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Universal Dependencies

A Framework for Morphosyntactic Annotation

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Based on collaborative work with Marie-Catherine de Marneffe, Filip Ginter, Yoav Goldberg, Jan Hajic, Christopher Manning, Ryan McDonald, Natalia Silveira, Slav Petrov, Sampo Pyysalo, Sebastian Schuster, Reut Tsarfaty, Francis Tyers, Daniel Zeman and many others

Why?

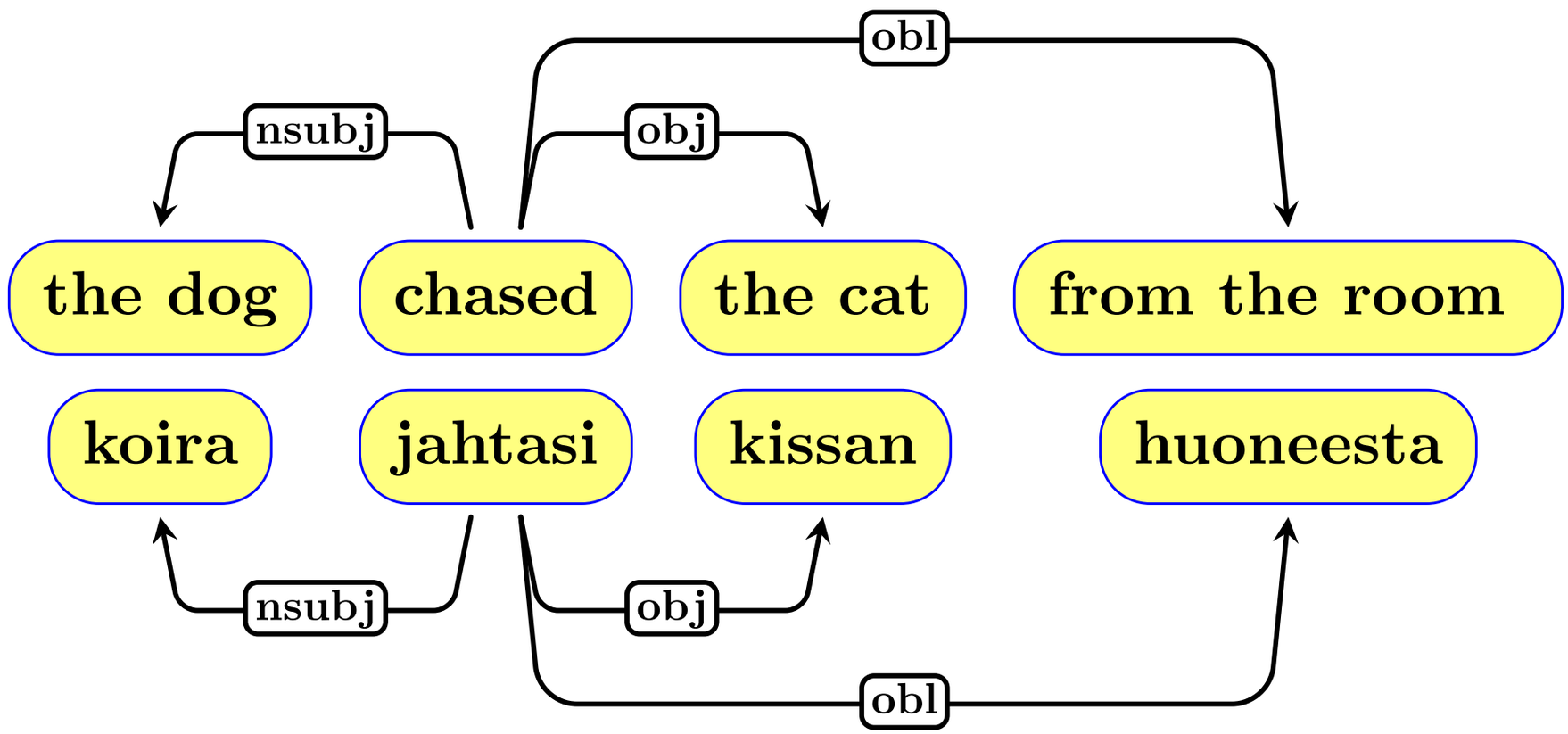
Cross-linguistically consistent morphosyntactic annotation

Facilitate multilingual research in NLP and linguistics

- Meaningful linguistic analysis across languages
- Syntactic parsing in cross-lingual settings
- NLP systems for multiple languages
- Facilitate resource-building for new languages

Complement – not replace – language-specific schemes

How?



Focus on grammatical relations between (content) words

Who?

Open community effort – a big tent

UD v2.1: 60 languages, 102 treebanks, 214 contributors

Come join us at http://universaldependencies.org

Plan for the Talk

Basic principles of UD

The UD annotation framework

- Word segmentation
- Morphological annotation
- Syntactic annotation
- CoNLL-U format

Challenges for UD

Basic Principles

The UD Philosophy

The UD Philosophy

Maximize parallelism – but don't overdo it

- Don't annotate the same thing in different ways
- Don't make different things look the same
- Don't annotate things that are not there

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- Don't make different things look the same
- Don't annotate things that are not there

Universal taxonomy with language-specific elaboration

- Languages select from a universal pool of categories
- Allow language-specific extensions

Grammatical Relations

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- Maps between overt morphosyntax and semantic roles
- Prominent in linguistic typology – comparative concepts
- Useful for downstream NLP tasks – shallow semantics
- Traditional concepts familiar to non-specialists

Words

Words

Basic annotation units are words – lexicalism

- Words have properties – morphological annotation
- Words enter into relations – syntactic annotation

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Basic annotation units are words – lexicalism

- Words have properties – morphological annotation
- Words enter into relations – syntactic annotation

Primacy of content words – universalism

- Content words are linked by grammatical relations
- Function words are seen as syncategorematic

Annotation Framework

Word Segmentation

What is a word?

- Single part-of-speech tag
- Real syntactic relation

Two-level segmentation

- Represent orthographic tokens and syntactic words

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Text	Words
du	de le

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Text	Words
du	de le
dámelo	da me lo

Word Segmentation

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Text	Words
du	de le
dámelo	da me lo
ושמהשמש	ו ש מ ה שמש

Word Segmentation

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Two-level segmentation

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Text	Words
du	de le
dámelo	da me lo
ושמהשמש	ו ש מ ה שמש
大阪国際会議場	大阪 国際 会議場

Morphology

Le **chat** **chasse** **les** **chiens** **.**

Morphology

Le	**chat**	**chasse**	**les**	**chiens**	**.**
le	**chat**	**chasser**	**le**	**chien**	**.**

- Lemma representing the semantic content of the word

Morphology

Le	**chat**	**chasse**	**les**	**chiens**	**.**
le	**chat**	**chasser**	**le**	**chien**	**.**
DET	**NOUN**	**VERB**	**DET**	**NOUN**	**PUNCT**

- Lemma representing the semantic content of the word
- Part-of-speech tag representing its grammatical class

Morphology

Le				hiens	.
le				hien	.
DET	N			OUN	PUNCT

Open	Closed	Other
ADJ	ADP	PUNCT
ADV	AUX	SYM
INTJ	CCONJ	X
NOUN	DET	
PROPN	NUM	
VERB	PART	
	PRON	
	SCONJ	

- Lemma rep of the word
- Part-of-speech tag representing its grammatical class

Morphology

Le	chat	chasse	les	chiens	.
le	chat	chasser	le	chien	.
DET	NOUN	VERB	DET	NOUN	PUNCT
Definite=Def Gender=Masc Number=Sing	Gender=Masc Number=Sing	Mood=Ind Number=Sing Person=3 Tense=Pres VerbForm=Fin	Definite=Def Gender=Masc Number=Plur	Gender=Masc Number=Plur	

- Lemma representing the semantic content of the word
- Part-of-speech tag representing its grammatical class
- Features representing lexical and grammatical properties of the lemma or the particular word form

Morphology

Lexical	Inflectional Nominal	Inflectional Verbal
PronType	Gender	VerbForm
NumType	Animacy	Mood
Poss	Number	Tense
Reflex	Case	Aspect
Foreign	Definite	Voice
Abbr	Degree	Evident
		Polarity
		Person
		Polite

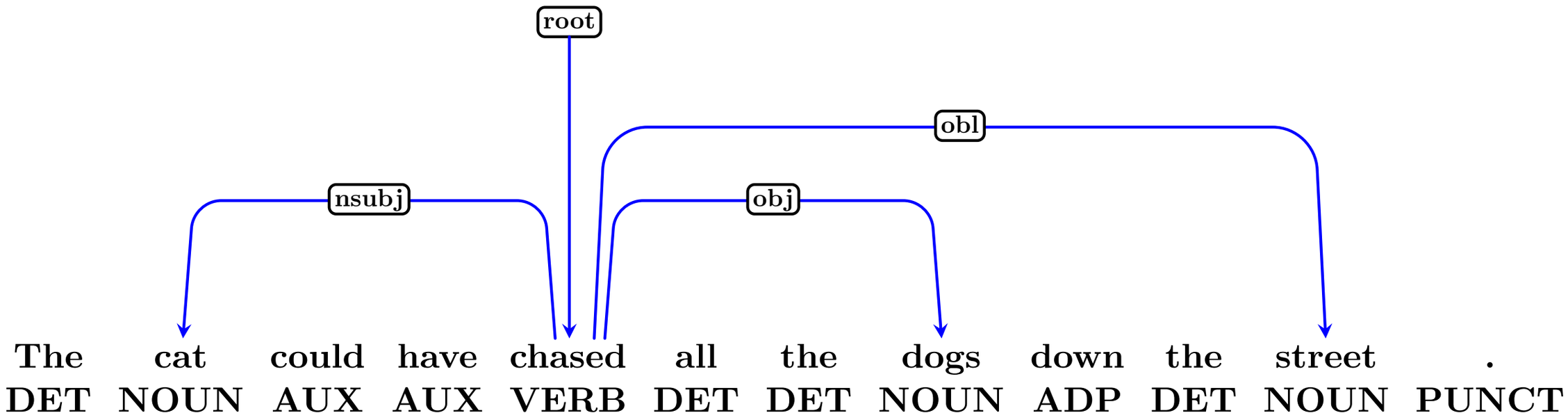
Le … hiens .
le … hien .
DET … OUN PUNCT
Definite=Def … er=Masc
Gender=Masc … er=Plur
Number=Sing

