Multilingual Named Entity Recognition with SpaCy and Stanza

A comparison of two NLP tools

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1. Introduction

Investigate runtime, accuracy and differences on **NER**

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Using Spanish and English data

- **Europarl corpus** (parallel, annotated)
- **OpenSubtitles** (largely parallel, unannotated)

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Stanza slower in all instances

SpaCy is slightly less accurate in English, but does a large amount of mistakes on Spanish data

2. Data and Resources

Main source for NER: **“Evaluation Corpus for Named Entity Recognition using Europarl”**

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Europarl corpus:

- consists of transcriptions of European Parliament sessions
- plenty of various detailed sentences
- contain different entities
- 4 entity types: LOC, PER, ORG, MISC
- manually annotated by Nora Aranberri

```
Resumption      O
of      O
the     O
session O

I       O
declare O
resumed O
the     O
session O
of      O
the     O
European        B-ORG
Parliament      I-ORG
adjourned       O
on      O
Friday  O
17      O
December        O
1999    O
,       O
and     O
I       O
would   O
like    O
once    O
again   O
to      O
wish    O
```

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Movie subtitles from “opensubtitles.org”

- using subtitles from “Back to the Future” and “El Hoyo”
- everyday language is used
- largely parallel
- contain many names and places, also fictional ones
- unannotated

En octubre es tiempo inventario..

...y Statler Toyota esta
haciendo el mejor negocio del año...

...en todos los modelos Totoya de 1985....

...no va a encontrar un auto mejor...

...a un precio mejor con un mejor servicio
en cualquier lugar de Hill Valley.

El senado espera votar sobre
esto hoy.

En otras noticias, oficiales de las
instalaciones de investigación nuclear del pacifico...

...han negado el rumor
de que el caso de la perdida de...

...plutonio haya sido un robo
de sus instalaciones hace dos semanas...

Un grupo terrorista libio se ha
declarado responsable por el robo.

Sin embargo, los oficiales ahora
atribuyen la discrepancia a un simple error.

El FBI, que esta investigando el asunto,
no emitió comentarios.

¿Doc?

Software:

- Python version 3.11.4
- NLP libraries:
  - SpaCy v3.6
  - Stanza 1.4.0.
- SpaCy language models:
  - en_core_web_md in English
  - es_core_news_md in Spanish

SpaCy and **Stanza** over **NLTK**:

Unable to find on which data the language model is trained on, therefore we can’t prove that the data used in our project wasn’t used for the training.

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Also used the **re-library** for regular expressions.

3. Method (the Code)

- utils.py:
  - contains auxiliary methods
  - load the data
  - perform Named Entity Recognition
  - evaluate the results

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  - evaluate the results
- el_hoyo.py & back_to_the_future.py, europarl_en.py & europarl_es.py:
  - evaluations of the different files executed with the help of methods implemented in utils.py
  - results loaded into text files with respective file names, such as europarl_en_eval.txt

Duration of the Stanza NER in seconds: 413.985 sec

Accuracy of the Stanza NER in percent: 96.698 %

Differences:

Index	Word	Gold Label	Prediction
11	European	B-ORG	S-MISC
12	Parliament	I-ORG	O
55	millennium	B-MISC	O
56	bug	I-MISC	O
225	European	B-ORG	S-MISC
226	Parliament	I-ORG	O
253	Parliament	B-ORG	O
309	House	O	S-ORG
336	Rule	O	B-MISC
337	143	O	E-MISC
404	European	B-ORG	B-MISC

```
Duration of the SpaCy NER in seconds:  3.064 sec
Duration of the Stanza NER in seconds: 97.466 sec

Concordance of the SpaCy and Stanza in percent: 98.128 %

Differences:
```

Index	Word	Spacy Label	Stanza Label
94	Goreng	O	S-PER
205	Don	B-PER	O
507	Don	B-PER	O
528	Aren	O	S-PER
655	Isn	O	S-PER
673	Hotter	O	S-PER
817	QUIXOTE	B-ORG	O
941	Aren	O	S-PER
960	don	B-PER	O
1020	Samurai-Max	B-PER	S-MISC
1055	Samurai-Max	B-PER	S-MISC

