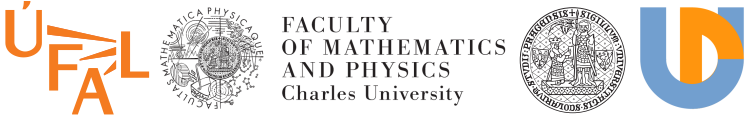
Universal Dependencies: Comparing Languages in Space and Time



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https://universaldependencies.org/

Outline

1. Introduction to Universal Dependencies
2. Parsing UD, shared tasks
3. Use in digital humanities
4. Parallel treebanks: Bible, PUD
5. Language change
6. (Closer to meaning: Enhanced and Deep UD)

Universal Dependencies

- Set of annotation guidelines (+ underlying theory)
- Set of annotated corpora (treebanks)

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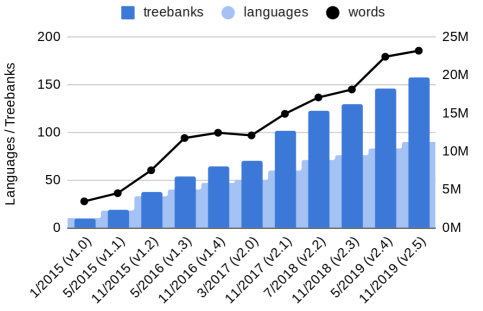
- Set of annotated corpora (treebanks)

- Same things annotated same way across languages…
- … while highlighting different coding strategies

Universal Dependencies: History

- 2014 June: kick-off meeting
- 2015 January: data release 1.0
  (10 treebanks, 10 languages)
- 2015 May: release 1.1; since then,
  new release every half-a-year
- 2016 December: v2 guidelines
- 2017 May: first UD workshop in Gothenburg
- 2017 July: first CoNLL shared task in UD parsing
- 2017 November: data release 2.1
  (102 treebanks, 60 languages)
- 2020 July: IWPT shared task in Enhanced UD parsing
- 2021 May: release 2.8
  (202 treebanks, 114 languages)



Basic Universal Dependencies: 114 (112) Languages and Growing

I.-E.: Armenian West+East, Ancient Greek, Greek, Albanian, Breton, Irish, Manx, Scottish, Welsh, Afrikaans, Danish, Dutch, English, Faroese, Frisian, German, Gothic, Icelandic, Low Saxon, Norwegian, Swedish, Swiss German, Catalan, French, Galician, Italian, Latin, Old French, Portuguese, Romanian, Spanish, Belarusian, Bulgarian, Church Slavonic, Croatian, Czech, Old Russian, Polish, Russian, Serbian, Slovak, Slovenian, Ukrainian, Upper Sorbian, Latvian, Lithuanian, Kurmanji, Persian, Khunsari, Nayini, Soi, Hindi, Kangri, Bhojpuri, Marathi, Sanskrit, Urdu; **Uralic:** Erzya, Estonian, Finnish, Hungarian, Karelian, Livvi, Komi Permyak+Zyrian, Moksha, Sámi North+Skolt; **Dravid.:** Tamil, Telugu; **Turkic:** Kazakh, Old Turkish, Turkish, Uyghur; **Af.-As.:** Akkadian, Amharic, Arabic Modern+Levant, Assyrian, Beja, Coptic, Hebrew, Maltese; **Sino-Tib.:** Cantonese, Classical Chinese, Chinese; **Tai-Kadai:** Thai; **Aus.-As.:** Vietnamese; **Austrones.:** Indonesian, Tagalog; **Tupian:** Mundurukú, Akuntsú, Makuráp, Guajajára, Kaapor, Tupinambá, Mbyá; **Other:** Buryat, Japanese, Korean, Chukchi, Yupik, Basque, Sw. Sign, Naija, Bambara, Wolof, Yoruba, Warlpiri, K'iche', Apurinã

Design Principles

- Dependency
  - Widely used in practical NLP systems
  - Available in treebanks for many languages

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  - Basic annotation units are words
    - But what is a word? – syntactic words
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  - Words enter into syntactic relations

Design Principles

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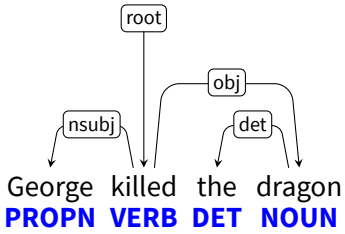
  - Available in treebanks for many languages
- Lexicalism
  - Basic annotation units are words
    - ★ But what is a word? – syntactic words
  - Words have morphological properties
  - Words enter into syntactic relations
- Recoverability
  - Transparent mapping from input text to word segmentation

Same Thing Same Way



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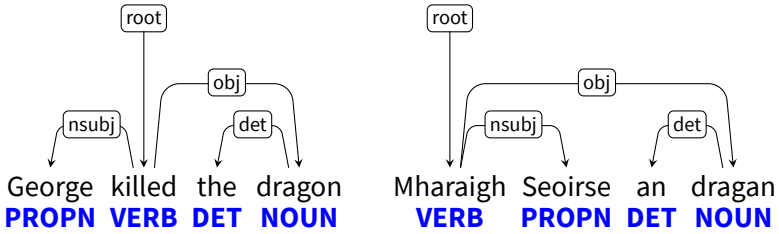

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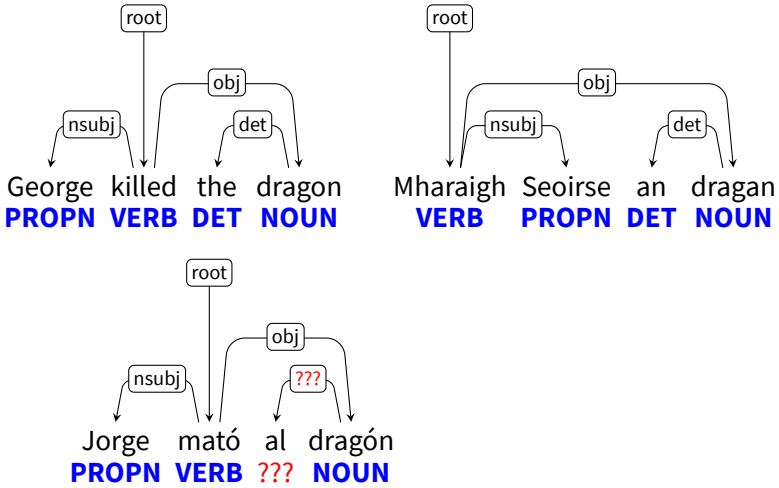