- Lemma rep … of the word
- Part-of-spe … tical class
- Features representing lexical and grammatical properties of the lemma or the particular word form

Syntax

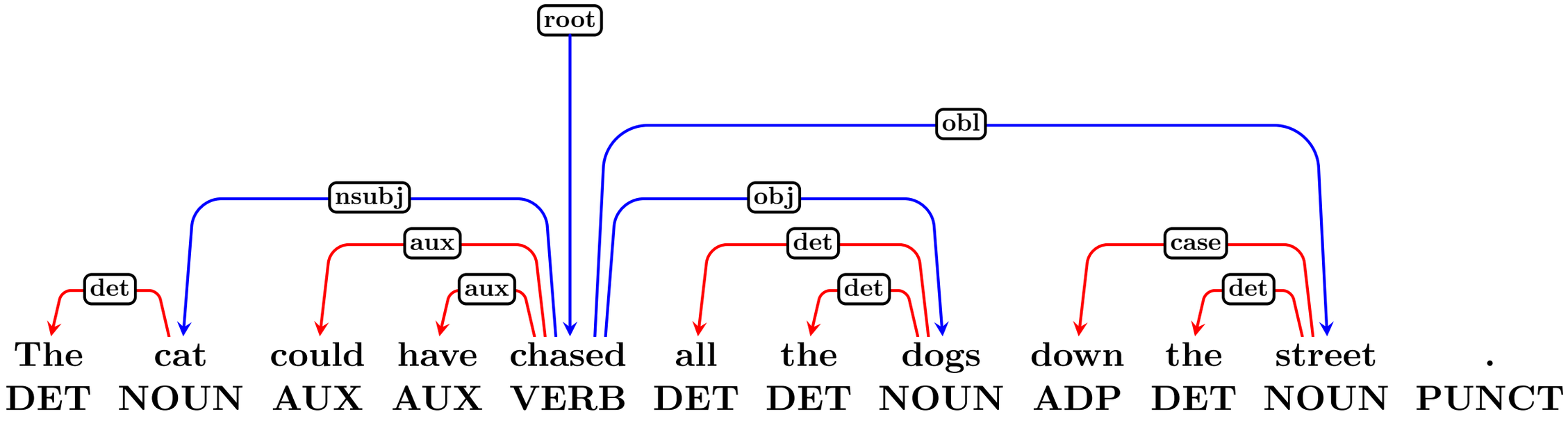
The	cat	could	have	chased	all	the	dogs	down	the	street	.
DET	NOUN	AUX	AUX	VERB	DET	DET	NOUN	ADP	DET	NOUN	PUNCT

Syntax



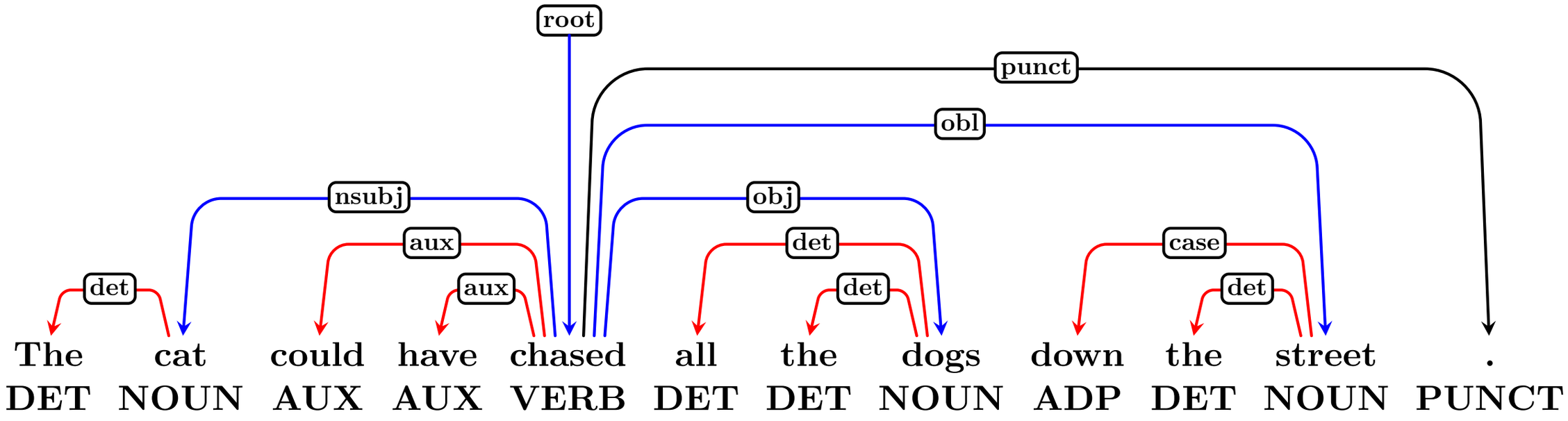
- Content words are linked by grammatical relations

Syntax

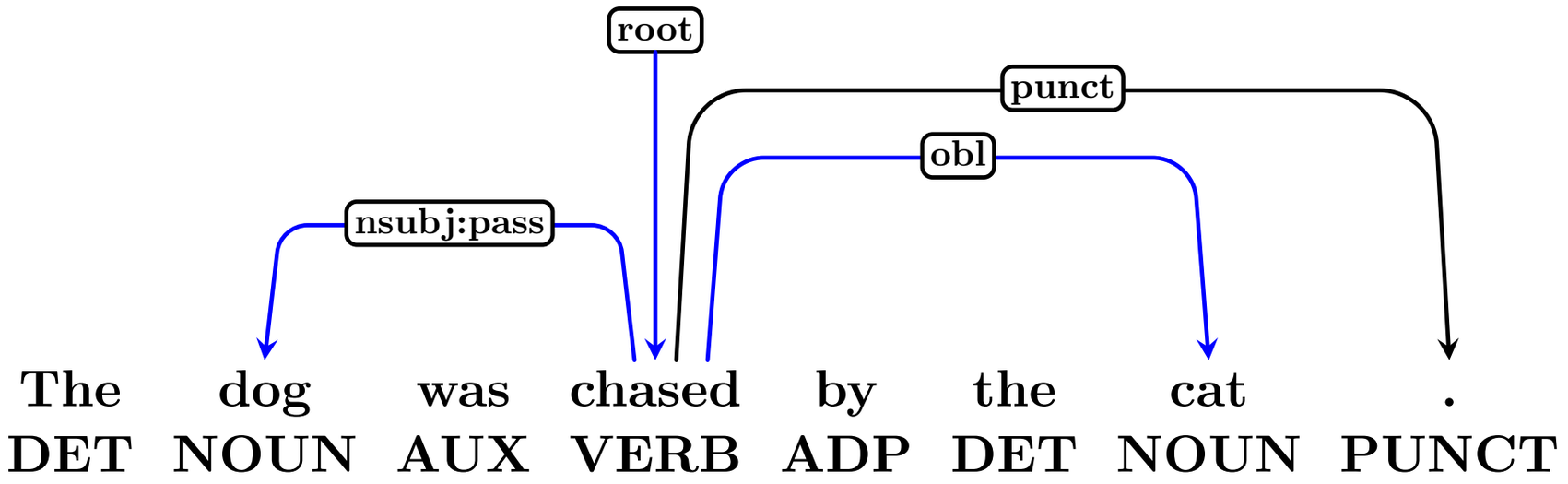


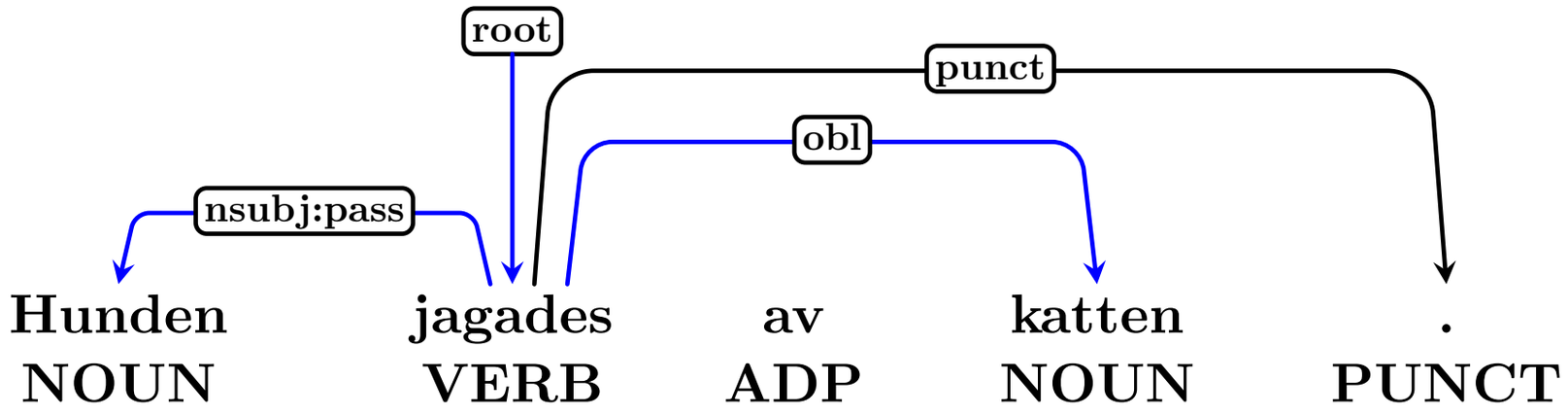
- Content words are linked by grammatical relations
- Function words attach to the content word they modify

