One Text / Two Languages

How linguists and programmers approach code-switching

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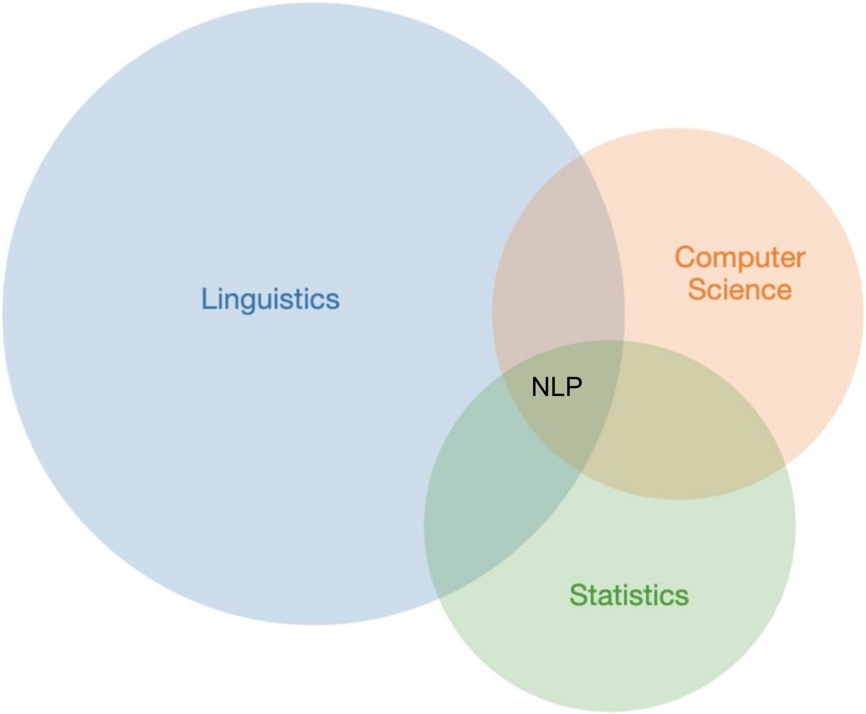
https://github.com/jserigos/One-Text-Two-Languages

Intro

About me and this workshop

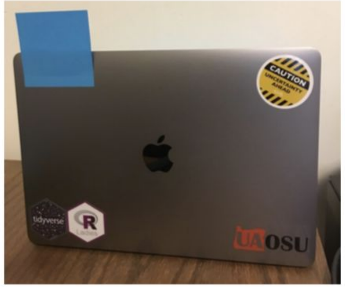


Goals of this workshop

1. Code-switching
2. NLP pipeline
3. Language Identification

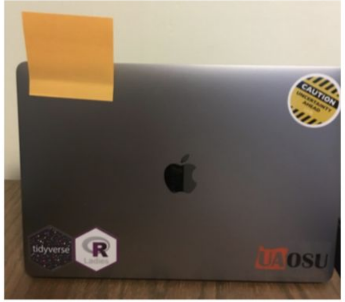
No sticky note: "I'm happily working on it"

Blue sticky note: "I'm all done and ready to move on"



Orange sticky note: "I'm stuck, can someone help me?"

Alternatively, flag one of us down



Your background in Natural Language Processing

No experience

Some experience

Lots of experience

Code switching

What is it?

Why does it occur?

Why does it matter?

Text 1

Hindi - English

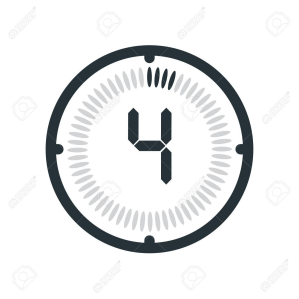
यहाँ पे मुझे कई बार थोड़ा अकेलापन लगते है क्योंकि दोस्त ही यहाँ family है, दोस्त ही परिवार है। जितने दोस्त हैं उन्ही के साथ आप कुछ समय बिता सकते हो और अपनी बातें share कर सकते हो, क्योंकि कोई immediate family या कोई direct family यहाँ तो है नहीं, तो मुझे ये लगता है कई बारी कि थोड़ा अकेलापन है, थोड़ा emotional support थोड़ी family support कम है यहाँ पे, जो कि India में थोड़ी easily available रहती है क्योंकि सब साथ में रहते हैं एक बड़े घर में, सब, पूरी family इकट्ठे रहेंगी। तो वो थोड़ा-सा missing लगता है।

Text 2

Spanish - English

La última vez que volví a Guadalajara, in 1997, para celebrar mi ternura, as I call it … —I know, ya sé, mamá. It's not the real word for it and I should speak right. La gente va a creer que I don't know right from wrong. Pero tú ya no estás para retarme, and I've always done my own thing anyway, que no?