4. Results

Data Source	*SpaCy runtime (in sec)*	*Stanza runtime (in sec)*	*Difference (in %)*
back_to_the_future_en	4.518	232.392	~ 5043%
back_to_the_future_es	4.152	220.313	~ 5206%
el_hoyo_en	3.064	97.466	~ 3078 %
el_hoyo_es	1.977	99.637	~ 4937.7 %

[Chart 1] Runtime comparison of SpaCy and Stanza on the subtitle files

Data source	*Total data points*	*Concordant predictions*	*Concordance (in %)*
el_hoyo_en	7427	7288	98.128 %
el_hoyo_es	7032	5621	79.935 %
back_to_the_future_en	13085	12798	97.807 %
back_to_the_future_es	11464	9346	81.525 %

[Chart 2] Concordance between Spacy and Stanza on the subtitle files

Data Source	*Tool*	*Total data points*	*Correct predictions*	*Accuracy (in %)*	*Runtime (in sec)*	*Runtime difference (in %)*
europarl_en	SpaCy	22320	21407	95.909 %	~7.473	5443.87%
	Stanza		21583	96.698 %	~413.985	
europarl_es	SpaCy	23279	20662	88.758 %	~7.12	7686.52%
	Stanza		22204	95.382 %	~554.904	

[Chart 3] Accuracy and runtime of SpaCy and Stanza on the Europarl corpus

Europarl - English

- problem with entities specific to context of the European Union, e.g. names of legal texts and organisations
- annotating salutations as PER
- not recognizing several names of persons
- recognizing capitalized words/multi word expressions as ORG

Europarl - Spanish

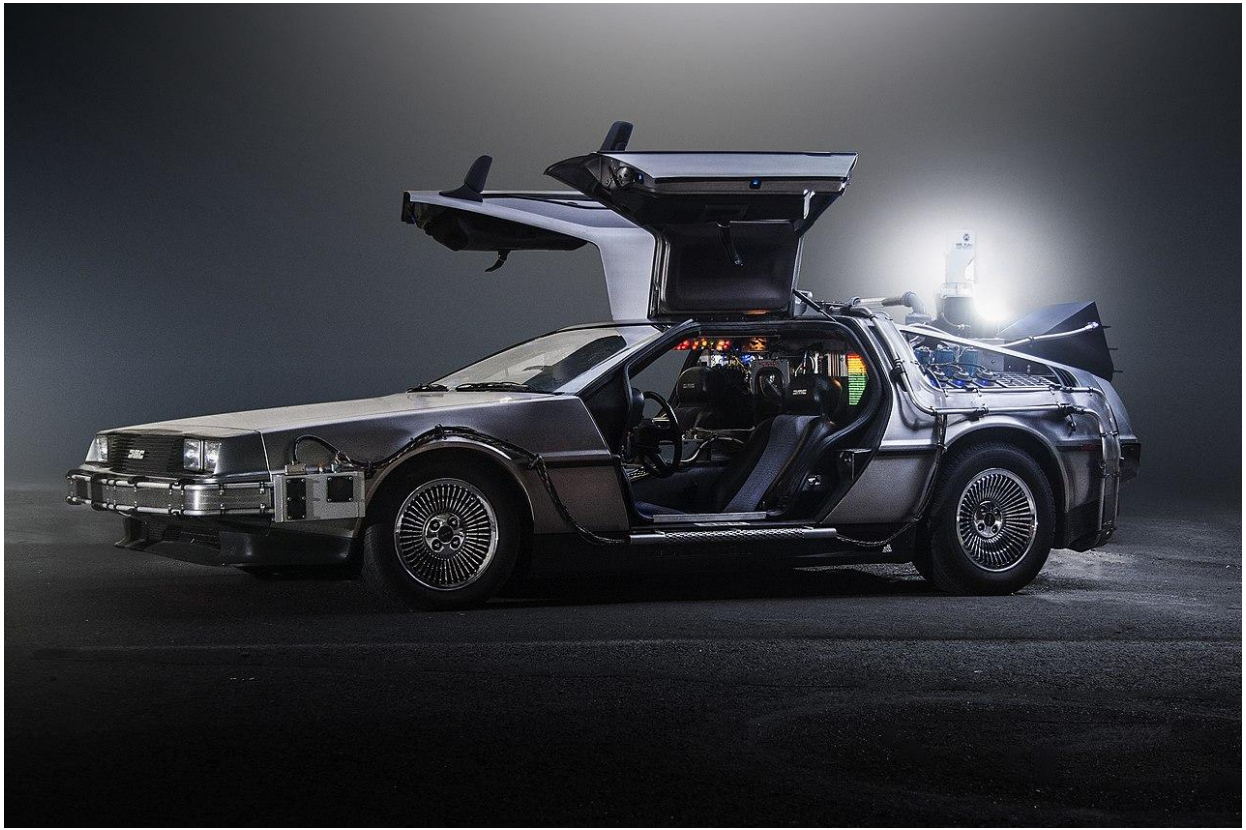
- Stanza: same errors like in English plus some additional cases
  - Russia labeled as ORG instead of LOC
  - declaring all other country adjectives non-entities (O) instead of MISC