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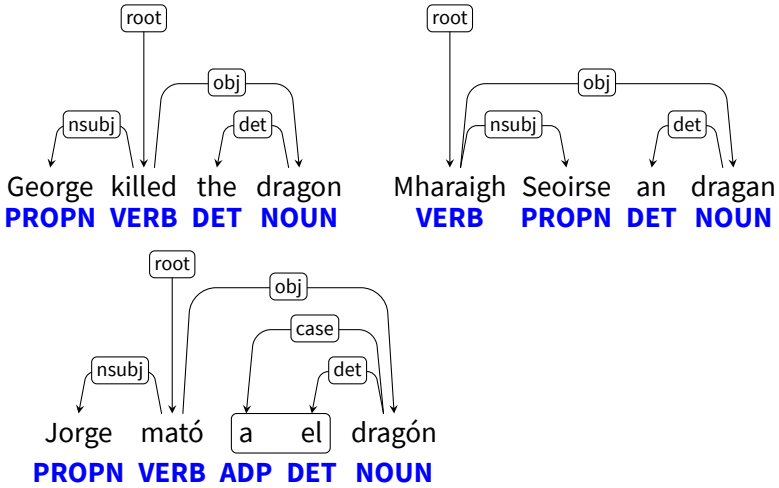

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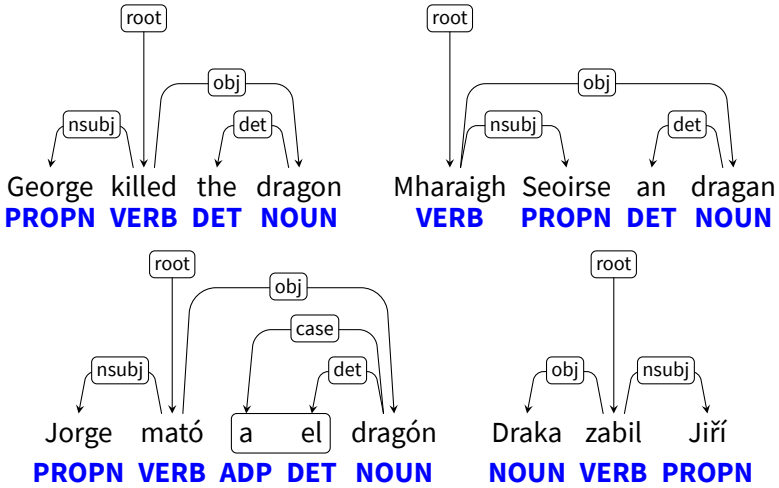
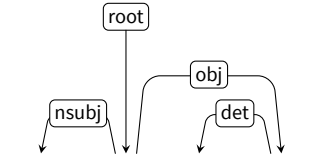


Same Meaning ≠ Same Construction!



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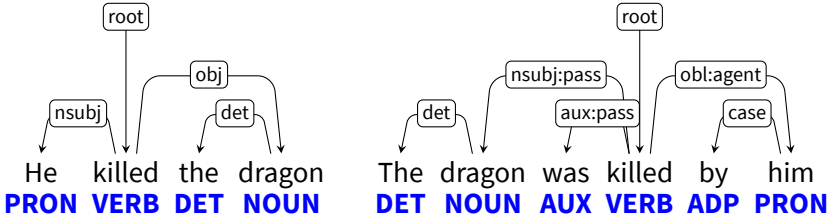

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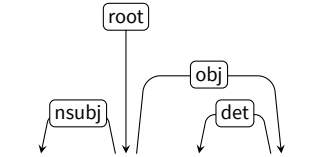

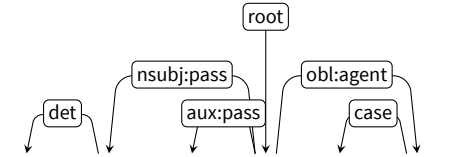

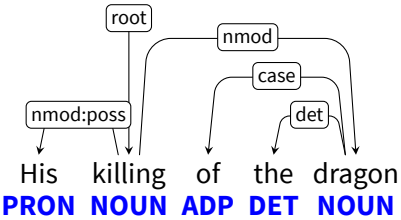

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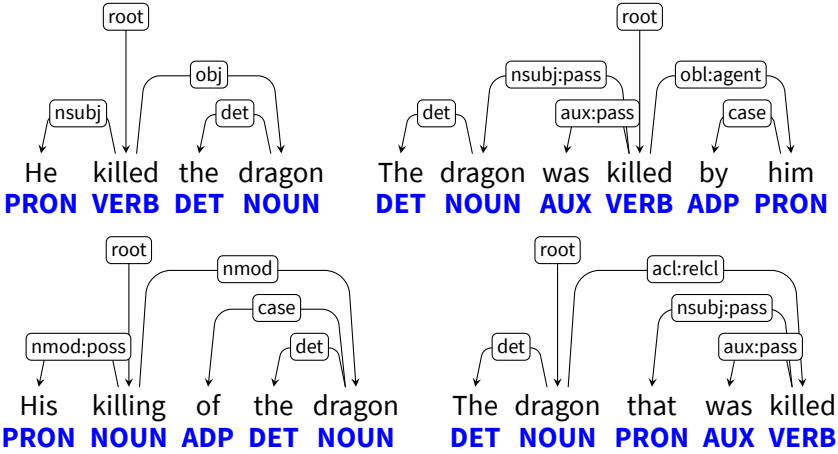
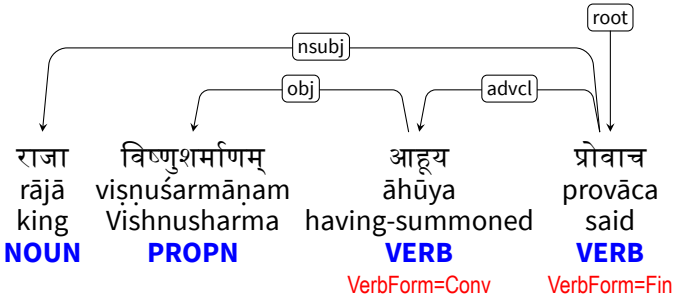
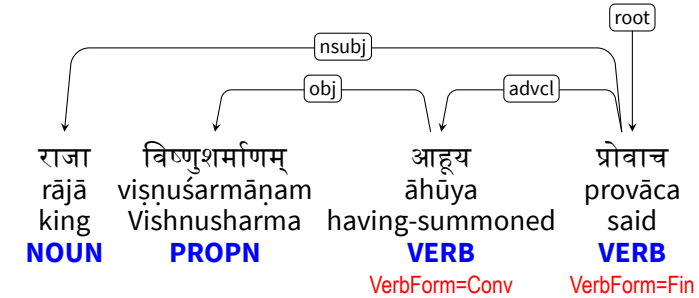