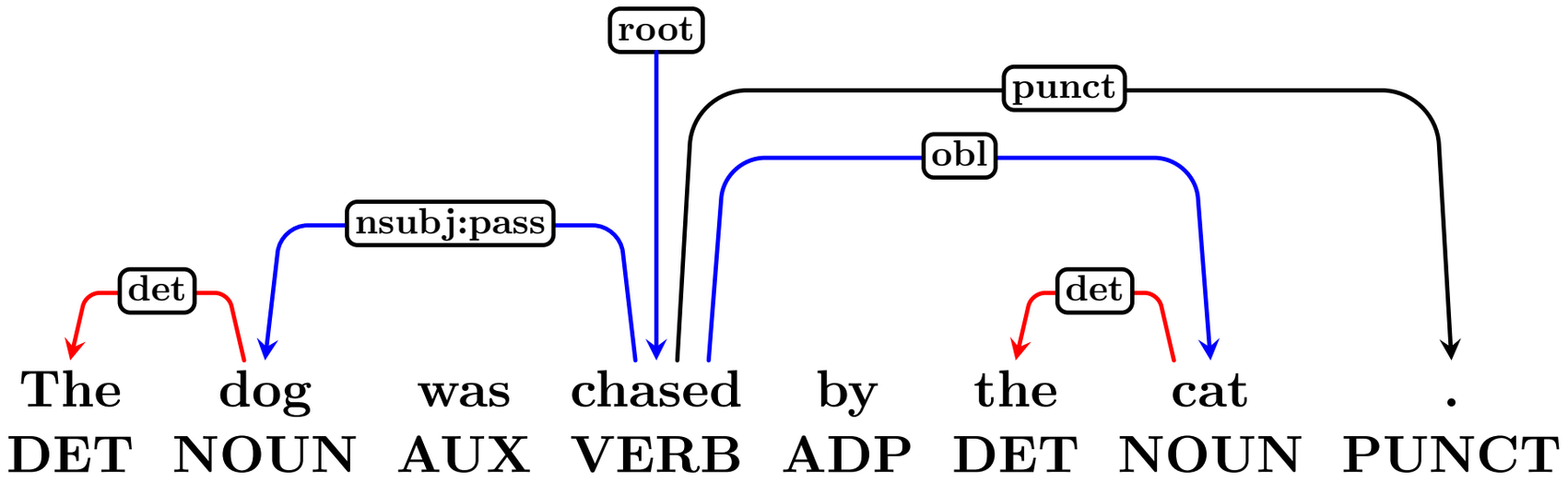
Syntax



- Content words are linked by grammatical relations
- Function words attach to the content word they modify
- Punctuation attach to head of phrase or clause


root
punct
obl
nsubj:pass
The dog was chased by the cat .
DET NOUN AUX VERB ADP DET NOUN PUNCT


