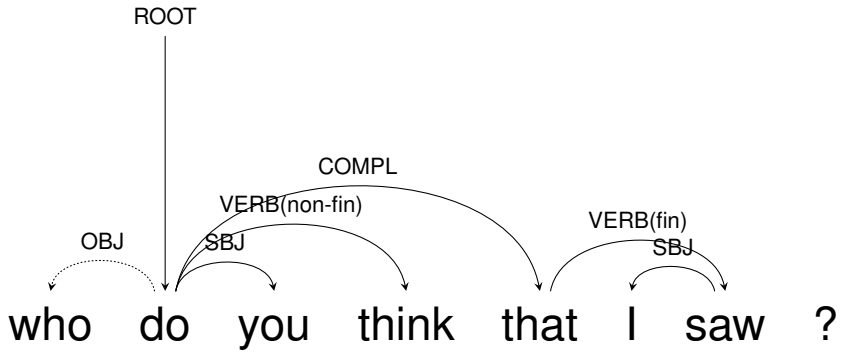
Crossing Dependencies

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



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.

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Crossing Dependencies

In any case, in some languages and constructions crossing dependencies just seem unavoidable, and we have to accept them as a fact of human languages.

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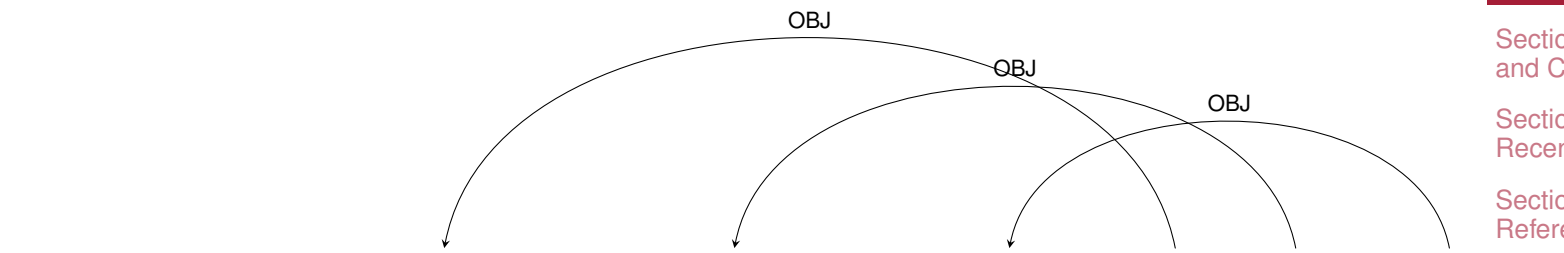
Swiss German[10] (gsw, Indo-European)



"[...] that we let the children help Hans paint the house."

[10] Central Alemannic in Glottolog 4.0.

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General Linguistics

Section 5: Pros and Cons of DG

Pros (Advantages)

- Valid also for languages with no *linearization constraints*
- Relatively easily implementable in *computational frameworks*
- Follows from some basic definitions regarding the *headedness of phrases*

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Cons (Disadvantages)

- Not valid for languages with *strong linearization constraints* (without further linearization rules)
- Does not explicitely model *agreement* and *case assignment* (at least not in the version presented here in class), and hence licenses sentences that would normally be assumed ungrammatical

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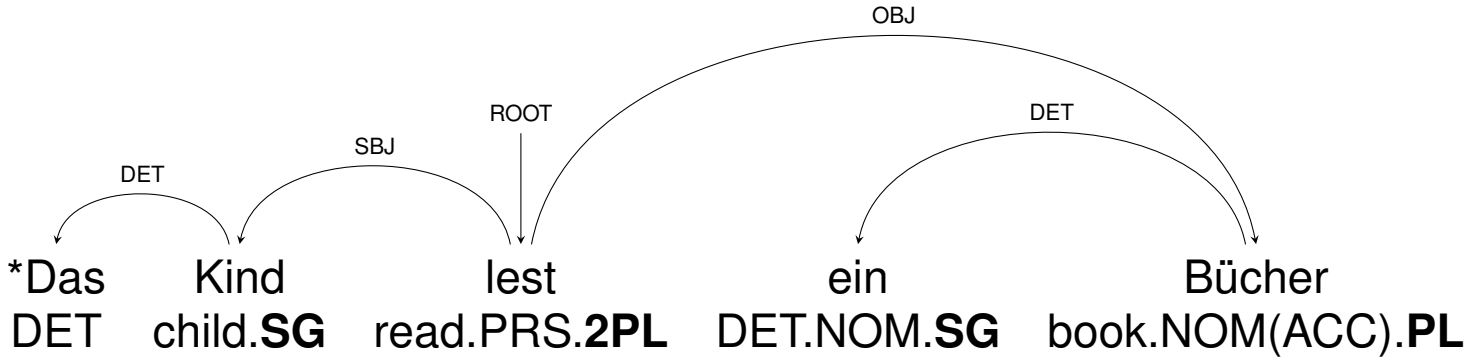