Language-specific Preferences



Language-specific Preferences



A Tour through UD

Morphology

Některé	dívky	si	nicméně	pochvalovaly	zmrzlinu	.
Some	*girls*		*nevertheless*	*praised*	*ice-cream*	*.*

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DET	NOUN	PRON	CCONJ	VERB	NOUN	PUNCT
PronType=Ind Gender=Fem Number=Plur Case=Nom	Gender=Fem Number=Plur Case=Nom	PronType=Prs Reflex=Yes Case=Dat		VerbForm=Part Tense=Past Voice=Act Aspect=Imp Gender=Fem Number=Plur	Gender=Fem Number=Sing Case=Acc	

- Lemma representing the semantic content of the word
- Part-of-speech tag representing the abstract lexical category associated with the word
- Features representing lexical and grammatical properties associated with the lemma or the particular word form

Part-of-Speech Tags

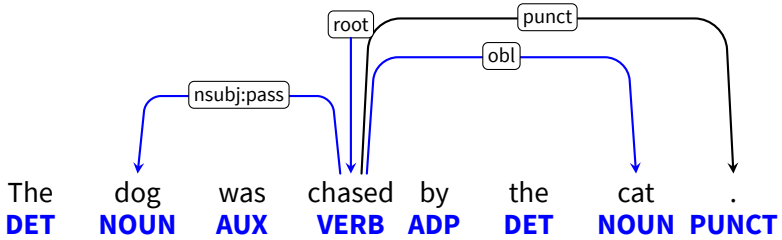
Open		Closed		Other	
NOUN	common noun	**PRON**	pronoun	**PUNCT**	punctuation
PROPN	proper noun	**DET**	determiner	**SYM**	symbol
VERB	verb	**AUX**	auxiliary	**X**	unknown
ADJ	adjective	**NUM**	numeral		
ADV	adverb	**ADP**	adposition		
INTJ	interjection	**SCONJ**	subordinator		
		CCONJ	coordinator		
		PART	particle		

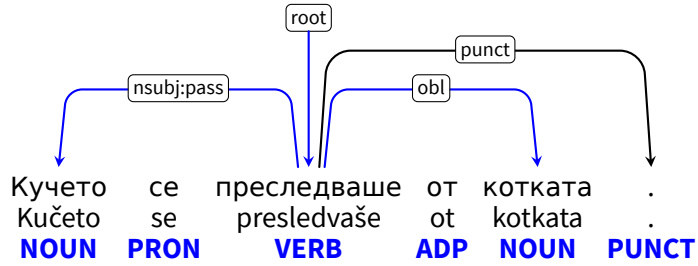
- Taxonomy of 17 universal POS tags
- All languages use the same inventory
  - Not all tags have to be used by all languages
  - Need extensions? Use features!

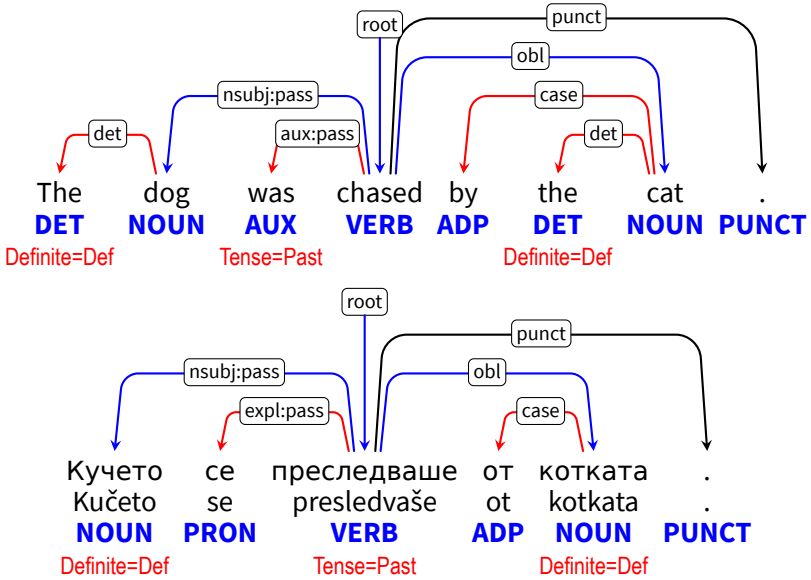
Features

Lexical	Nominal	Pronominal	Verbal
PronType	Gender	Person	VerbForm
NumType	Animacy	Clusivity	Mood
Poss(essive)	NounClass	Polite(ness)	Tense
Reflex(ive)	Number		Aspect
Foreign	Case		Voice
Abbr	Definite(ness)		Evident(iality)
Typo	Degree		Polarity

- 24 features, each with a number of possible *values*
- Languages select relevant features
- May add language-specific features or values