root
punct
obl
nsubj:pass
Hunden jagades av katten .
NOUN VERB ADP NOUN PUNCT


root
punct
obl
nsubj:pass
det
det
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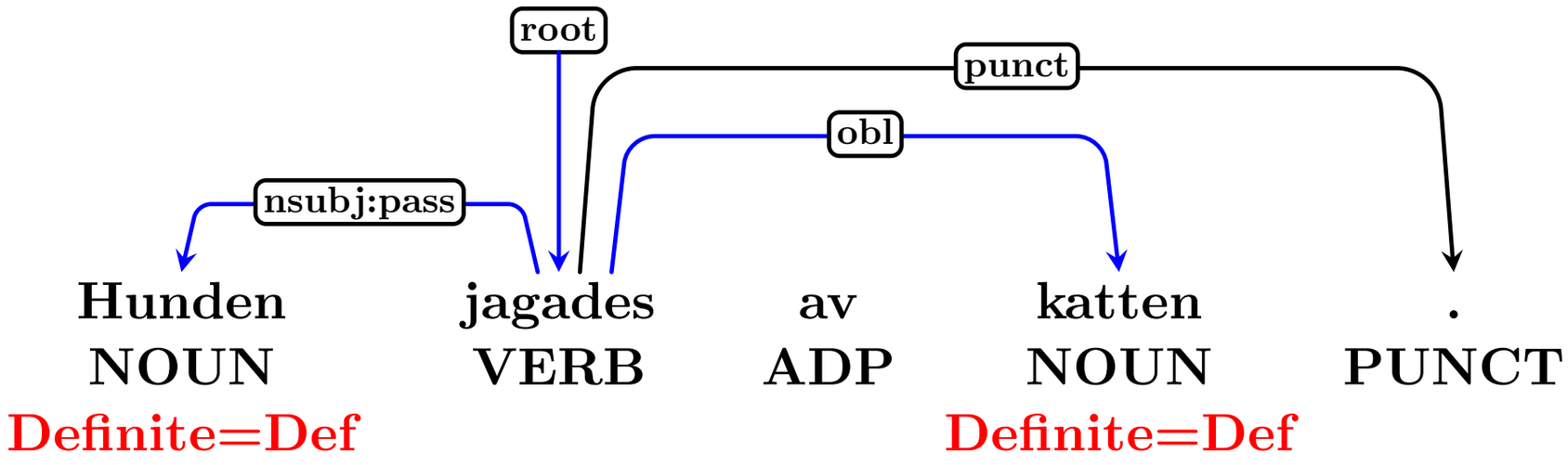
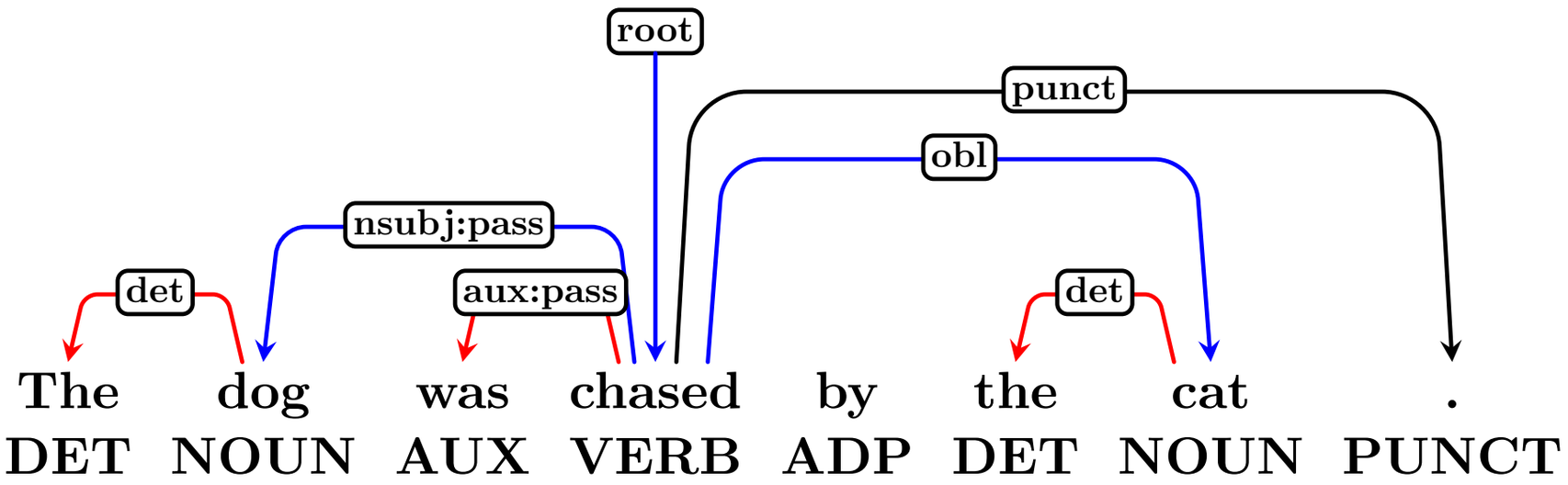
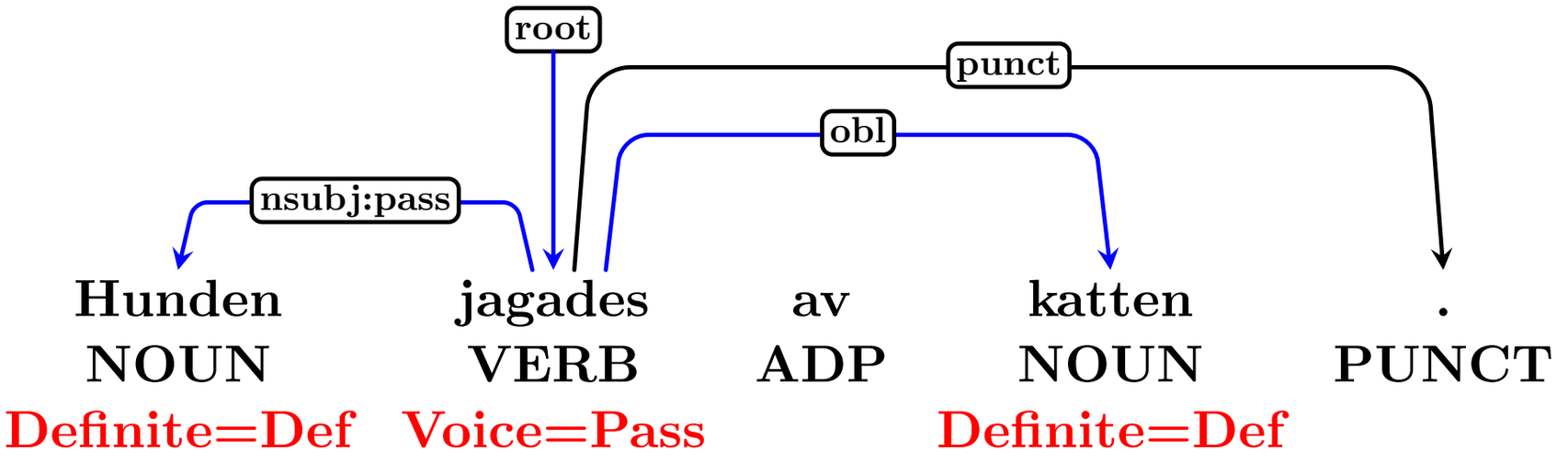
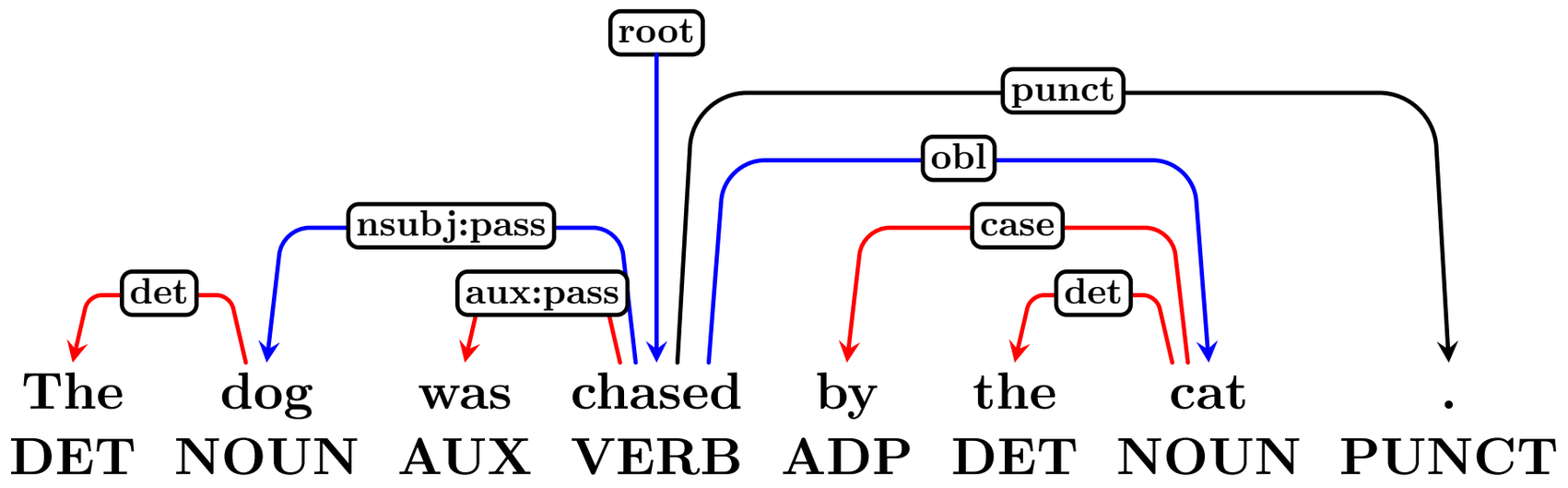
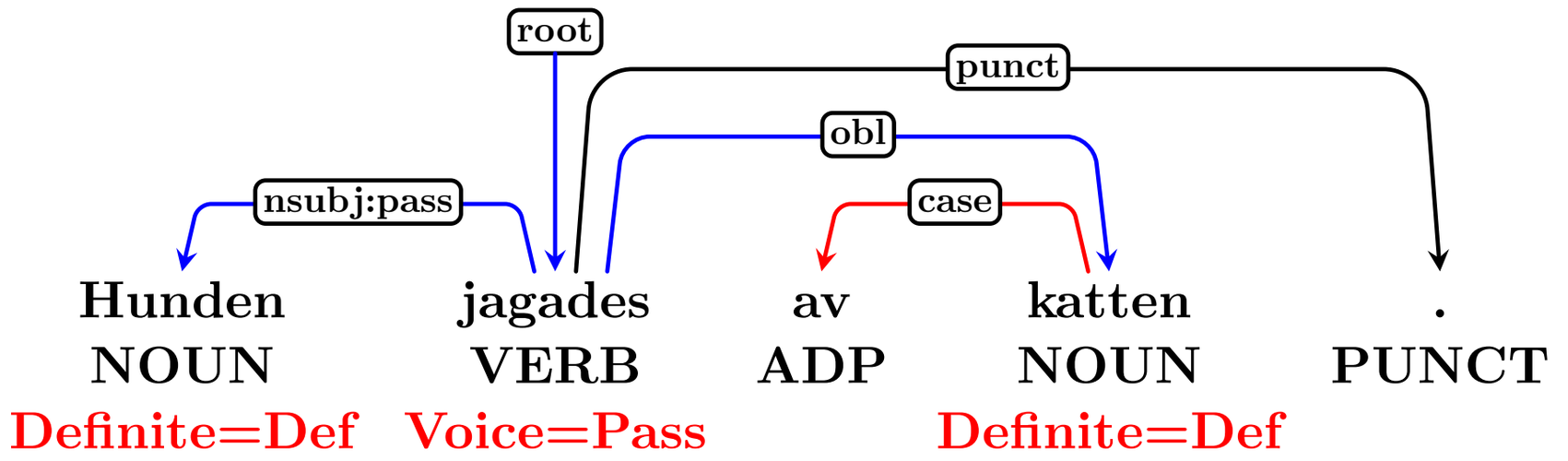
DET NOUN AUX VERB ADP DET NOUN PUNCT


root
punct
obl
nsubj:pass
Hunden jagades av katten .
NOUN VERB ADP NOUN PUNCT
Definite=Def
Definite=Def


root
punct
obl
nsubj:pass
det
aux:pass
det
The dog was chased by the cat .
DET NOUN AUX VERB ADP DET NOUN PUNCT


root
punct
obl
nsubj:pass
Hunden jagades av katten .
NOUN VERB ADP NOUN PUNCT
Definite=Def Voice=Pass Definite=Def


root
punct
obl
nsubj:pass
case
det
aux:pass
det
The dog was chased by the cat .
DET NOUN AUX VERB ADP DET NOUN PUNCT


root
punct
obl
nsubj:pass
case
Hunden jagades av katten .
NOUN VERB ADP NOUN PUNCT
Definite=Def Voice=Pass Definite=Def

Syntactic Relations

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Taxonomy of 37 universal syntactic relations

- Three types of structures: nominals, clauses, modifiers
- Core arguments vs. obliques (not arguments vs. adjuncts)
- Language-specific subtypes

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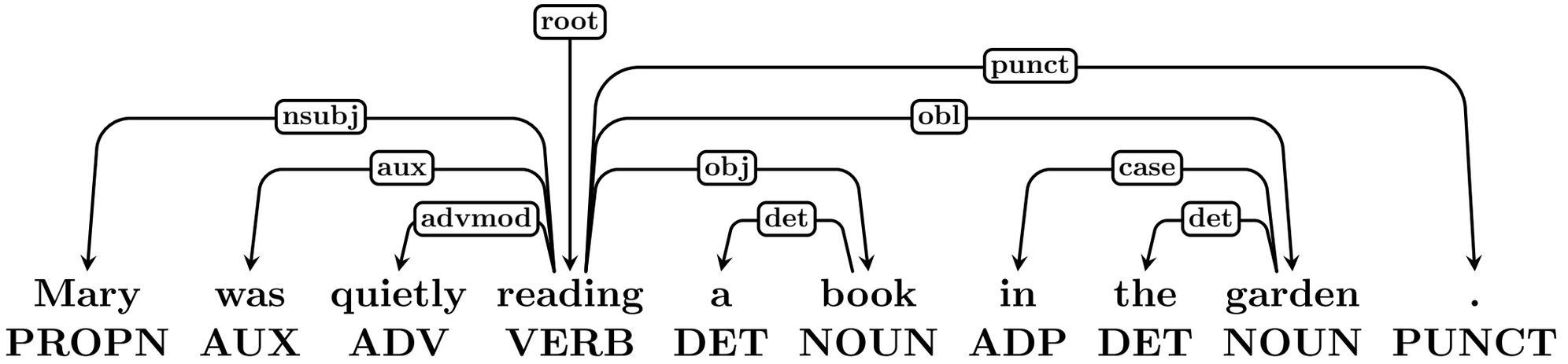
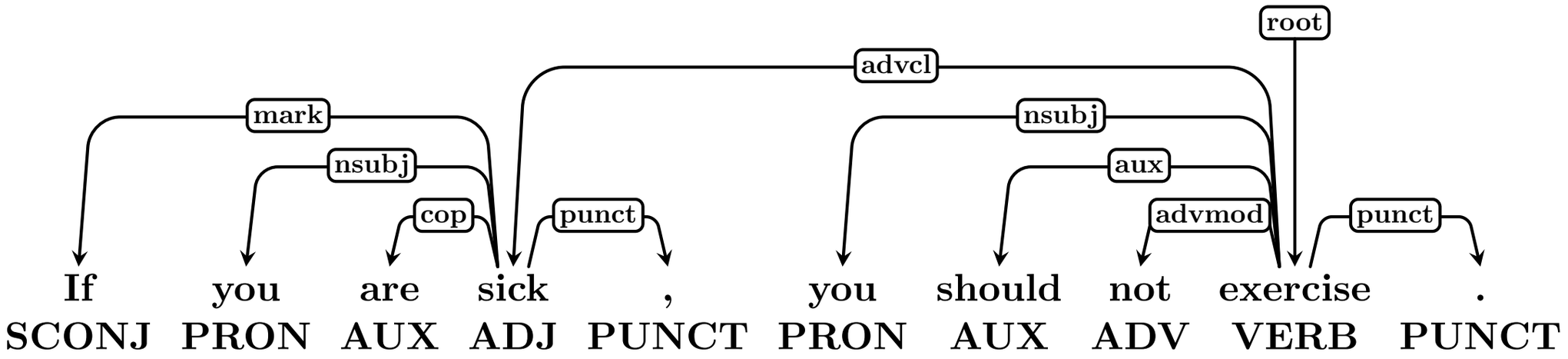
Basic and enhanced representations