Task 1 - What is code-switching?



For each text,

1. Underline all English tokens
2. Identify dominant language and embedded language
3. Classify words and phrase from the embedded language in terms of
   - Content words or grammatical words
   - Part of Speech: Nouns, verbs, adjectives, prepositions, articles
4. Define code-switching

**How do the two texts differ?

Text 1

Hindi - English

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Text 2

Spanish - English

La última vez que volví a Guadalajara, **in 1997**, para celebrar mi ternura, **as I call it … —I know**, ya sé, mamá. **It's not the real word for it and I should speak right**. La gente va a creer que **I don't know right from wrong**. Pero tú ya no estás para retarme, **and I've always done my own thing anyway,** que no?

Task 2 - How to identify languages

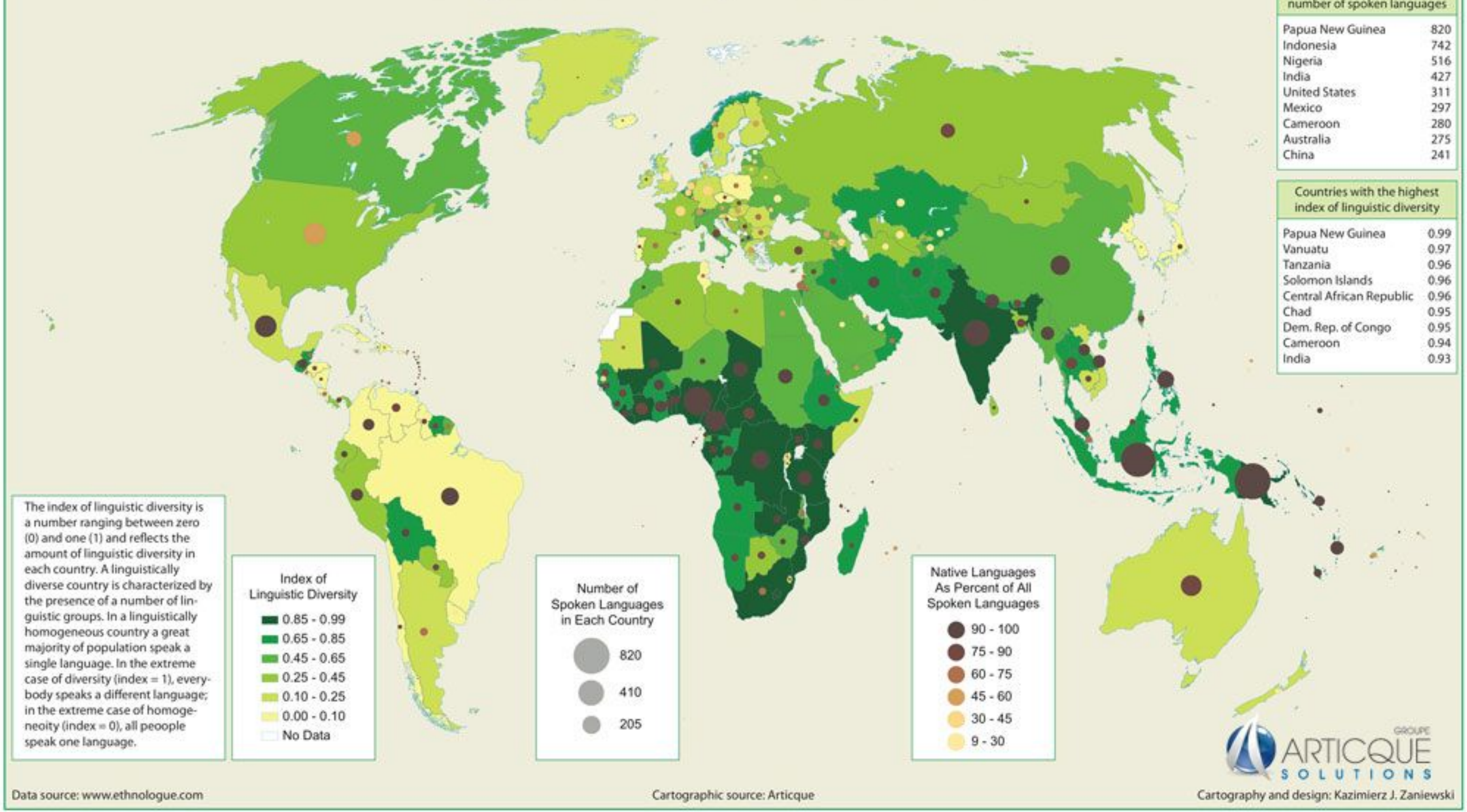
1. Outline a Pseudo Code to identify L1 & L2

