Investigating Dominant Word Order on Universal Dependencies with Graph Rewriting

Café TAL

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Goal

Determine a dominant word order of **Subject (S), Object (O), Verb (V)** on **74 languages (141 corpora)** of **Universal Dependencies** (UD) using **GREW**, a Graph Rewriting tool and compare our results with other references.

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Motivations

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- Utility of linguistic typology in NLP [Bender, 2016, O'Horan et al., 2016]:
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- Universal annotations of UD allow typological experiments on several languages

Methodology

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- Corpus level to observe variations between corpora of a given language:
  → 29 languages with more than one corpus
  → 45 languages with only one corpus

Defining a Dominant Word Order

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- The most frequent order considered as the dominant order if it is **at least twice as frequent** as the next most frequent:
  → ratio ≥ 2: the most frequent order is the dominant order
  → ratio < 2: No Dominant Order (NDO)

Using Graph Rewriting

GREW: Graph Rewriting Tool

Graph rewriting tool dedicated to NLP applications

- Query corpora using graph patterns
- Count the occurrences of each pattern in each corpus

GREW pattern for SVO order:

```
pattern {
    V [upos=VERB];
    V -[1=nsubj]-> S;
    V -[1=obj]-> O;
    S << V; V << O
}
```

Limits of UD annotations

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- The subject and the object may not be related to the same verb

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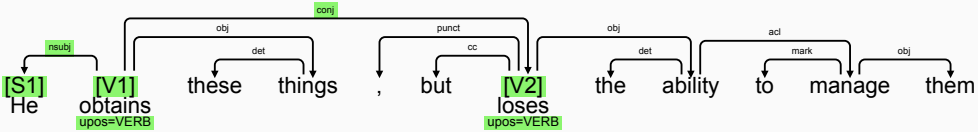

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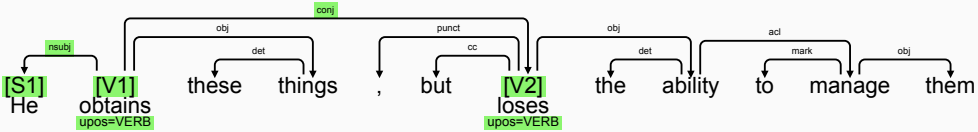
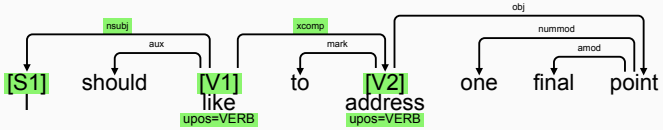


- Control or raising:



Results

Dominant Word Order in Multi-Corpora Languages

Intra-language Consistency

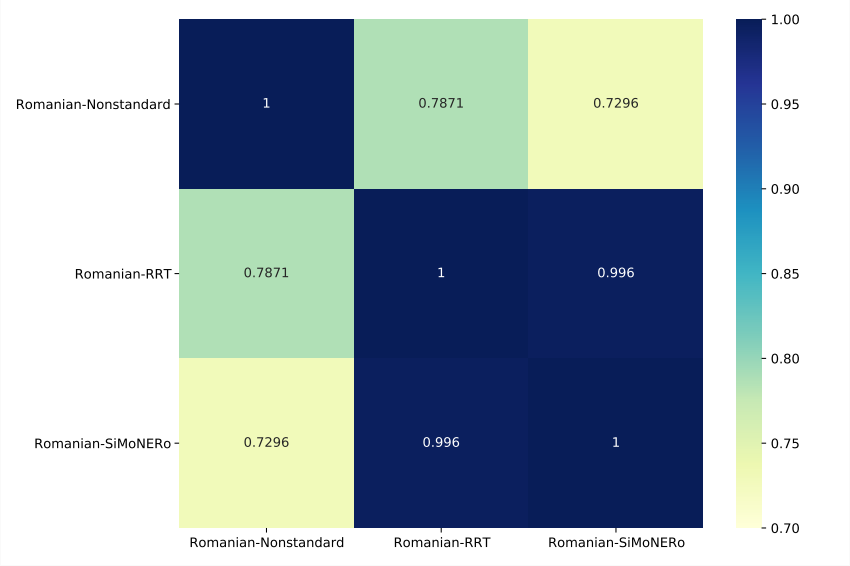
- Corpora as vectors with the frequencies of the six orders