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


root
punct
nsubj:pass
obl
Кучето се преследваше от котката .
Kučeto se presledvaše ot kotkata .
NOUN PRON VERB ADP NOUN PUNCT


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
Definite=Def
Tense=Past
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root
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obl
expl:pass
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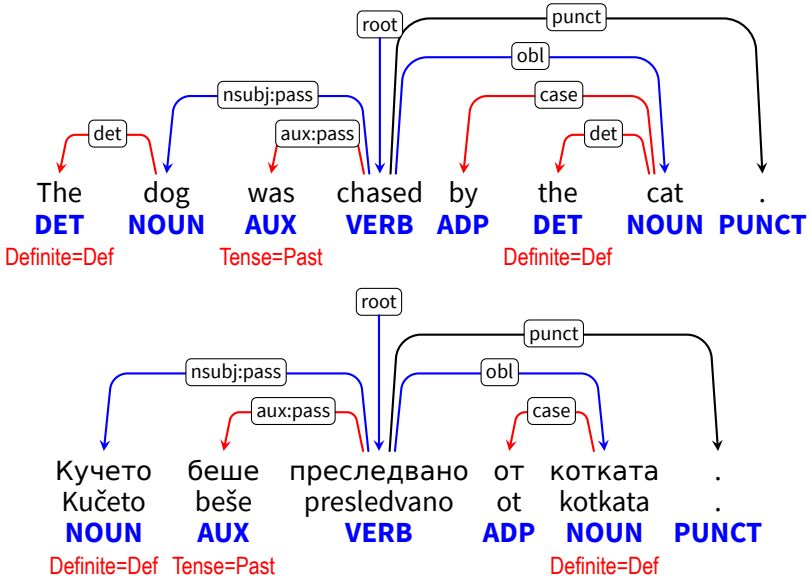
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root
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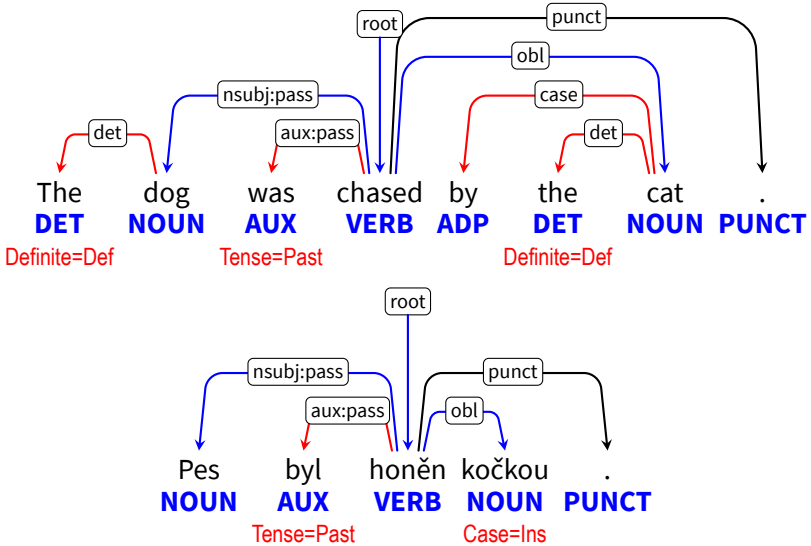
case
Кучето беше преследвано от котката .
Kučeto beše presledvano ot kotkata .
NOUN AUX VERB ADP NOUN PUNCT
Definite=Def
Tense=Past
Definite=Def


root
punct
obl
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det
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det
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DET NOUN AUX VERB ADP DET NOUN PUNCT
Definite=Def
Tense=Past
Definite=Def
root
nsubj:pass
punct
aux:pass
obl
Pes byl honěn kočkou .
NOUN AUX VERB NOUN PUNCT
Tense=Past
Case=Ins

Parsing UD

Parsing into Universal Dependencies

- Machine learning:
  - Train a model on the training part of a UD treebank
  - Apply it to new data ⇒ obtain annotations
  - End-to-end: from raw text to …
    - Sentence segmentation
    - Tokenization (word segmentation)
    - Morphology (lemmas, POS tags, features)
    - Syntax (relations between words)

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    - Morphology (lemmas, POS tags, features)
    - Syntax (relations between words)
- Evaluation: How good is it?
  - Align system-produced and gold-standard words
  - For the aligned pairs:
    - Percentage of correctly assigned lemmas, POS tags, feature values
    - Tree structure: correctly assigned parent node + relation type
    - Combined score (morpho+syntax): MLAS

Shared Tasks

- Long tradition in natural language processing
- Big tasks in UD parsing: CoNLL 2017 and 2018
  - `http://universaldependencies.org/conll18/results.html`
- UDPipe-Future on Czech PDT: MLAS = 85.10

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  - POS tagging: F = 99.01

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  - Feature values: F = 96.85

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  - Feature values: F = 96.85
  - Labeled dependency relations: F = 90.32

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  - Word segmentation: F = 94.53

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  - Word segmentation: F = 94.53
  - Lemmatization: F = 93.78
  - POS tagging: F = 92.97
  - Feature values: F = 94.52
  - Labeled dependency relations: F = 83.11

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  - POS tagging: F = 92.97
  - Feature values: F = 94.52
  - Labeled dependency relations: F = 83.11
- Stanford on English EWT: MLAS = 76.33