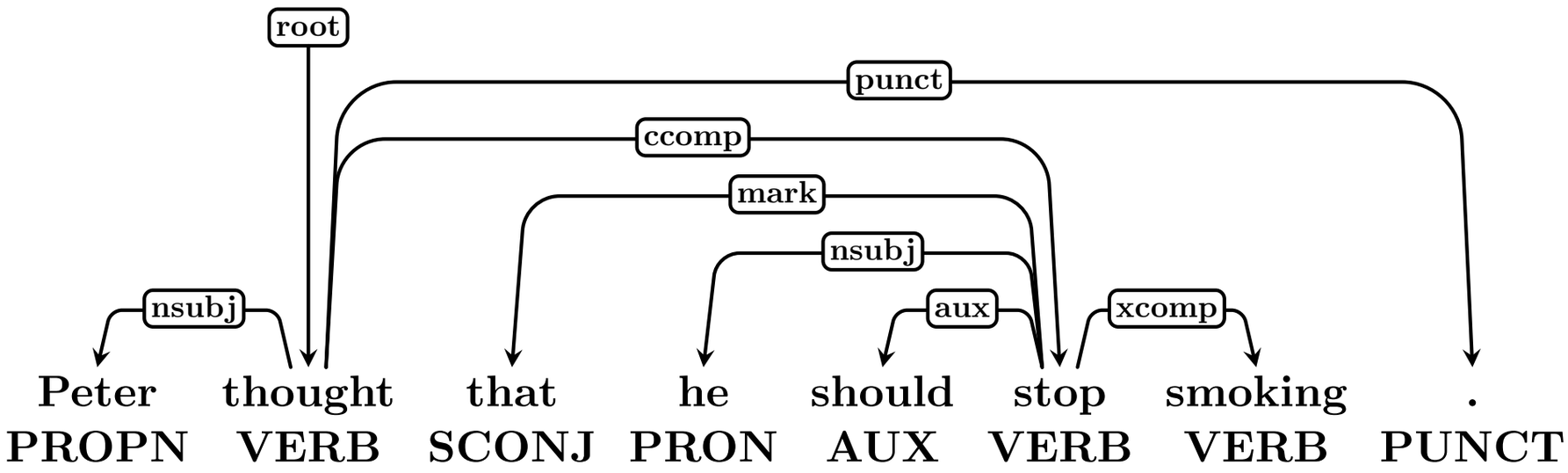
- Basic representation forms a (possibly non-projective) tree
- Additional relations in the enhanced representation

Syntactic Relations

	Nominal	Clause	Modifier Word	Function Word
Core Predicate Dep	nsubj obj iobj	csubj ccomp xcomp		
Non-Core Predicate Dep	obl vocative expl dislocated	advcl	advmod* discourse	aux cop mark
Nominal Dep	nmod appos nummod	acl	amod	det clf case
Coordination	**MWE**	**Loose**	**Special**	**Other**
conj cc	fixed flat compound	parataxis list	orphan goeswith reparandum	punct root dep


root
punct
nsubj
obl
aux
obj
case
advmod
det
det
Mary was quietly reading a book in the garden .
PROPN AUX ADV VERB DET NOUN ADP DET NOUN PUNCT


root
advcl
mark
nsubj
nsubj
aux
cop
punct
advmod
punct
If you are sick , you should not exercise .
SCONJ PRON AUX ADJ PUNCT PRON AUX ADV VERB PUNCT


root
punct
ccomp
mark
nsubj
nsubj
aux
xcomp
Peter thought that he should stop smoking .
PROPN VERB SCONJ PRON AUX VERB VERB PUNCT

Core Arguments

Core Arguments

Arguments of basic intransitive and transitive verbs

- Verbs usually only agree with core arguments
- Core arguments normally appear as bare nominals without adpositions
- Certain cases, traditionally called nominative, accusative, and absolutive are typically reserved core arguments
- Core arguments often occupy special positions in the clause
- Syntactic phenomena like control, relativization and passivization can be restricted to core arguments

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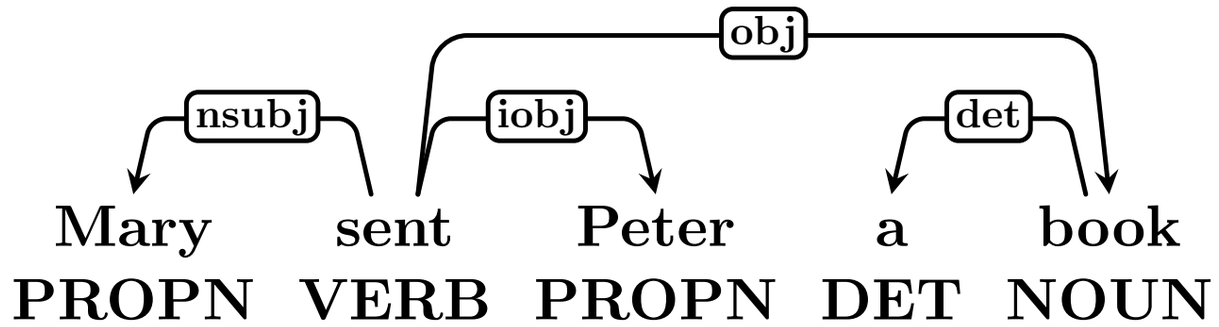
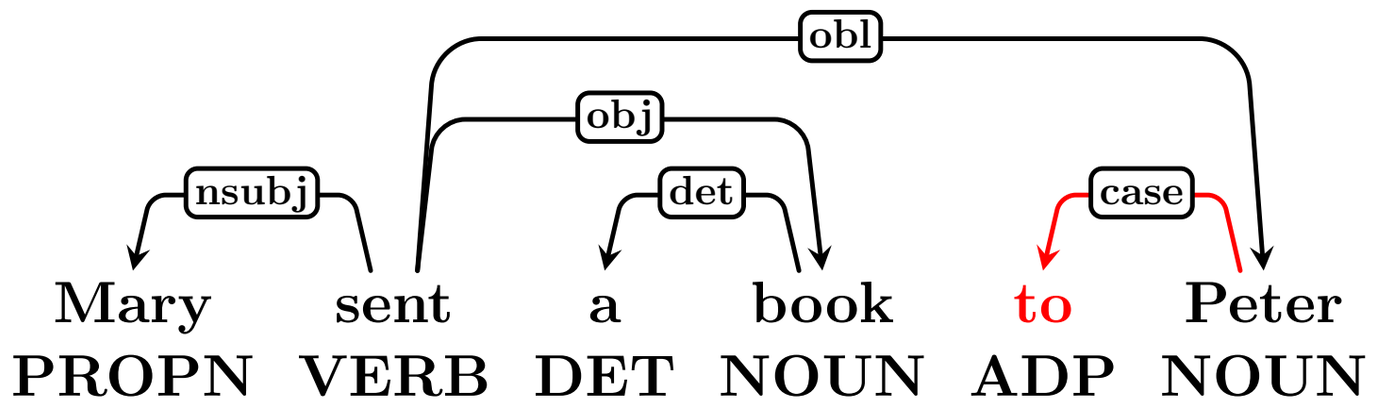
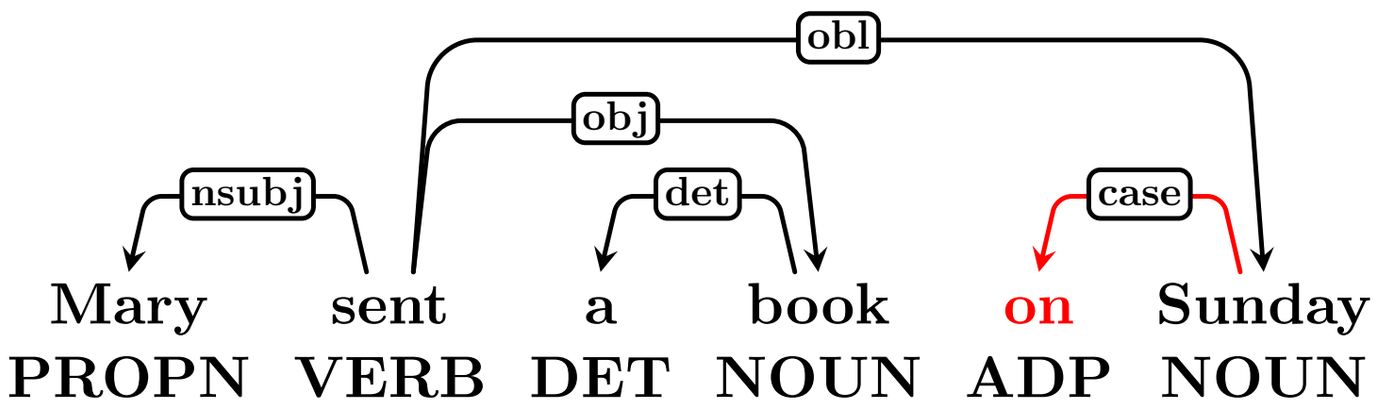
Do not confuse

