Tutorial on Universal Dependencies

Word segmentation and morphological annotation

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Morphological Annotation in UD

- Tokenization / word segmentation

- Lemmatization
- Universal part-of-speech tags
- Universal features
- Language-specific features

Tokenization

“María, I love you!” Juan exclaimed.

«¡María,	**te**	**amo!»,**	**exclamó**	**Juan.**
X	**PRON**	**X**	**VERB**	**X**

«	**¡**	**María**	**,**	**te**	**amo**	**!**	**»**	**,**
PUNCT	**PUNCT**	**PROPN**	**PUNCT**	**PRON**	**VERB**	**PUNCT**	**PUNCT**	**PUNCT**

- Classic tokenization:
  - Separate punctuation from words
  - Recognize certain clusters of symbols like “...”
  - Perhaps keep together things like `user@mail.x.edu`

Word Segmentation

Let's go to the sea.

Vámonos	**al**	**mar**	**.**	**Vamos**	**nos**	**a**	**el**	**mar**	**.**
VERB?	**X**	**NOUN**	**PUNCT**	**VERB**	**PRON**	**ADP**	**DET**	**NOUN**	**PUNCT**

- **Syntactic word** vs. orthographic word
- **Multi-word tokens**
- Two-level scheme:
  - Tokenization (low level, punctuation, concatenative)
  - Word segmentation (higher level, not necessarily concatenative)

Word Segmentation

- Lexicalist hypothesis:
  - Words (not morphemes) are the basic units in syntax
  - Words enter in dependency relations
  - Words are forms of lemmas and have morphological features

- Orthographic vs. syntactic word
  - Syntactically autonomous part of orthographic word
  - Contractions *(al = a + el)*
  - Clitics *(vámonos = vamos + nos)*
    - *¿A qué hora nos vamos mañana?*
    - *Nos despertamos a las cinco.*
      "We wake up at five."
    - *Nuestro guía nos despierta a las cinco.*
      "Our guide wakes us up at five."

Contractions in Arabic

He abdicated in favour of his son Baudouin.

يتنازل	عن	العرش	لابنه	بودوان
yatanāzalu	**^{c}an**	**al-^{c}arši**	**li+ibni+hi**	**būdūān**
surrendered	**on**	**the throne**	**to son his**	**Baudouin**
VERB	**ADP**	**NOUN**	**ADP+NOUN+PRON**	**PROPN**

Chinese Word Segmentation

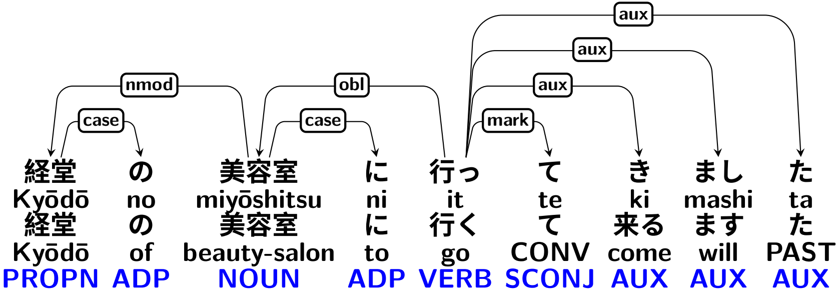
We are now in Valencia.

現在我們在瓦倫西亞。
Xiàn zài wǒ men zài wǎ lún xī yǎ.
We are now in Valencia.

現在	**我們**	**在**	**瓦倫西亞**	**。**
Xiànzài	**wǒmen**	**zài**	**Wǎlúnxīyǎ**	**.**
Now	**we**	**in**	**Valencia**	**.**
ADV	**PRON**	**ADP**	**PROPN**	**PUNCT**

Words in Japanese

I went to the beauty salon of Kyōdō [, Beyond-R.]



nmod
case
obl
case
aux
aux
aux
mark

経堂	の	美容室	に	行っ	て	き	まし	た
Kyōdō	no	miyōshitsu	ni	it	te	ki	mashi	ta
経堂	の	美容室	に	行く	て	来る	ます	た
Kyōdō	of	beauty-salon	to	go	CONV	come	will	PAST
PROPN	ADP	NOUN	ADP	VERB	SCONJ	AUX	AUX	AUX

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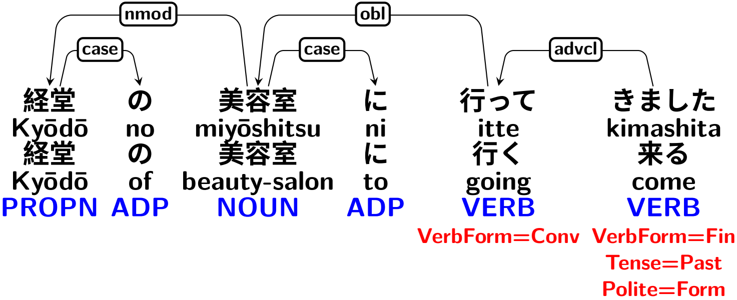