Token	Language
Cuando	Spanish
hice	Spanish
find	English
out	English
que	Spanish
estaba	Spanish

Why do people code-switch?

- More than half of the world’s population is multilingual…
- So why not?

Linguistic Diversity Around the World



Countries with the largest number of spoken languages	
Papua New Guinea	820
Indonesia	742
Nigeria	516
India	427
United States	311
Mexico	297
Cameroon	280
Australia	275
China	241

Countries with the highest index of linguistic diversity	
Papua New Guinea	0.99
Vanuatu	0.97
Tanzania	0.96
Solomon Islands	0.96
Central African Republic	0.96
Chad	0.95
Dem. Rep. of Congo	0.95
Cameroon	0.94
India	0.93

The index of linguistic diversity is a number ranging between zero (0) and one (1) and reflects the amount of linguistic diversity in each country. A linguistically diverse country is characterized by the presence of a number of linguistic groups. In a linguistically homogeneous country a great majority of population speak a single language. In the extreme case of diversity (index = 1), everybody speaks a different language; in the extreme case of homogeneoity (index = 0), all peoople speak one language.

Data source: www.ethnologue.com

Cartographic source: Articque

Cartography and design: Kazimierz J. Zaniewski

Why does code-switching matter to linguists?

- Answer research questions
  - Who code-switches?
  - When do they code-switch?
  - Why do they code-switch?
- Debunk the myths about code-switching
  - X Children code-switch because they confuse the two languages
  - X People who code-switch do not know how to properly speak either language
  - X People code-switch because they are lazy

Why does code-switching matter?

What can I help you with?

Hey Siri, play *Despacito*

Hey Siri, text my husband “Llego a casa en 10 minutos”

Turning text into data

Text 2

Spanish - English

La última vez que volví a Guadalajara, in 1997, para celebrar mi ternura, as I call it … –I know, ya sé, mamá. It's not the real word for it and I should speak right. La gente va a creer que I don't know right from wrong.

Chávez-Silverman, S. (2004). *Killer crónicas: bilingual memories*. Univ of Wisconsin Press.

Token	Lang.	POS	Named Entity	Speaker
a	Spanish	Prep	no	Susana
Guadalajara	Spanish	Noun	yes	Susana
,	NA	Punct	no	Susana
in	English	Prep	no	Susana
1997	NA	Num	no	Susana
para	Spanish	Prep	no	Susana