- Core arguments vs. oblique dependents – grammatical encoding
- Arguments vs. adjuncts – valency or subcategorization

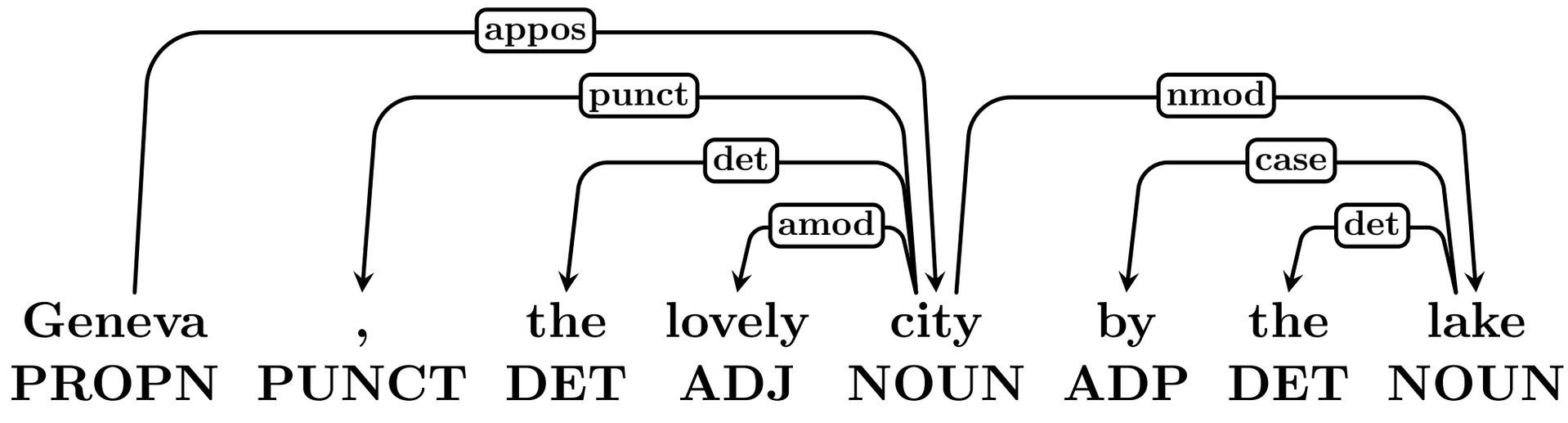

obj
nsubj
iobj
det
Mary sent Peter a book
PROPN VERB PROPN DET NOUN


obl
obj
nsubj
det
case
Mary sent a book to Peter
PROPN VERB DET NOUN ADP NOUN

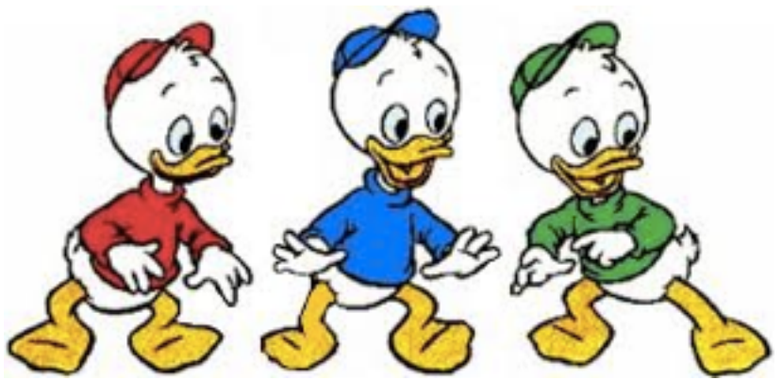

obl
obj
nsubj
det
case
Mary sent a book on Sunday
PROPN VERB DET NOUN ADP NOUN

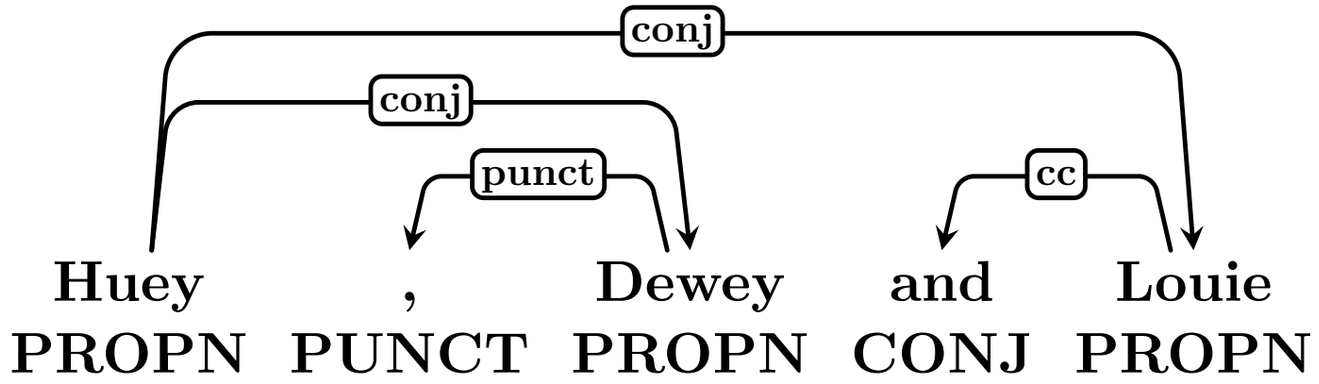
Noun Phrases

Nominal	Clause	Modifier Word	Function Word
nmod appos nummod	acl	amod	det clf case



Coordination

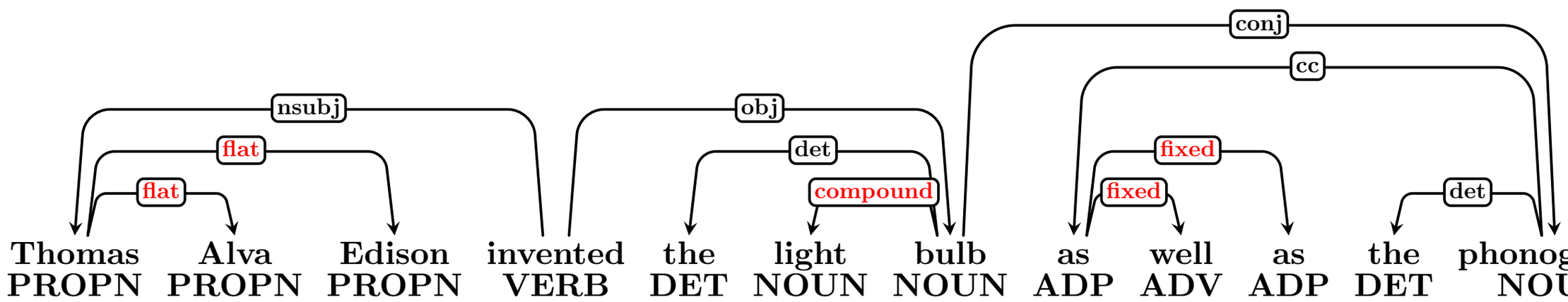




Coordinate structures are rooted in the first conjunct

- Subsequent conjuncts depend on it via the conj relation
- Conjunction depends on following conjunct via the cc relation
- Punctuation depends on following conjunct via the punct relation

Multiword Expressions



Only restricted classes of MWEs get special treatment:

- Fixed grammaticized expressions (fixed)
- Semi-fixed expressions with no clear head (flat)
- Lexical compounds – normally headed (compound)

Loose Joining Relations

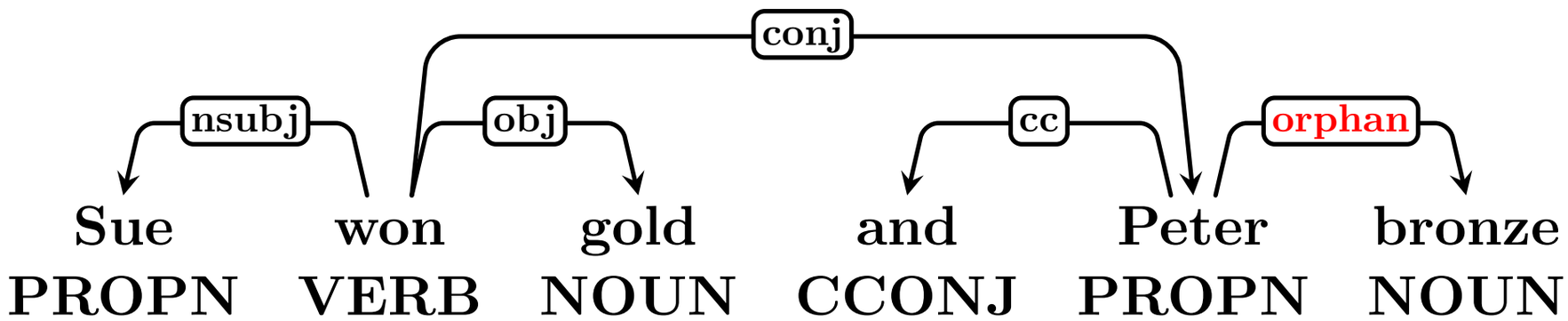
The parataxis relation:

- Side-by-side sentences ("run-on sentences")
  Bearded dragons are sight hunters, they need to see the food to move.
- Injective clauses (parentheticals)
  Calafia has great fries (they are to die for!) and decent burgers.
- Certain types of reported speech
  That guy, he said, left early this morning.
- Tag questions
  It's not me, is it?