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Section 6: Recent Research

Two competing pressures that shape word order:

1. Dependency length minimization

The head of a sentence/phrase (e.g. the verb) should be placed in a way that **minimizes** dependency lengths.

2. Predictability maximization

The head of a sentence/phrase should be placed in a way that **maximizes** its predictability.

Ferrer-i-Cancho (2017). The placement of the head that maximizes predictability. An information theoretic approach.

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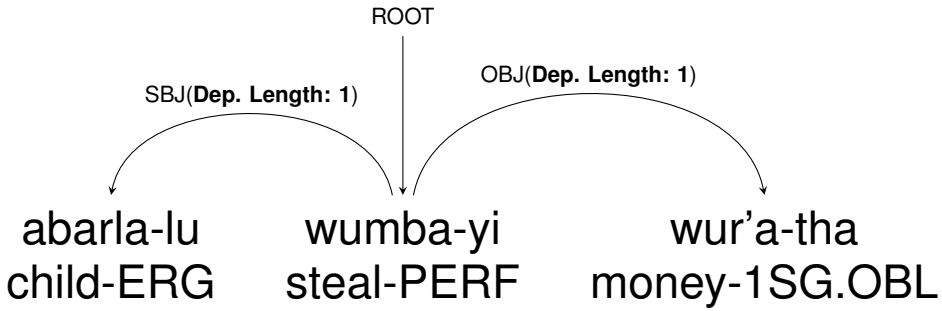
Dependency length minimization

Placing the verb (head) in the *medial position* **minimizes dependency lengths** (everything else being equal).

Nhanda (nha, Pama-Nyungan)



"The child stole my money."

Adopted from Velupillai (2012), p. 282.

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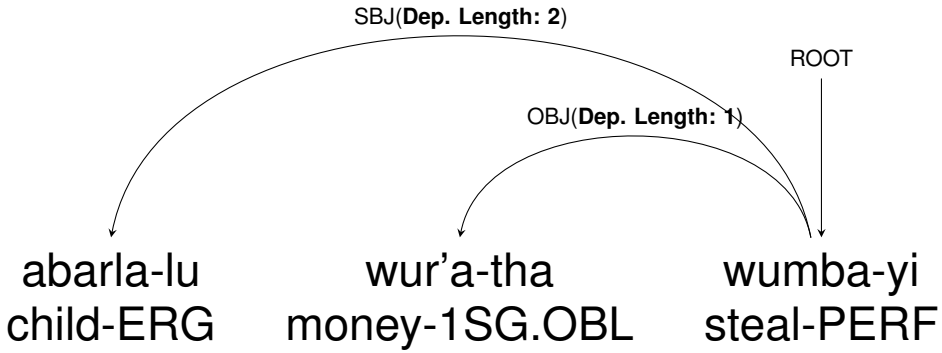
Dependency length minimization

Placing the verb (head) in the *initial or final position* **increases dependency lengths** (everything else being equal).

Nhanda (nha, Pama-Nyungan)



"The child stole my money."

Adopted from Velupillai (2012), p. 282.