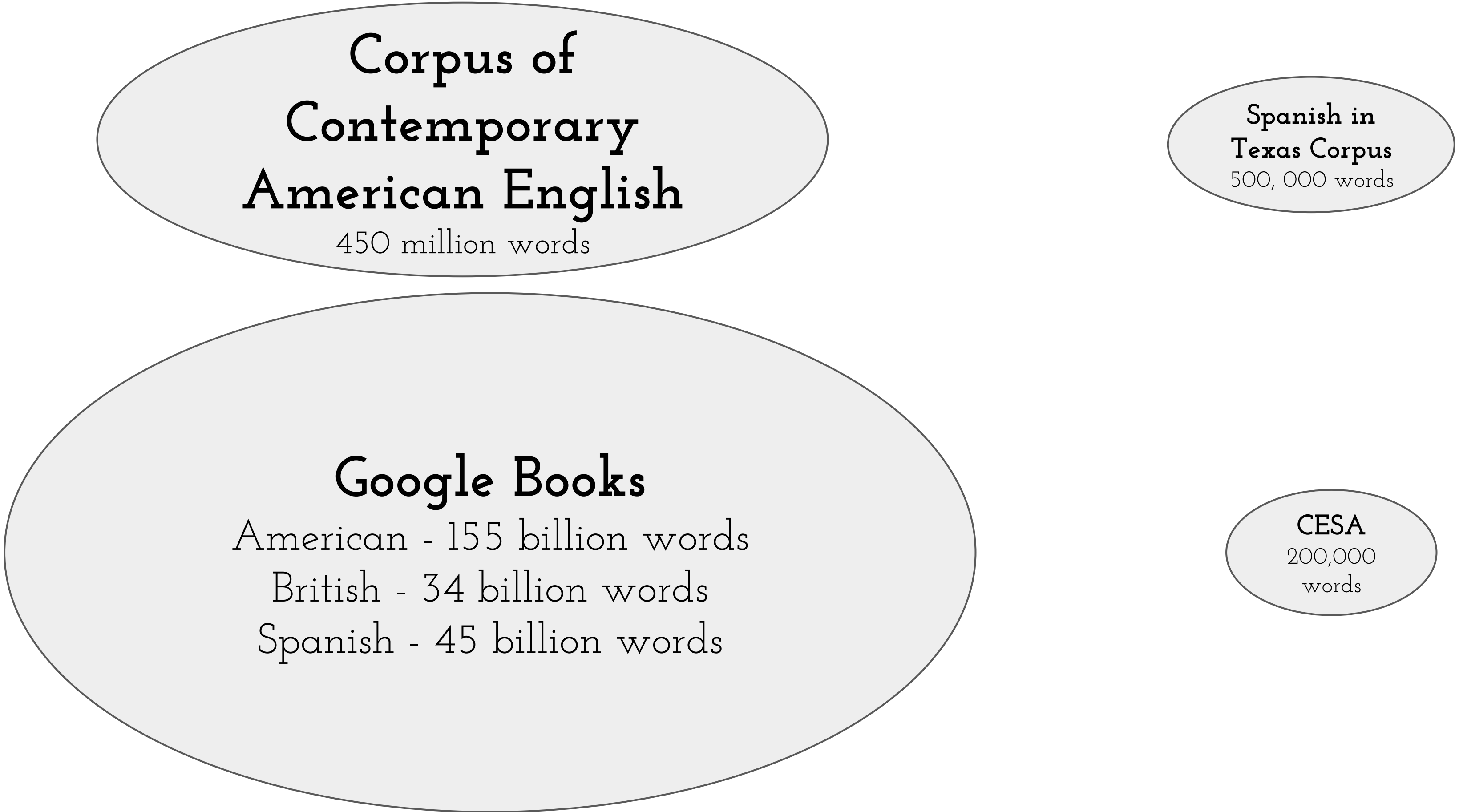
Natural Language Processing

Challenges of Code-switched Data

	Monolingual Texts	**Code-switched Texts**
Big Data	✔	~
NLP tools	✔ (NLTK, SpaCy)	~

Monolingual Data

Code-Switched Data



Corpus of Contemporary American English
450 million words

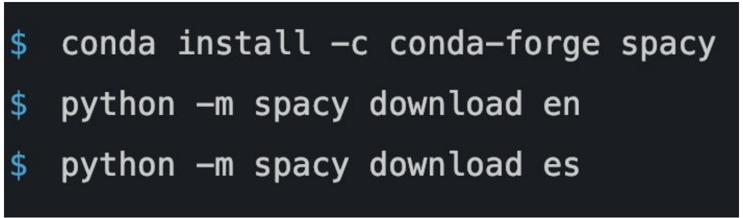
Google Books
American - 155 billion words
British - 34 billion words
Spanish - 45 billion words