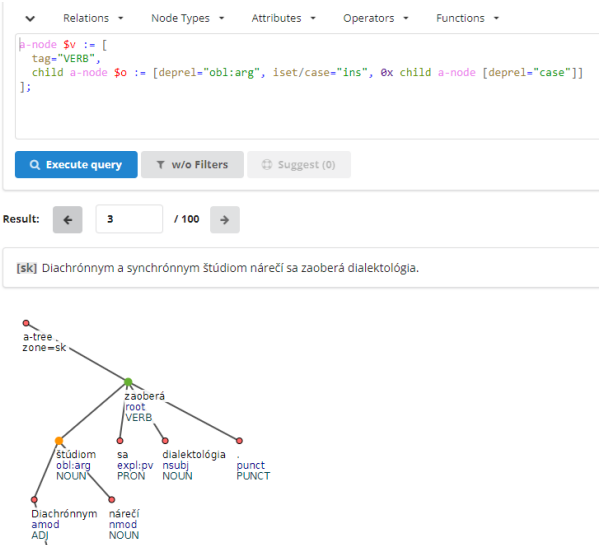
Off-the-Shelf Tools

- UDPipe (`https://lindat.mff.cuni.cz/services/udpipe/`)
  - `https://ufal.mff.cuni.cz/udpipe`
- Stanza (`https://stanfordnlp.github.io/stanza/`)

Use in Digital Humanities

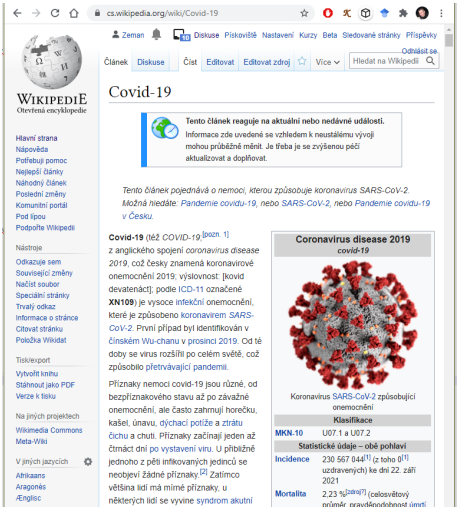
Linguists Can Search Treebanks

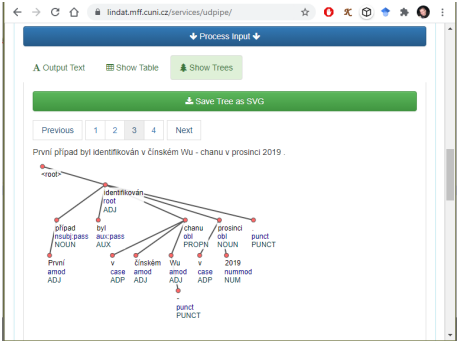
https://lindat.mff.cuni.cz/services/pmltq/



Linguists Can Parse and Search New Data

`https://lindat.mff.cuni.cz/services/udpipe/`



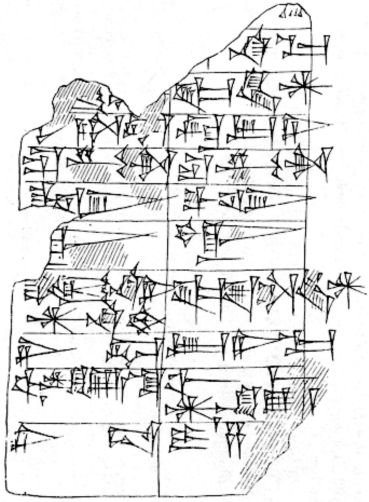


Language Learning

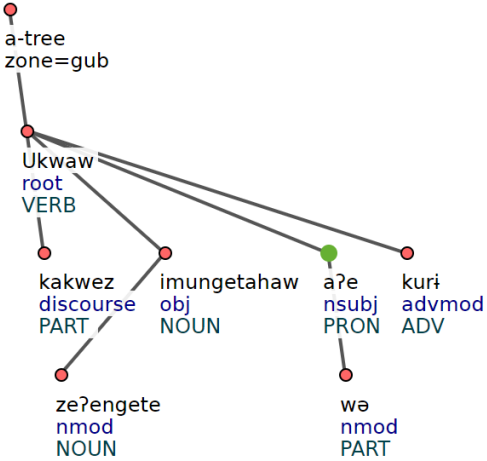
- Check grammar usage in the corpus
- Learner corpora

Historical Linguistics, Classical Languages

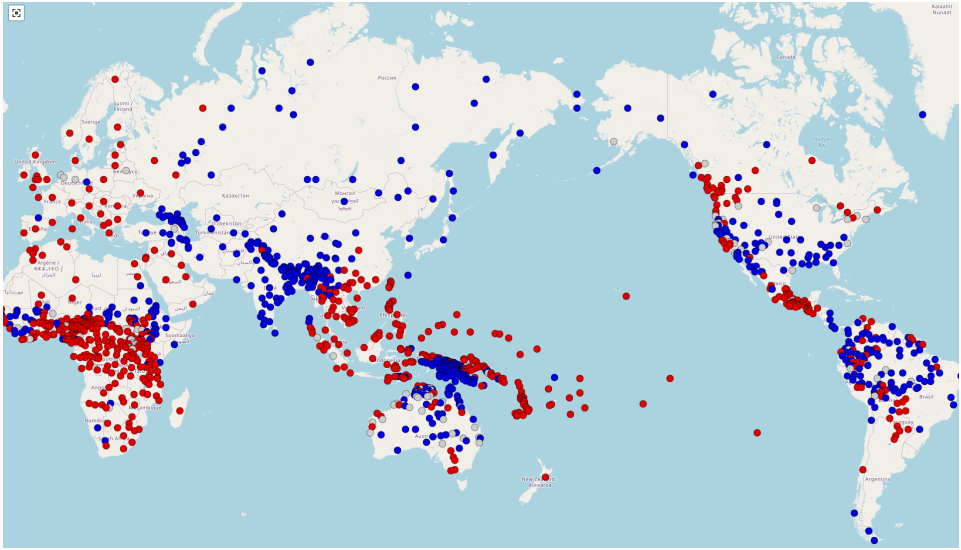
- Old Turkish
- Classical Chinese
- Sanskrit
- Akkadian
- Coptic
- Ancient Greek
- Latin
- Old French
- Gothic
- Old Church Slavonic
- Old East Slavic