	SVO	SOV	VSO	VOS	OSV	OVS
Romanian_Nonstandard	**38.07%**	**31.87%**	9.66%	3.97%	1.71%	14.72%
Romanian_RRT	**85.32%**	7.76%	1.12%	0.70%	1.18%	3.91%
Romanian_SiMoNERo	**97.61%**	0.97%	0.09%	0.09%	0.13%	1.10%

Distribution vectors for the Romanian corpora.

- Computing the cosine between the vectors for each corpus
- Cosine value close to 1 when two corpora display similar distributions

Intra-language Consistency



Cosine values between the three Romanian corpora in UD 2.7_{1K}.

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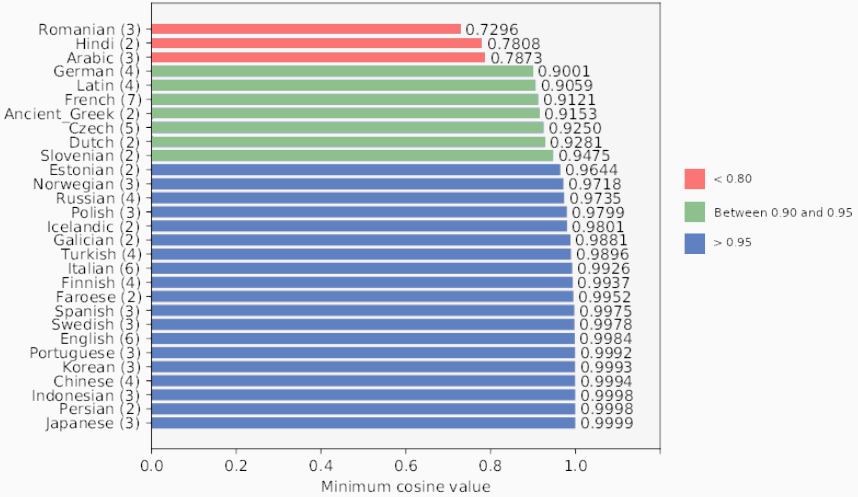

Multi-corpora (nb in parenthesis) languages ordered by minimum cosine value.

Basic Analysis

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- Different text periods: `Latin`, `Ancient Greek`, `German-LIT`
- Non-standard annotations: `Hindi-HDTB` where the object is a verb
- Language specifics: `Arabic-PADT` with topicalization

Comparison with other sources

Comparison with WALS

59 languages in common, same dominant word order for 48

Language	UD 2.7_{1K}	WALS
Amharic	**1 NDO**	**SOV**
Arabic	1 VSO, 2 NDO	VSO
Belarusian	**1 SVO**	**NDO**
Estonian	1 SVO, 1 NDO	SVO
German	2 SOV, 2 NDO	NDO
Greek	**1 SVO**	**NDO**
Hindi	1 SOV, 1 NDO	SOV
Mbya Guarani	**1 NDO**	**SVO**
Romanian	2 SVO, 1 NDO	SVO
Slovenian	1 SVO, 1 NDO	SVO
Urdu	**1 NDO**	**SOV**

Differences with WALS.

Comparison with Östling [Östling, 2015]

- Word order typology based upon the translated and aligned New Testament
- 52 languages in common, same dominant order for 38

Language	UD 2.7_{1K}	Östling
Amharic	**1 NDO**	**SOV**
Ancient Greek	2 NDO	SVO
Armenian	1 NDO	SVO
Basque	**1 SOV**	**SVO**
Dutch	2 NDO	SOV
Estonian	1 SVO, 1 NDO	SVO
German	2 SOV, 2 NDO	SOV
Hindi	1 SOV, 1 NDO	SOV
Hungarian	1 NDO	SVO
Latin	1 SOV, 3 NDO	SVO
Mbya Guarani	1 NDO	SVO
Romanian	2 SVO, 1 NDO	SVO
Slovenian	1 SVO, 1 NDO	SVO
Welsh	**1 VSO**	**SVO**

Differences with Östling.