The list relation:

- Chains of comparable items
  Steve Jones Phone: 555-9814 Email: jones@abc.edf

Ellipsis

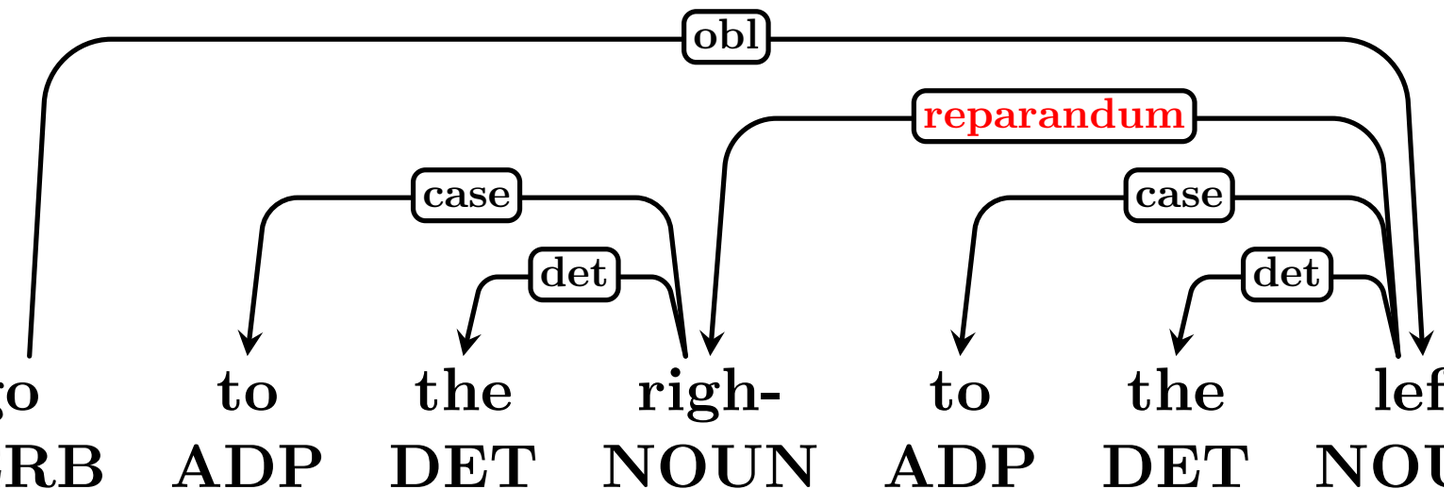


The UD approach to ellipsis (from v2):

1. If the elided word has no children, do nothing.
2. If the elided word has children, promote one of them to be the head.
3. If the elided word is a predicate and the new head a core argument, attach other non-functional elements with the orphan relation.

Implicit relations are recovered in enhanced dependencies

Disfluencies



The reparandum relation:

- Disfluencies that are overridden in a speech repair

The goeswith relation:

- Parts of words resulting from orthographic or editing mistakes

Punctuation

- A punctuation mark separating coordinated units is attached to the following conjunct.
- A punctuation mark preceding or following a subordinated unit is attached to this unit.
- Within the relevant unit, a punctuation mark is attached at the highest possible node that preserves projectivity.
- Paired punctuation marks should be attached to the same word unless that would create non-projectivity.

Special Relations

The root relation:

- The word at the root of the dependency tree
- Normally the predicate of the main clause
- Exactly one word in each tree

The dep relation:

- Unspecified syntactic relation (when all else fails)

A Two-Level Architecture

- Universal relations to allow cross-linguistic comparison
- Subtypes to capture language-specific phenomena

A Two-Level Architecture

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Universal	Subtype

A Two-Level Architecture

- Universal relations to allow cross-linguistic comparison
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Universal	Subtype
acl	acl:relcl

A Two-Level Architecture

- Universal relations to allow cross-linguistic comparison
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Universal	Subtype
acl	acl:relcl
compound	compound:prt

A Two-Level Architecture

- Universal relations to allow cross-linguistic comparison
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Universal	Subtype
acl	acl:relcl
compound	compound:prt
nmod	nmod:poss

A Two-Level Architecture

- Universal relations to allow cross-linguistic comparison
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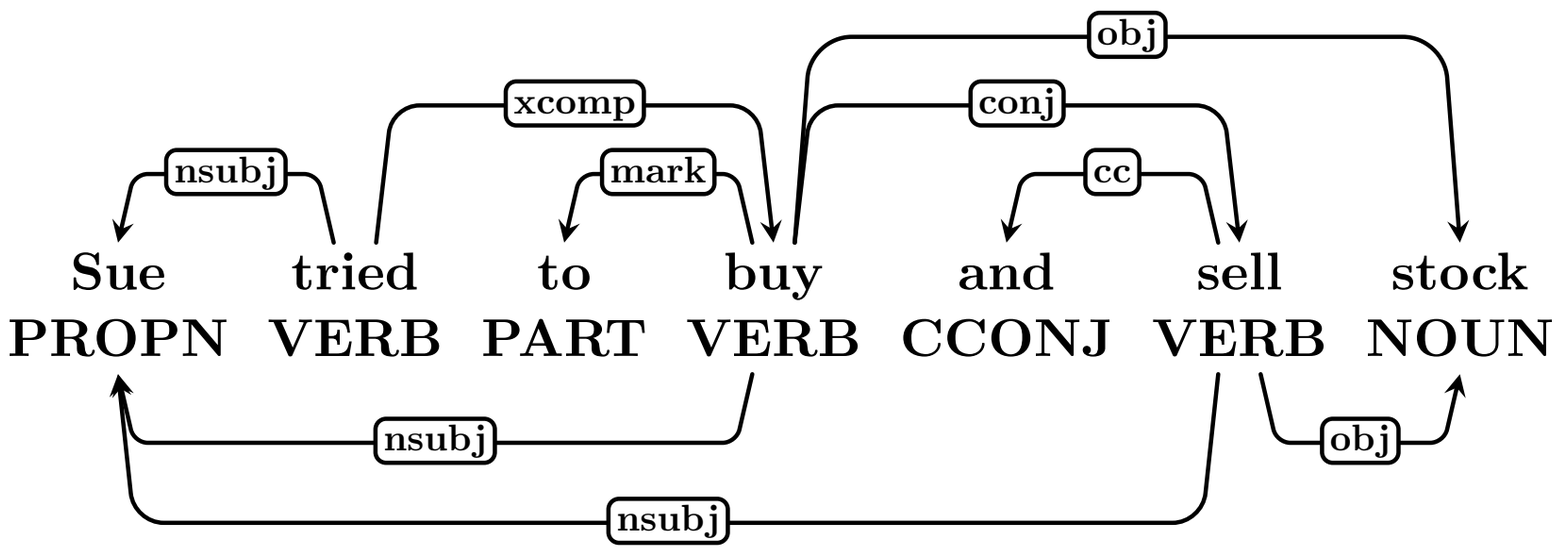
Universal	Subtype
acl	acl:relcl
compound	compound:prt
nmod	nmod:poss
flat	flat:name