Spanish in Texas Corpus
500, 000 words

CESA
200,000 words

Set Up

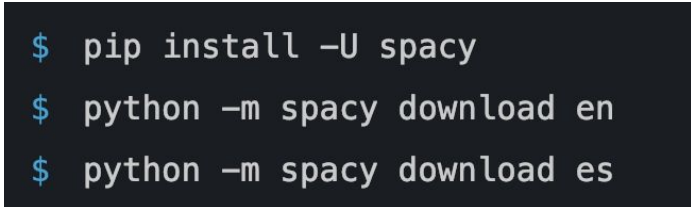
- Download repo → https://github.com/jserigos/One-Text-Two-Languages
- Open jupyter notebook → Step1-NLP_Pipeline.ipynb
- Install SpaCy → https://spacy.io/usage/
    - requires numpy >= 1.10. download will fail if older version of numpy



```
$  conda install -c conda-forge spacy
$  python -m spacy download en
$  python -m spacy download es
```

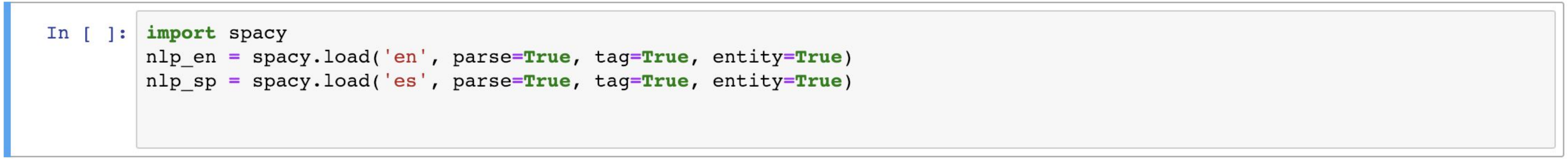
⇧sudo

or



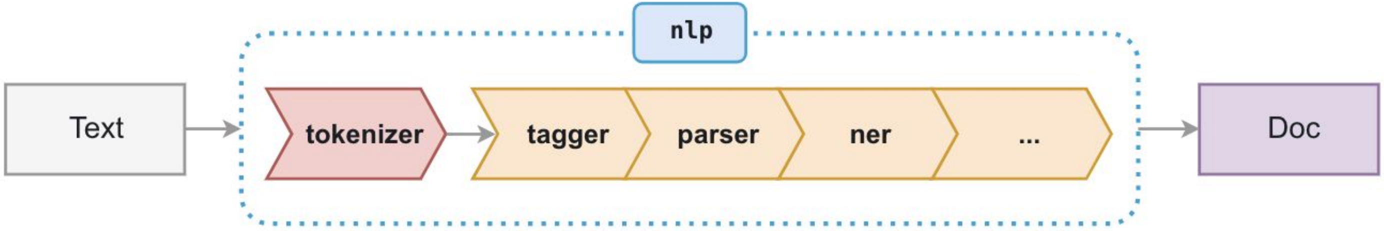
```
$  pip install -U spacy
$  python -m spacy download en
$  python -m spacy download es
```

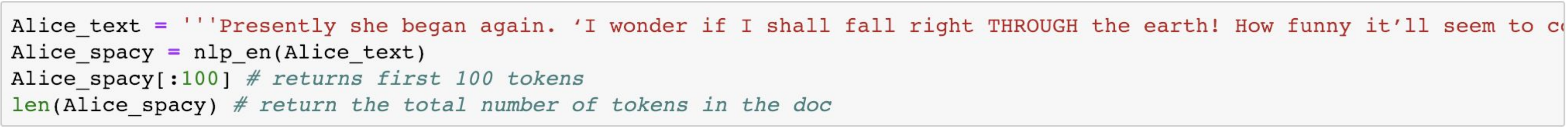
⇧sudo



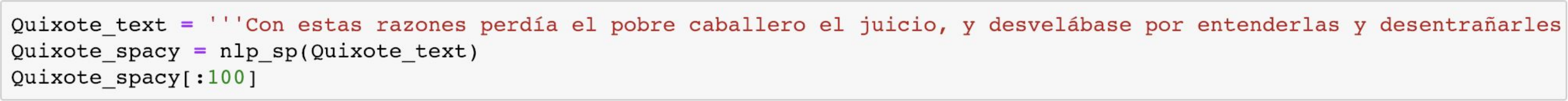
```
In [ ]: import spacy
        nlp_en = spacy.load('en', parse=True, tag=True, entity=True)
        nlp_sp = spacy.load('es', parse=True, tag=True, entity=True)
```