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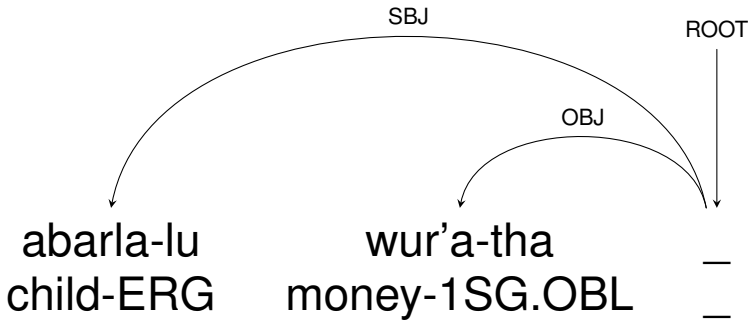
Predictability maximization

However, placing the verb (head) in the *final position* increases its **predictability**.

Nhanda (nha, Pama-Nyungan)



"The child _ my money."

Adopted from Velupillai (2012), p. 282.

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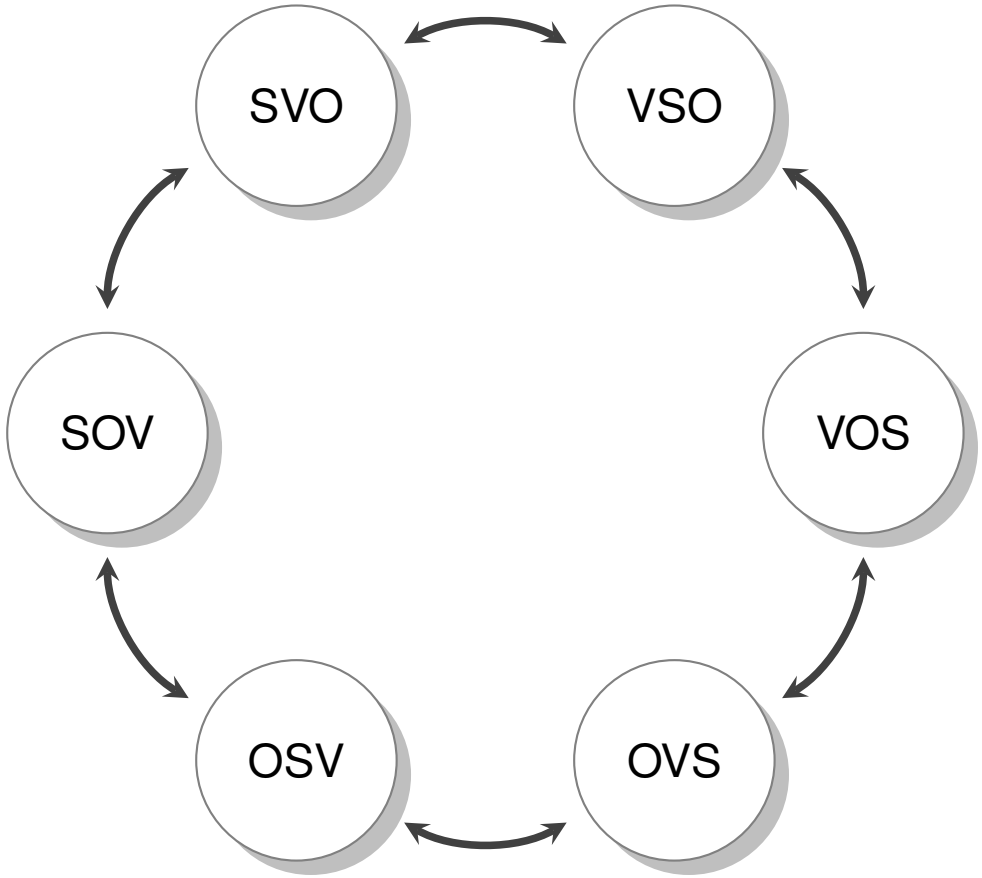
Word Order Change and Evolution: The Permutation Ring



Ferrer-i-Cancho (2017). The placement of the head that maximizes predictability. An information theoretic approach.