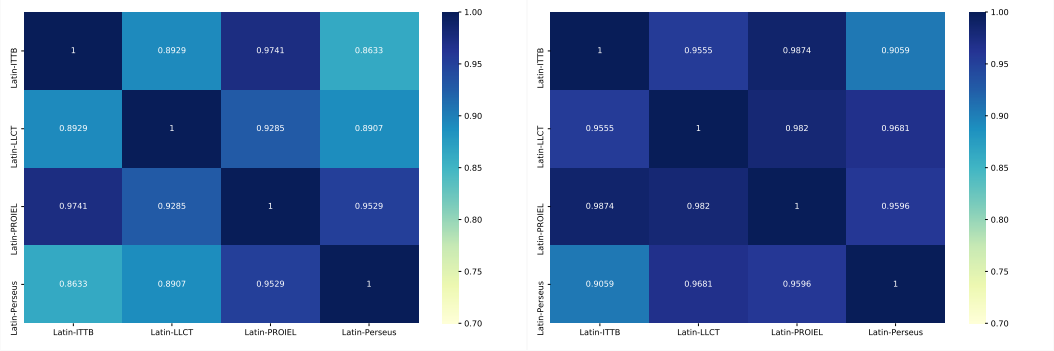
Influence of Implicit Subjects

Comparison with/without isubj

		Without isubj		With isubj	
Language	Corpora	Order	Ratio	Order	Ratio
Czech	CAC	SVO	4.27	SVO	5.28
	CLTT	SVO	6.85	SVO	8.18
	FicTree	**NDO (SVO/SOV)**	**1.97**	**SVO**	**2.20**
	PDT	SVO	3.36	SVO	3.96
	PUD	SVO	6.58	SVO	6.17
Estonian	EDT	SVO	3.80	SVO	3.19
	EWT	**SVO**	**2.05**	**NDO (SVO/SOV)**	**1.70**
German	GSD	NDO (SOV/SVO)	1.03	NDO (SOV/SVO)	1.03
	HDT	**NDO (SOV/SVO)**	**1.87**	**SOV**	**2.01**
	LIT	SOV	2.30	SOV	2.53
	PUD	NDO (SOV/SVO)	1.47	NDO (SOV/SVO)	1.62
Latin	ITTB	NDO (SVO/SOV)	1.22	NDO (SVO/SOV)	1.12
	LLCT	**NDO (OSV/SVO)**	**1.07**	**NDO (SOV/SVO)**	**1.40**
	PROIEL	NDO (SOV/SVO)	1.21	NDO (SOV/SVO)	1.16
	Perseus	SOV	2.42	SOV	2.17

Corpora for which the word order changes with/without isubj and associated ratio.

Comparison with/without isubj



Cosine values between the Latin corpora, without isubj on the left, with isubj on the right.

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- They can be used to NLP applications or to complete databases:
  → WALS does not cover dead-languages
  → WALS does not provide feature 81A for six languages: Faroese, Galician, Kazakh, Maltese, Naija and Slovak

Conclusion

- Results obtained on UD corpora consistent with typology databases
- They can be used to NLP applications or to complete databases:
  → WALS does not cover dead-languages
  → WALS does not provide feature 81A for six languages: Faroese, Galician, Kazakh, Maltese, Naija and Slovak
- GREW useful to query UD corpora and to overcome limits of UD annotations

Thank you for your attention

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GREW rule for isubj

```
rule conj {
    pattern {
        V1 [upos=VERB]; V2 [upos=VERB];
        V1 -[1=conj]-> V2;
        V1 -[1=nsubj]-> S1;
    }
    without { V2 -[1=nsubj]-> S2; }
    commands { add_edge V2 -[isubj]-> S1; }
}
```

GREW rule adding the isubj relation.