経堂	の	美容室	に	行って	きました
Kyōdō	no	miyōshitsu	ni	itte	kimashita
経堂	の	美容室	に	行く	来る
Kyōdō	of	beauty-salon	to	going	come
PROPN	ADP	NOUN	ADP	VERB	VERB
				VerbForm=Conv	VerbForm=Fin Tense=Past Polite=Form

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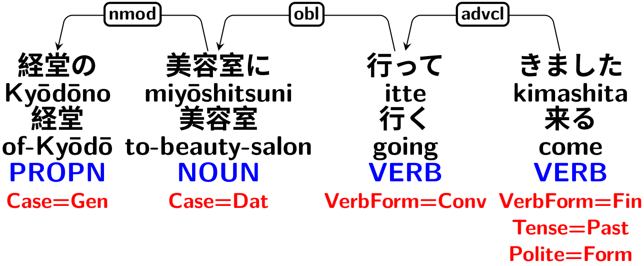

nmod obl advcl

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Kyōdōno	miyōshitsuni	itte	kimashita
経堂	美容室	行く	来る
of-Kyōdō	to-beauty-salon	going	come
PROPN	NOUN	VERB	VERB

Case=Gen	Case=Dat	VerbForm=Conv	VerbForm=Fin
			Tense=Past
			Polite=Form

Vietnamese: Words with Spaces

All the concrete country roads are the result of...

Tất cả	**đường**	**bêtông**	**nội đồng**	**là**	**thành quả**	**...**
All	**road**	**concrete**	**country**	**is**	**achievement**	**...**
PRON	**NOUN**	**NOUN**	**NOUN**	**AUX**	**NOUN**	**PUNCT**

- Spaces delimit monosyllabic morphemes, not words.
- Multiple syllables without space occur in loanwords *(bêtông).*
- Spaces are allowed to occur word-internally in Vietnamese UD.

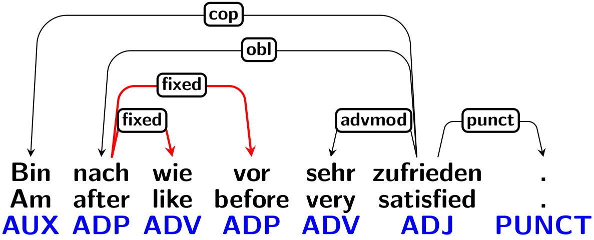
Numbers with Spaces

```
#   text = Il touche environ 100 000 sesterces par an.
1   Il         il        PRON    ...  2  nsubj    _ _
2   touche     toucher   VERB    ...  0  root     _ _
3   environ    environ   ADV     ...  4  advmod   _ _
4   100 000    100 000   NUM     ...  5  nummod   _ _
5   sesterces  sesterce  NOUN    ...  2  obj      _ _
6   par        par       ADP     ...  7  case     _ _
7   an         an        NOUN    ...  2  obl      _ SpaceAfter=No
8   .          .         PUNCT   ...  2  punct    _ _
```

Fixed Expressions

One syntactic word spans several orthographic words?

I am still very satisfied.



Bin	nach	wie	vor	sehr	zufrieden	.
Am	after	like	before	very	satisfied	.
AUX	ADP	ADV	ADP	ADV	ADJ	PUNCT

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  - Border case? Keep orthographic words (if they exist).
  - **Splitting clitics is not mandatory!**
    - Just because something is clitic does not mean it cannot be captured by features.

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- Words with spaces
  - Vietnamese writing system
  - Very restricted set of exceptions (numbers)
  - Special relations elsewhere (`fixed`, `compound`)

Recoverability: CoNLL-U Format

# text = Vámonos al mar.
# text_en = Let's go to the sea.

ID	FORM	LEMMA	UPOS	...	HEAD		_	MISC
1-2	Vámonos	_	_	...	_	_	_	_
1	Vamos	ir	VERB	...	0	root	_	_
2	nos	nosotros	PRON	...	1	obj	_	_
3-4	al	_	_	...	_	_	_	_
3	a	a	ADP	...	5	case	_	_
4	el	el	DET	...	5	det	_	_
5	mar	mar	NOUN	...	1	obl	_	SpaceAfter=No
6	.	.	PUNCT	...	1	punct	_	_

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ID	**FORM**	**LEMMA**	**UPOS**	...	**HEAD**		_	**MISC**
1-2	Vámonos	_	_	...	_	_	_	_
1	Vamos	ir	VERB	...	0	root	_	_
2	nos	nosotros	PRON	...	1	obj	_	_
3-4	al	_	_	...	_	_	_	_
3	a	a	ADP	...	5	case	_	_
4	el	el	DET	...	5	det	_	_
5-6	**mar.**	_	_	...	_	_	_	_
5	mar	mar	NOUN	...	1	obl	_	_
6	.	.	PUNCT	...	1	punct	_	_

Tokenization vs. Multi-word Tokens Summary

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- Boundary between two letters? Typically high level.
  - Exceptions: Chinese, Japanese.
- Non-concatenative? High level!