Spacy



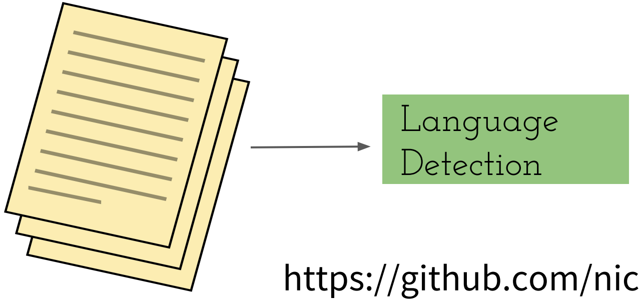


```
Alice_text = '''Presently she began again. ‘I wonder if I shall fall right THROUGH the earth! How funny it’ll seem to c
Alice_spacy = nlp_en(Alice_text)
Alice_spacy[:100] # returns first 100 tokens
len(Alice_spacy) # return the total number of tokens in the doc
```

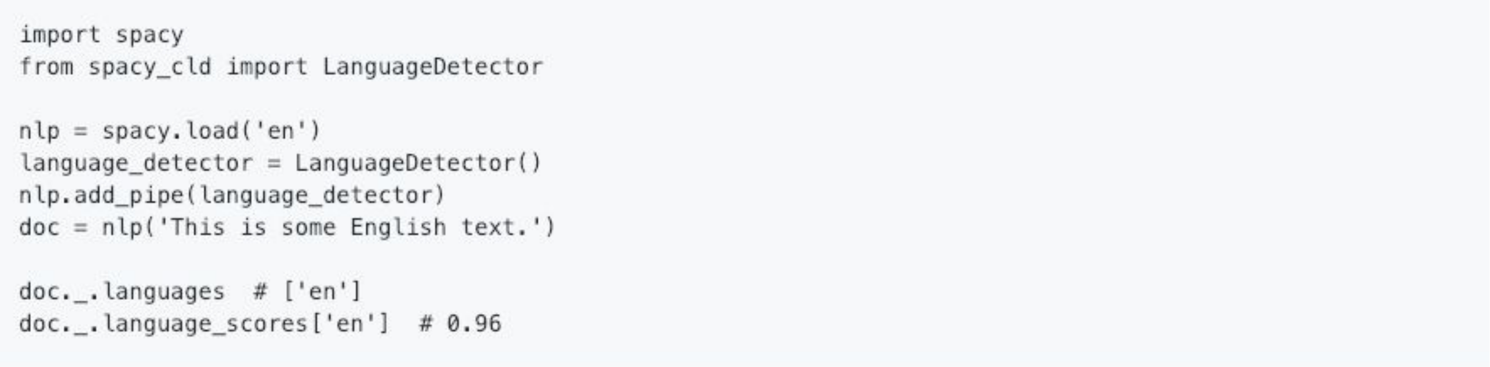


```
Quixote_text = '''Con estas razones perdía el pobre caballero el juicio, y desvelábase por entenderlas y desentrañarles
Quixote_spacy = nlp_sp(Quixote_text)
Quixote_spacy[:100]
```