Documentation of Endangered Languages



Linguistic Typology



Linguistic Typology

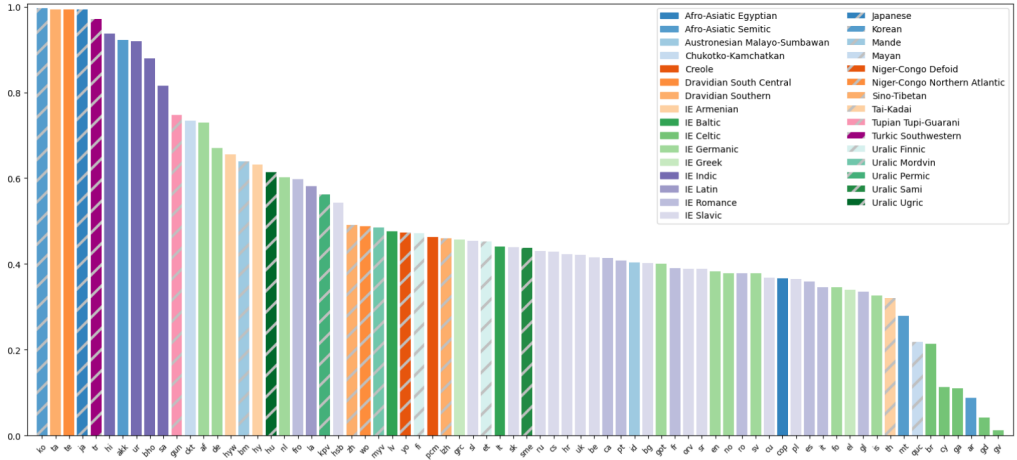
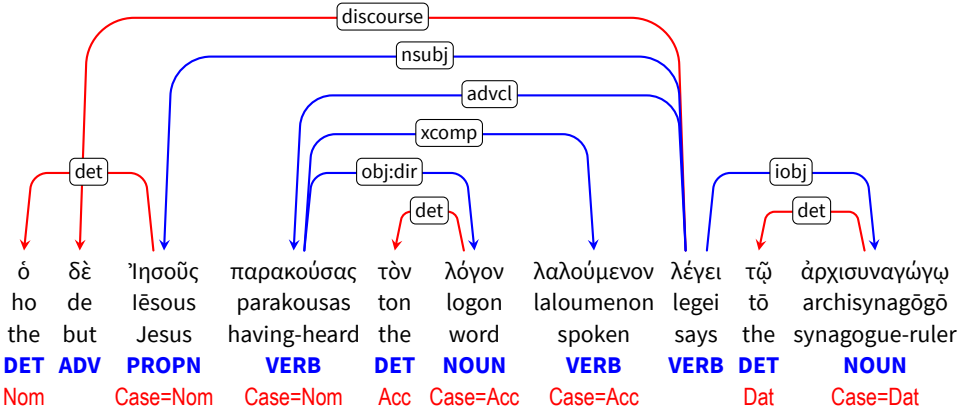


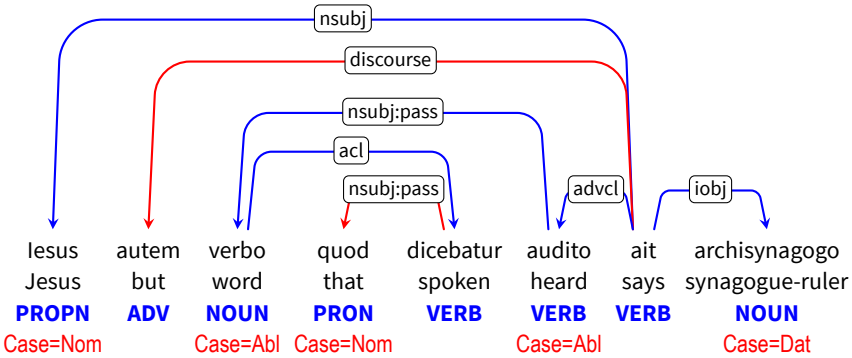
Figure 7 Percentage of head-final dependencies. Each bar is one language.

UD Ancient Greek PROIEL



“But overhearing what they said, Jesus said to the ruler of the synagogue” (Mark 5:36)

UD Latin PROIEL



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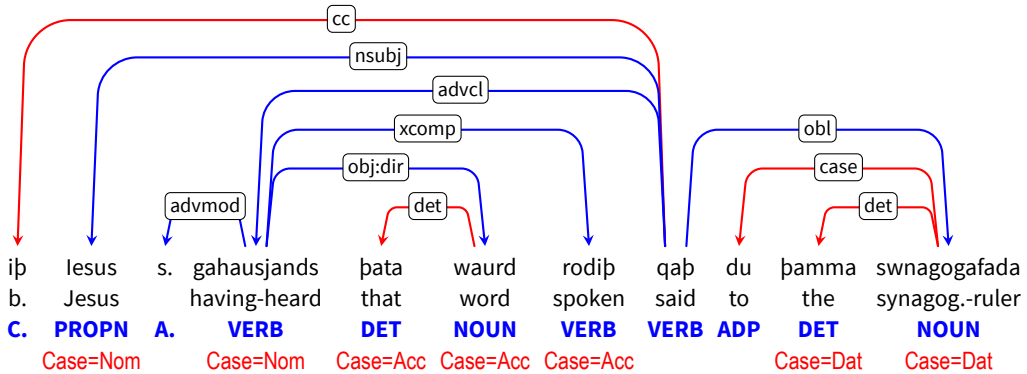
UD Gothic PROIEL