Lemmas

- Basic or citation form (⇒ it is an existing word in most cases)
- Disambiguating ids, if available, go to MISC
- Derivational vs. inflectional morphology (if participles are ADJ, their lemma should not be infinitive)

Lemmas

within a year Algeria will become an islamic state

13	do	do	ADP	...	LId=do-1
14	roka	rok	NOUN	...	_
15	se	se	PRON	...	LGloss=(zvr._zájmeno/částice)
16	Alžírsko	Alžírsko	PROPN	...	_
17	stane	stát	VERB	...	LId=stát-2
18	islámským	islámský	ADJ	...	_
19	státem	stát	NOUN	...	LId=stát-1|LGloss=(státní_útvar)|SpaceAfter=No

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Part-of-Speech Tags

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

- 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!

Part-of-Speech Tags

- Traditionally a mixture of morphological, syntactic/distributional and semantic/notional criteria
- Prefer grammatical > semantic criteria
  - Language-particular definition of a category
- But the **name** of the category is universal
  - Translated words: overlapping categories, but not perfect match
    - UPOS of English *dog* is **NOUN**; so is French *chien* or Russian *собака*
- Preferably POS is encoded in lexicon, not heavily usage-dependent
  - But not for incompatible syntactic functions (e.g. **PRON** vs. **SCONJ**)

Features

Lexical	Inflectional (“Nominal”)	Inflectional (“Verbal”)
PronType	**Gender**	**VerbForm**
NumType	**Animacy**	**Mood**
Poss	**NounClass**	**Tense**
Reflect	**Number**	**Aspect**
Foreign	**Case**	**Voice**
Abbr	**Definite**	**Evident**
Typo	**Degree**	**Polarity**
		Person
		Polite
		Clusivity

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

Language-Specific Features

Three types of infinitives in Finnish:
Example: *olla* “to be”

1st	2nd	3rd
olla	ollessa	olemassa
	ollen	olemaan
		olemasta
		olemalla
		olematta

Language-Specific Features

Joku	**yrittää**	**piristää**	**itseään**	**värjäämällä**	**hiuksensa**
Someone	**tries**	**to-uplift**	**oneself**	**by-staining**	**their-hair**
PRON	**VERB**	**VERB**	**PRON**	**VERB**	**NOUN**
	VerbForm=Fin	**VerbForm=Inf**		**VerbForm=Inf3**	
	Mood=Ind			**Case=Ade**	
	Tense=Pres				

Language-Specific Features

Joku	yrittää	piristää	itseään	värjäämällä	hiuksensa
Someone	tries	to-uplift	oneself	by-staining	their-hair
PRON	VERB	VERB	PRON	VERB	NOUN
	VerbForm=Fin	VerbForm=Inf		VerbForm=~~Inf3~~	
	Mood=Ind			Case=Ade	
	Tense=Pres				

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Someone	tries	to-uplift	oneself	by-staining	their-hair
PRON	VERB	VERB	PRON	VERB	NOUN
	VerbForm=Fin	VerbForm=Inf		VerbForm=Inf	
	Mood=Ind	InfForm=1		InfForm=3	
	Tense=Pres			Case=Ade	

Layered Features

Czech adjectives agree with nouns in gender.

velký	**bratr**
big	**brother**
ADJ	**NOUN**
Gender=Masc	**Gender=Masc**

velká	**sestra**
big	**sister**
ADJ	**NOUN**
Gender=Fem	**Gender=Fem**

Layered Features

Possessive adjectives: agreement gender vs. lexical gender

otcův	**bratr**
father's	**brother**
ADJ	**NOUN**
Gender=Masc	**Gender=Masc**
Gender[psor]=Masc	

matčin	**bratr**
mother's	**brother**
ADJ	**NOUN**
Gender=Masc	**Gender=Masc**
Gender[psor]=Fem	

otcova	**sestra**
father's	**sister**
ADJ	**NOUN**
Gender=Fem	**Gender=Fem**
Gender[psor]=Masc	

matčina	**sestra**
mother's	**sister**
ADJ	**NOUN**
Gender=Fem	**Gender=Fem**
Gender[psor]=Fem	