Europarl - Spanish

- Stanza: same errors like in English plus some additional cases
  - Russia labeled as ORG instead of LOC
  - declaring all other country adjectives non-entities (O) instead of MISC
- SpaCy: shares errors and differences with Stanza, seemingly inexplicable mistakes occur as well
  - whole sentences labeled as MISC
  - non-entities recognized as persons

- SpaCy has problems recognizing names of persons: labeling non-entities as PER and some names as O
- both NLP tools struggle recognizing “Doc” (nickname of Doctor Emmett Brown) as PER
- specific names of the fictional characters, events and locations are difficult to recognize for SpaCy
- Stanza isn’t correctly labeling “DeLorean”
- SpaCy: labeling whole sentences in Spanish subtitles as MISC

Source: https://commons.wikimedia.org/wiki/File:Back-to-the-future-logo.svg



DeLorean time machine

Source: https://de.m.wikipedia.org/wiki/Datei:TeamTimeCar.com-BTTF_DeLorean_Time_Machine-OtoGodfrey.com-JMortonPhoto.com-07.jpg

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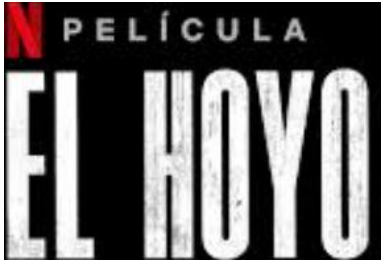

- SpaCy
  - labels in Spanish subtitles whole sentences and words that are not entities as MISC, LOC and PER
  - doesn't recognize names of the main characters Goreng and Trimagashi
- Stanza recognizes sometimes non-entities as PER

- SpaCy labels God and Christ as O, Stanza as PER

Source: https://www.netflix.com/de/title/81128579

5. Challenges and Open Issues

- it was difficult to ensure that both SpaCy and Stanza split the text data in the same way
- need to “post-process” predictions by SpaCy because of different tag set

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- need to “post-process” predictions by SpaCy because of different tag set
- more difficult than anticipated to find parallel annotated corpora for NER
- in future research, the NLTK NLP tool could be included in the comparison

6. Summary and Conclusion

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- English: much shorter runtime of SpaCy outweighs the only slightly improved accuracy of Stanza (less than 1% higher)
- Spanish: SpaCy produces large number of errors compared to Stanza and also many seemingly inexplicable labels
- Stanza offers extensive knowledge of fictional names, applies to both English and Spanish

7. Sources

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Thank you for your attention!