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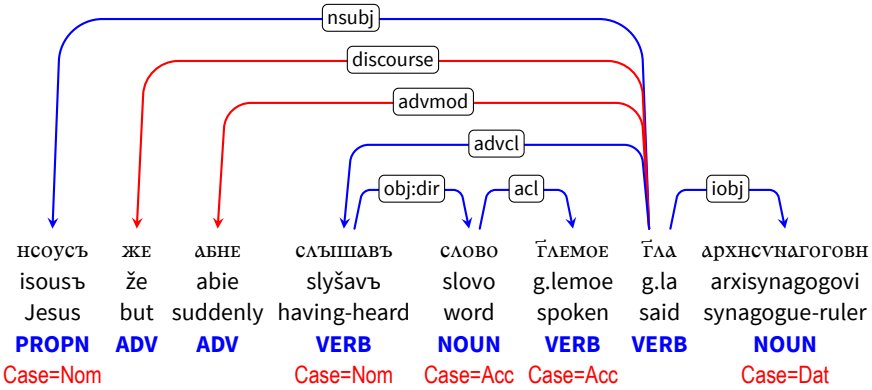
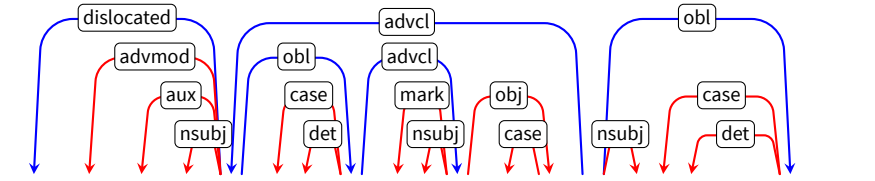
UD Old Church Slavonic PROIEL



“But overhearing what they said, Jesus said to the ruler of the synagogue” (Mark 5:36)

UD Coptic Scriptorium



iêsous de nterefsôtm epšače efčô mmof pečaf mparkʰisunagôgos

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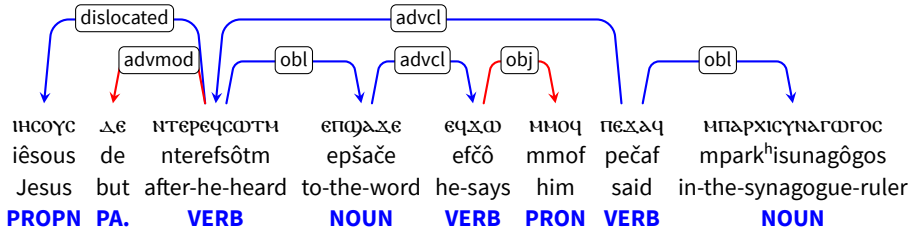

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Language Change

- Classical Latin → Medieval Latin → Old French → Modern French
  - or Catalan, Spanish, Galician, Portuguese, Italian, Romanian…

Language Change

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  - or Catalan, Spanish, Galician, Portuguese, Italian, Romanian…
- Old Church Slavonic → Old East Slavic → Russian
  - or Ukrainian, Belarusian, Polish, Upper Sorbian, Czech, Slovak, Slovenian, Croatian, Serbian, Bulgarian…

Language Change: The Slavic L-participle

- Past tense in modern East Slavic: -l / -la / -lo / -li, “finite” (no auxiliary).
- Past tense / active (“l”-)participle in West Slavic: auxiliary in 1st and 2nd persons. Also used in conditional mood.
- L-participle in Slovenian: auxiliary in all persons. Used for past, future and conditional.
- L-participle in old Slavic: perfect (resultative) aspect, and conditional.

она	пришла	к	нему
ona	prišla	k	nemu
she	came	to	him
PRON	**VERB**	**ADP**	**PRON**
	VerbForm=Fin		
	Tense=Past		

я	хотел	бы	поблагодарить
ja	hotel	by	poblagodarit’
I	like	would	to-thank
PRON	**VERB**	**AUX**	**VERB**
	VerbForm=Fin		VerbForm=Inf
	Tense=Past		

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přišel	jsi	nás	zabít
came	you-have	us	to-kill
VERB	**AUX**	**PRON**	**VERB**
VerbForm=Part	VerbForm=Fin		VerbForm=Inf
Tense=Past	Tense=Pres		

přišel	nás	zabít
he-came	us	to-kill
VERB	**PRON**	**VERB**
VerbForm=Part		VerbForm=Inf
Tense=Past		

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přišel	by	nás	zabít
came	he-would	us	to-kill
VERB	**AUX**	**PRON**	**VERB**
VerbForm=Part	VerbForm=Fin		VerbForm=Inf
Tense=Past	Mood=Cnd		

přišel	nás	zabít
he-came	us	to-kill
VERB	**PRON**	**VERB**
VerbForm=Part		VerbForm=Inf
Tense=Past		

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daleč	boste	prišli	prišel	je	do	ugotovitve
far	you-will	come	come	he-has	to	conclusion
ADV	**AUX**	**VERB**	**VERB**	**AUX**	**ADP**	**NOUN**
	VerbForm=Fin	VerbForm=Part	VerbForm=Part	VerbForm=Fin		
	Tense=Fut			Tense=Pres		

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прншелъ	есн	погоубнтъ	насъ	да	не	бн	отъшелъ	отъ	нихъ
prišelъ	jesi	pogubitъ	nasъ	da	ne	bi	otъšelъ	otъ	nichъ
come	you-have	to-kill	us	that	not	would	leave	from	them
VERB	**AUX**	**VERB**	**PRON**	**SCONJ**	**PART**	**AUX**	**VERB**	**ADP**	**PRON**
VerbForm=Part	VerbForm=Fin	VerbForm=Inf				Fin	VerbForm=Part		
Aspect=Res	Tense=Pres					Cnd	Aspect=Res		

Summary

- Over the last 7 years, UD has become very popular in computational linguistics
- Annotated data now exist for languages for which it was unthinkable before

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- Common annotation scheme for typologically diverse languages
- Easier processing and searching
- Cross-linguistic studies possible