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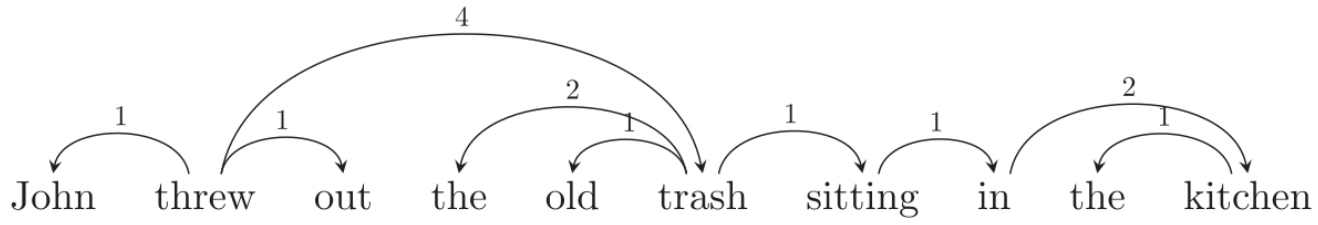
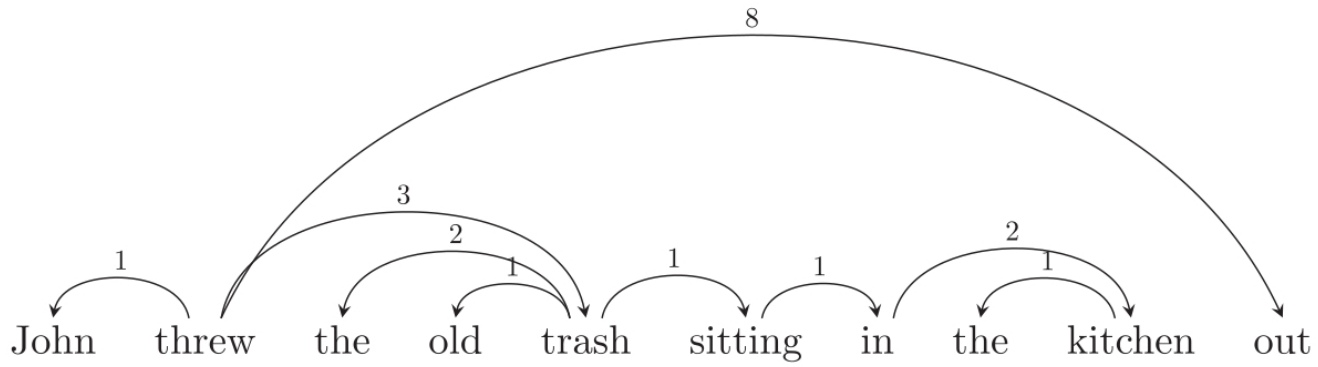
Dependency length minimization



Sentence C: Total dependency length = 14



Sentence D: Total dependency length = 20

Futrell et al. (2015). Large-scale evidence of dependency length minimization in 37 languages.