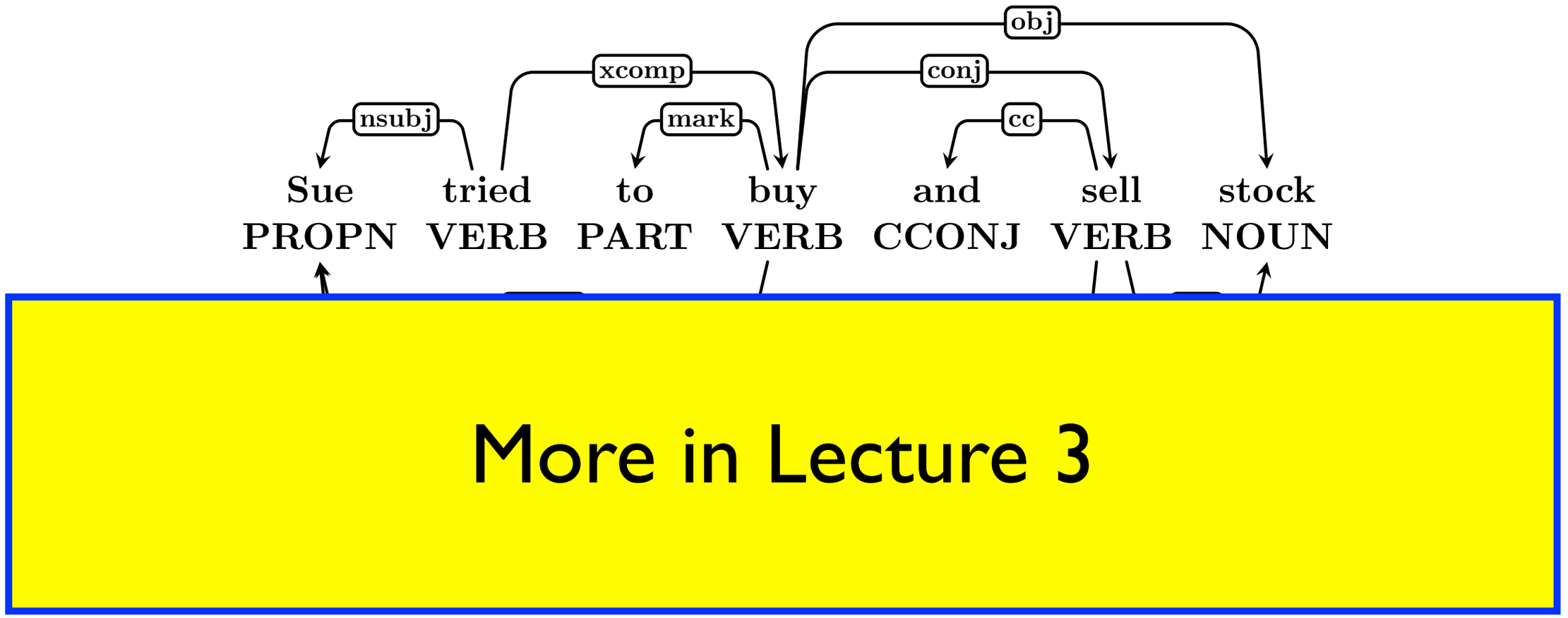
Enhanced Representation



An extended dependency graph containing

- Null nodes for elided predicates
- Additional subject relations for control and raising constructions
- Propagation of dependents over coordination
- Coreference in relative clause constructions
- Labels augmented with function word information

Enhanced Representation



- Additional subject relations for control and raising constructions
- Propagation of dependents over coordination
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- Labels augmented with function word information

CoNLL-U Format

- Revised version of the CoNLL-X format
- Two-level segmentation and enhanced dependencies

CoNLL-U Format

ID
1–2
1
2
3–4
3
4
5
6

- Revised version of the CoNLL-X format
- Two-level segmentation and enhanced dependencies

CoNLL-U Format

ID	FORM
1-2	Vámonos
1	Vamos
2	nos
3-4	al
3	a
4	el
5	mar
6	.

- Revised version of the CoNLL-X format
- Two-level segmentation and enhanced dependencies

CoNLL-U Format

ID	FORM	LEMMA
1-2	Vámonos	_
1	Vamos	ir
2	nos	nosotros
3-4	al	_
3	a	a
4	el	el
5	mar	mar
6	.	.

- Revised version of the CoNLL-X format
- Two-level segmentation and enhanced dependencies

CoNLL-U Format

ID	FORM	LEMMA	UPOSTAG
1-2	Vámonos	_	_
1	Vamos	ir	VERB
2	nos	nosotros	PRON
3-4	al	_	_
3	a	a	ADP
4	el	el	DET
5	mar	mar	NOUN
6	.	.	.

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CoNLL-U Format

ID	FORM	LEMMA	UPOSTAG	XPOSTAG
1-2	Vámonos	_	_	_
1	Vamos	ir	VERB	_
2	nos	nosotros	PRON	_
3-4	al	_	_	_
3	a	a	ADP	_
4	el	el	DET	_
5	mar	mar	NOUN	_
6	.	.	.	_

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CoNLL-U Format

ID	FORM	LEMMA	UPOSTAG	XPOSTAG	FEATS
1-2	Vámonos	_	_	_	_
1	Vamos	ir	VERB	_	Mood=Imp|Number=Plur|Person=1
2	nos	nosotros	PRON	_	PronType=Per|Number=Plur|Person=1
3-4	al	_	_	_	_
3	a	a	ADP	_	_
4	el	el	DET	_	Definite=Def|Number=Sing|
5	mar	mar	NOUN	_	Number=Sing|Gender=Masc
6	.	.	.	_	_

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CoNLL-U Format

ID	FORM	LEMMA	UPOSTAG	XPOSTAG	FEATS	HEAD
1-2	Vámonos	_	_	_	_	_
1	Vamos	ir	VERB	_	Mood=Imp|Number=Plur|Person=1	0
2	nos	nosotros	PRON	_	PronType=Per|Number=Plur|Person=1	1
3-4	al	_	_	_	_	_
3	a	a	ADP	_	_	5
4	el	el	DET	_	Definite=Def|Number=Sing|	5
5	mar	mar	NOUN	_	Number=Sing|Gender=Masc	1
6	.	.	.	_	_	1

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CoNLL-U Format

ID	FORM	LEMMA	UPOSTAG	XPOSTAG	FEATS	HEAD	DEPREL
1-2	Vámonos	_	_	_	_	_	_
1	Vamos	ir	VERB	_	Mood=Imp|Number=Plur|Person=1	0	root
2	nos	nosotros	PRON	_	PronType=Per|Number=Plur|Person=1	1	expl
3-4	al	_	_	_	_	_	_
3	a	a	ADP	_	_	5	case
4	el	el	DET	_	Definite=Def|Number=Sing|	5	det
5	mar	mar	NOUN	_	Number=Sing|Gender=Masc	1	obl
6	.	.	.	_	_	1	punct

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CoNLL-U Format

ID	FORM	LEMMA	UPOSTAG	XPOSTAG	FEATS	HEAD	DEPREL	DEPS
1-2	Vámonos	_	_	_	_	_	_	_
1	Vamos	ir	VERB	_	Mood=Imp|Number=Plur|Person=1	0	root	_
2	nos	nosotros	PRON	_	PronType=Per|Number=Plur|Person=1	1	expl	_
3-4	al	_	_	_	_	_	_	_
3	a	a	ADP	_	_	5	case	_
4	el	el	DET	_	Definite=Def|Number=Sing|	5	det	_
5	mar	mar	NOUN	_	Number=Sing|Gender=Masc	1	obl	_
6	.	.	.	_	_	1	punct	_

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CoNLL-U Format

ID	FORM	LEMMA	UPOSTAG	XPOSTAG	FEATS	HEAD	DEPREL	DEPS	MISC
1-2	Vámonos	_	_	_	_	_	_	_	_
1	Vamos	ir	VERB	_	Mood=Imp|Number=Plur|Person=1	0	root	_	_
2	nos	nosotros	PRON	_	PronType=Per|Number=Plur|Person=1	1	expl	_	_
3-4	al	_	_	_	_	_	_	_	_
3	a	a	ADP	_	_	5	case	_	_
4	el	el	DET	_	Definite=Def|Number=Sing|	5	det	_	_
5	mar	mar	NOUN	_	Number=Sing|Gender=Masc	1	obl	_	_
6	.	.	.	_	_	1	punct	_	_

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Challenges

Current Issues

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Lack of consistency across (and within) languages

- Guidelines are often not specific enough to determine unique analysis
- Language-specific traditions bias application of guidelines
- Conversion from other annotation schemes add further bias
- Most teams have limited resources for fixing problems

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Lack of support for additional annotation

- The UD scheme (and CoNLL-U) is not designed to capture everything
- But everyone wants to encode their favorite linguistic distinction
- Leads to increasing complexity, opaqueness and inconsistency
- Keep UD annotation clean and simple – facilitate additional layers

Manning's Law

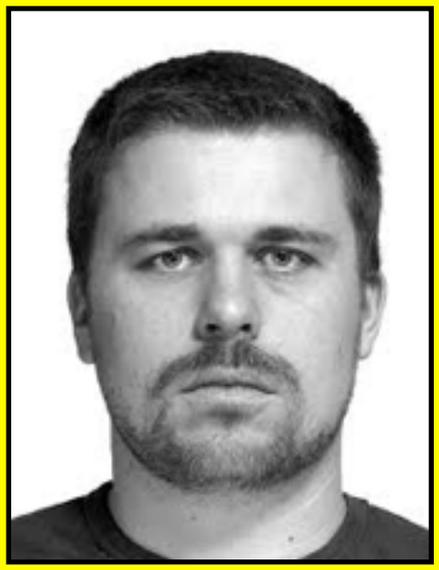
The secret to understanding the design (and relative success) of UD is to realize that it is a very subtle compromise between approximately 6 things:

1. **UD needs to be satisfactory on linguistic analysis grounds for individual languages.**
2. **UD needs to be good for linguistic typology, i.e., providing a suitable basis for bringing out cross-linguistic parallelism across languages and language families.**
3. **UD must be suitable for rapid, consistent annotation by a human annotator.**
4. **UD must be suitable for computer parsing with high accuracy.**
5. **UD must be easily comprehended and used by a non-linguist, whether a language learner or an engineer with prosaic needs for language processing.**
6. **UD must support well downstream language understanding tasks (relation extraction, reading comprehension, machine translation, …).**

It's easy to come up with a proposal that improves UD on one of these dimensions. The interesting and difficult part is to improve UD while remaining sensitive to all these dimensions.

Manning's Law

Ginter's Razor



Changes should not be multiplied beyond necessity!

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