455 Contributors

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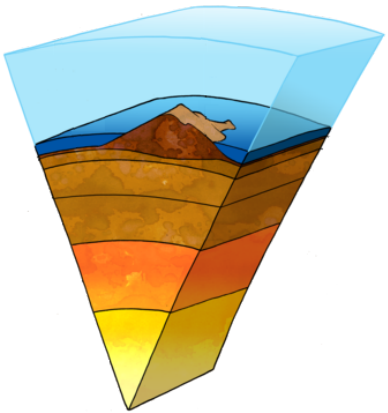
Thanks!
ありがとう！

https://universaldependencies.org/

Closer to Meaning: Enhanced and Deep UD

Multiple Layers of Dependencies



Form

- Surface syntax
- Deep syntax
- Semantics

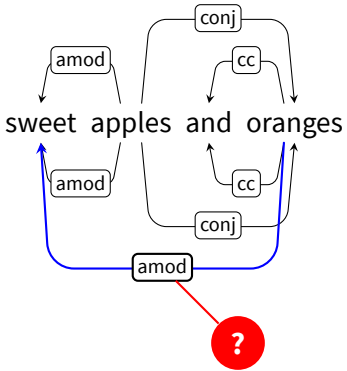
Meaning

Enhanced Universal Dependencies

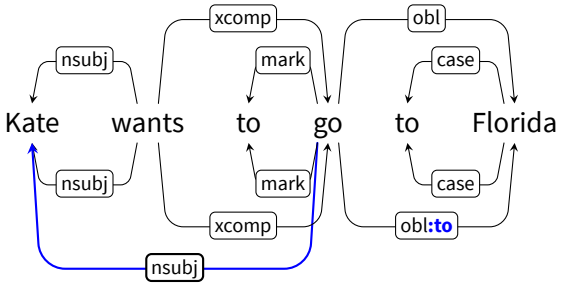
Currently available (at least partially) for 18 languages:

 Arabic,  Belarusian,  Bulgarian,  Chukchi,  Czech,  Dutch,  English,
 Estonian,  Finnish,  Italian,  Latvian,  Lithuanian,  Polish,  Russian,  Slovak,
 Swedish,  Tamil,  Ukrainian

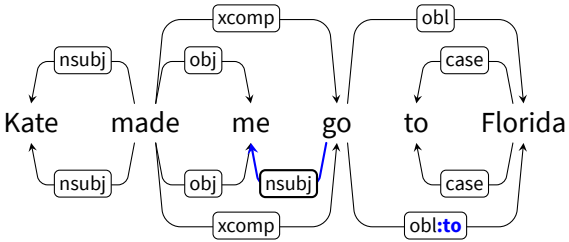
Enhanced UD: Shared Dependent of Coordination



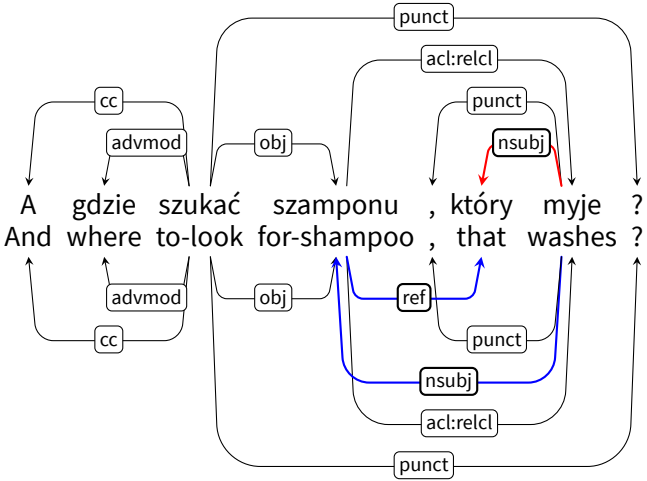
Enhanced UD: External Subject of Controlled Predicate



Enhanced UD: External Subject in Object-Control Construction

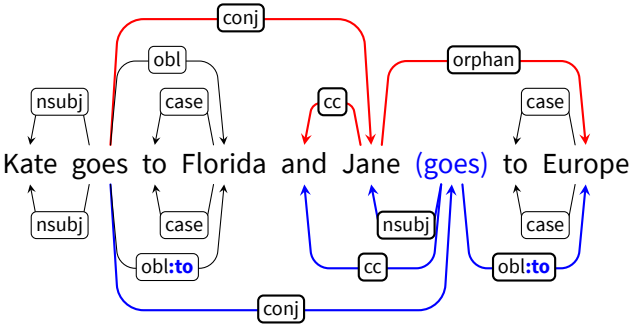


Enhanced UD: Relative Clauses

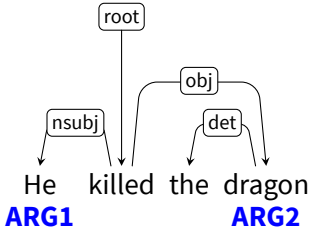


“And where to look for shampoo that works?”

Enhanced UD: Gapping and Stripping



Deep UD: Normalization of Syntactic Alternations



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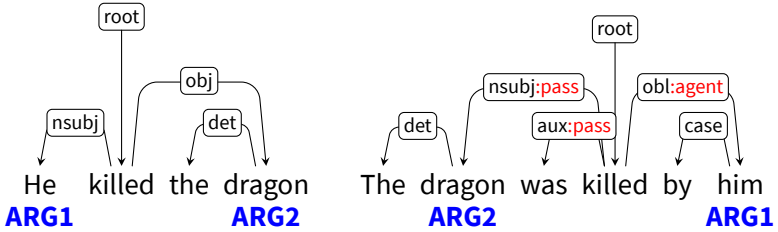

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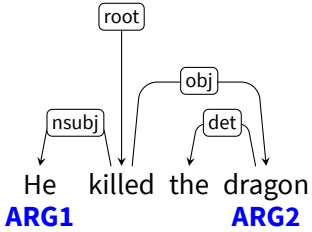

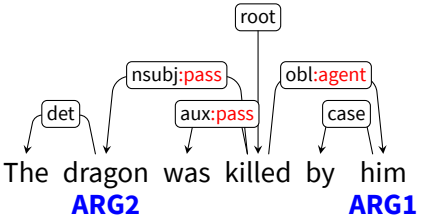

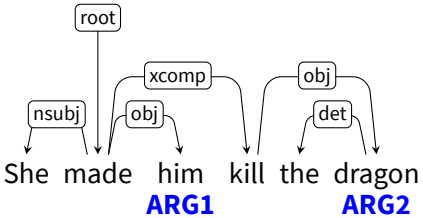

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