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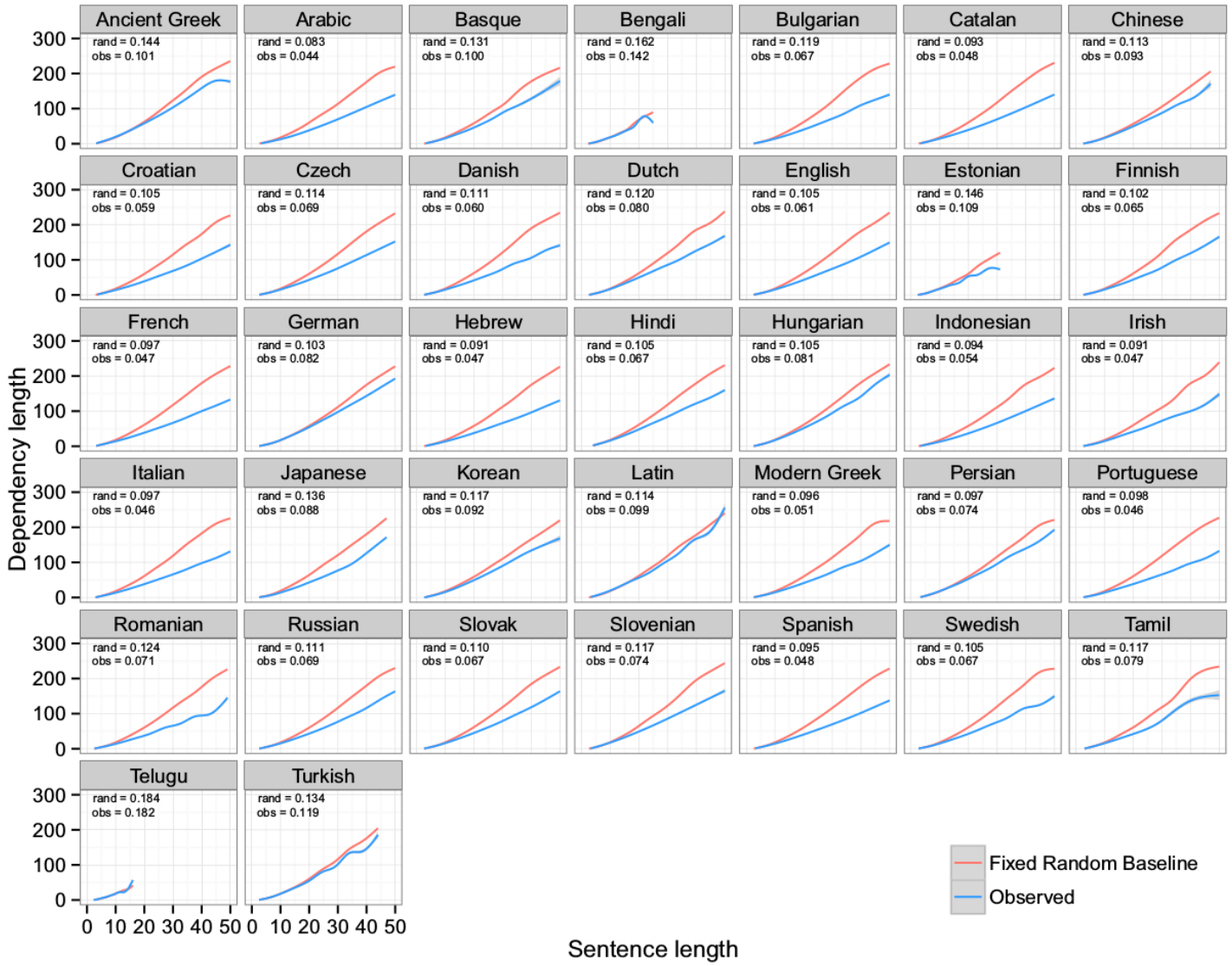

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Universal Dependencies

Universal Dependencies (UD) is a framework for consistent annotation of grammar (parts of speech, morphological features, and syntactic dependencies) across different human languages. UD is an open community effort with over 200 contributors producing more than 100 treebanks in over 70 languages. If you're new to UD, you should start by reading the first part of the Short Introduction and then browsing the annotation guidelines.

- Short introduction to UD
- UD annotation guidelines
- More information on UD:
  - How to contribute to UD
  - Tools for working with UD
  - Discussion on UD
  - UD-related events
- Query UD treebanks online:
  - SETS treebank search maintained by the University of Turku
  - PML Tree Query maintained by the Charles University in Prague
  - Kontext maintained by the Charles University in Prague
  - Grew-match maintained by Inria in Nancy
  - INESS maintained by the University of Bergen
- Download UD treebanks

If you want to receive news about Universal Dependencies, you can subscribe to the UD mailing list. If you want to discuss individual annotation questions, use the Github issue tracker.

Current UD Languages

Information about language families (and genera for families with multiple branches) is mostly taken from WALS Online (IE = Indo-European).

Afrikaans	1	49K		IE, Germanic
Akkadian	1	1K		Afro-Asiatic, Semitic
Amharic	1	10K		Afro-Asiatic, Semitic
Ancient Greek	2	416K		IE, Greek
Arabic	3	1,042K	W	Afro-Asiatic, Semitic
Armenian	1	36K		IE, Armenian
Assyrian	1	<1K		Afro-Asiatic, Semitic
Bambara	1	13K		Mande
Basque	1	121K		Basque
Belarusian	1	13K		IE, Slavic
Breton	1	10K	W	IE, Celtic
Bulgarian	1	156K		IE, Slavic
Buryat	1	10K		Mongolic
Cantonese	1	13K		Sino-Tibetan
Catalan	1	531K		IE, Romance

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Thank You.

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