Multi-valued Features (Disjunction / Parallel Application)

- Feature can have two or more values
- Interpreted as disjunction
- Example: in some languages, many pronouns function both as interrogative and relative, but some pronouns are only relative. The former will have **PronType=Int,Rel**
- In other cases, it is desirable to disambiguate by context. Polish *którym* (form of *który* "which") can be **Case=Ins**, **Loc** in singular or **Dat** in plural but we do not want to annotate **Case=Dat,Ins,Loc**!
- All values of the feature/language? Omit the feature completely! Polish: ~~**Gender=Fem,Masc,Neut**~~. Spanish: ~~**Gender=Fem,Masc**~~

Multi-valued Features (Serial Application)

- Currently used in Turkish (language-specific values)

- Two or more morphemes in chain, affecting the same feature

- Example: **Voice=CauPass** (causative + passive => someone is caused to do something)
  - *yanıl* “be wrong”
  - *yanılmışım* **Voice=Act** “I was wrong”
  - *okuru yanılttığını* **Voice=Cau** “mislead the reader”
  - *okurlar yanıltılmıştır* **Voice=CauPass** “readers were misled”

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  - Hypothetical: **Voice=PassCau** (not used in Turkish) could mean "to cause something to be done by someone"

Features Apply to Individual Words

Future tense in Spanish and German: no **Tense=Fut** in German!

Dormirá	**Er**	**wird**	**schlafen**
He-will-sleep	**He**	**will**	**sleep**
VERB	**PRON**	**AUX**	**VERB**
VerbForm=Fin	**PronType=Prs**	**VerbForm=Fin**	**VerbForm=Inf**
Mood=Ind	**Number=Sing**	**Mood=Ind**	
Tense=Fut	**Person=3**	**Tense=Pres**	
Number=Sing	**Gender=Masc**	**Number=Sing**	
Person=3	**Case=Nom**	**Person=3**	

Participle Types

некурящий	человек
nekurjaščij	čelovek
non-smoking	person
ADJ	NOUN
VerbForm=Part	
Tense=Pres	
Gender=Masc	Gender=Masc
Number=Sing	Number=Sing
Case=Nom	Case=Nom

начавшийся	разговор
načavšijsja	razgovor
that-has-started	conversation
ADJ	NOUN
VerbForm=Part	
Tense=Past	
Gender=Masc	Gender=Masc
Number=Sing	Number=Sing
Case=Nom	Case=Nom

- Sometimes features like **Tense** help distinguish participle types
- Not the same tense as with finite verbs (reference point)
- But useful because:
  - We use known UD primitives rather than language-specific labels such as ~~VerbForm=PastPart~~, or even ~~ParticType=Past~~
  - Reasonably close to the grammatical meaning

Conflicting Traditional Terminologies

- If possible, stay compatible with traditional grammar
- Often it is not possible: terminology conflicts
- **VerbForm=Conv** – <u>*converb*</u>, *transgressive*, *adverbial participle*, *gerund*

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- **VerbForm=Conv** – *converb*, *transgressive*, *adverbial participle*, *gerund*
- *Gerund* (**VerbForm=Ger**)
  - English: close to verbal nouns (**VerbForm=Vnoun**)
  - Spanish: more like present participle (**VerbForm=Part | Tense=Pres**)
  - Slavic: converb (**VerbForm=Conv**)

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  - Slavic: converb (**VerbForm=Conv**)
- *Aorist*
  - Ancient Greek, Turkish: neutral non-past tense (they use a language-specific value **Tense=Aor**)
  - Slavic languages: simple past tense (**Tense=Past**)

Questions?

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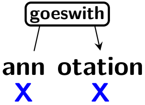
- Wrongly split word:



goeswith

ann **otation**

X **X**

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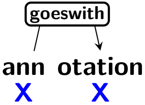

- Wrongly merged words: *thecar*
  - Fix tokenization (i.e. two lines); first line MISC: **SpaceAfter=No** | **CorrectSpaceAfter=Yes**
  - Sentence segmentation can be affected, too!

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- Suggestion: select which word to fix, e.g. *cars* to *car*
- FORM = *cars*; FEATS: **Number=Plur**; MISC: **Correct=car** | **CorrectNumber=Sing**
- cs: *viděl moři* “he saw the sea”
  - Should be *moře*
  - Would be **Case=Acc** (disambiguated from **Case=Acc,Gen,Nom,Voc**)
  - This form is **Case=Dat,Loc** (but which one?)
- *cestoval k moři* “he traveled to the sea” **Case=Dat**
- *plavil se po moři* “he sailed the sea” **Case=Loc**