NLP Pipeline



https://github.com/nickdavidhaynes/spacy-cld

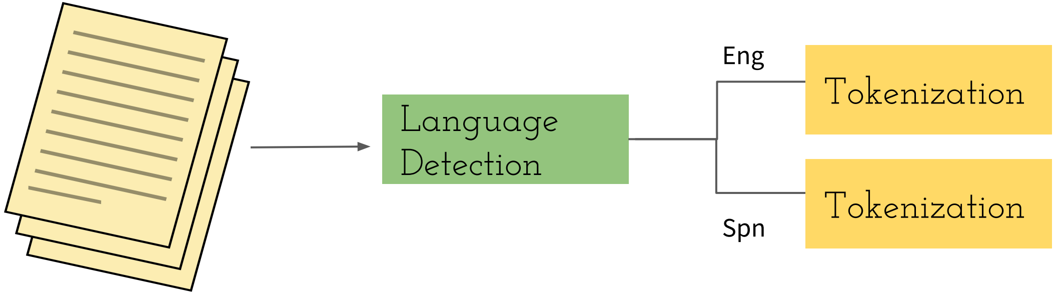


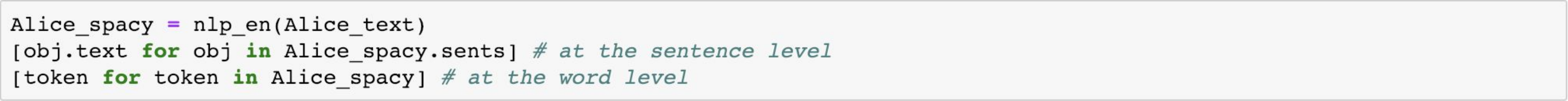
```
import spacy
from spacy_cld import LanguageDetector

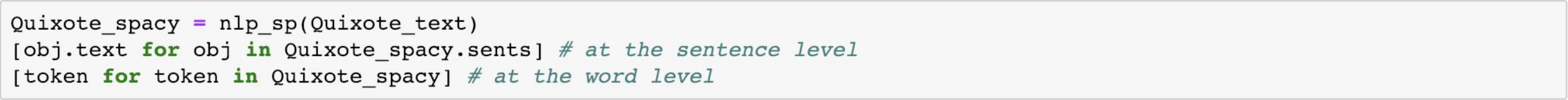
nlp = spacy.load('en')
language_detector = LanguageDetector()
nlp.add_pipe(language_detector)
doc = nlp('This is some English text.')

doc._.languages  # ['en']
doc._.language_scores['en']  # 0.96
```

NLP Pipeline




```
Alice_spacy = nlp_en(Alice_text)
[obj.text for obj in Alice_spacy.sents] # at the sentence level
[token for token in Alice_spacy] # at the word level
```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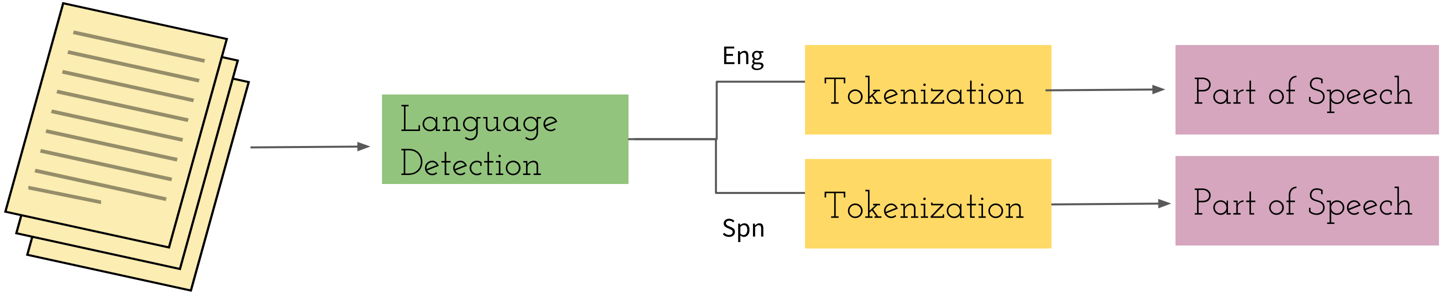
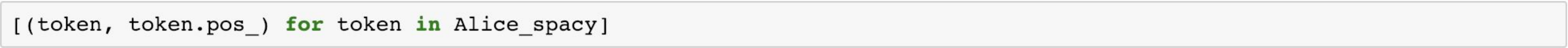
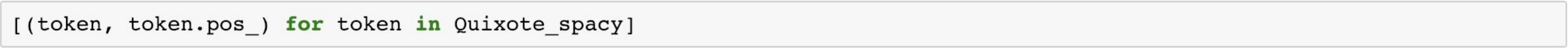
NLP Pipeline





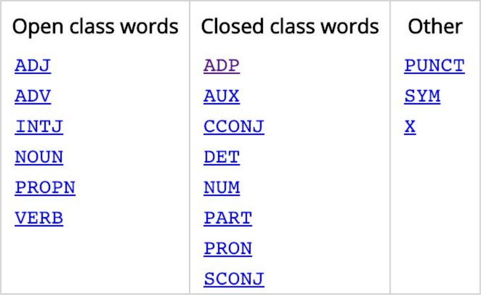
```
[(token, token.pos_) for token in Alice_spacy]
```



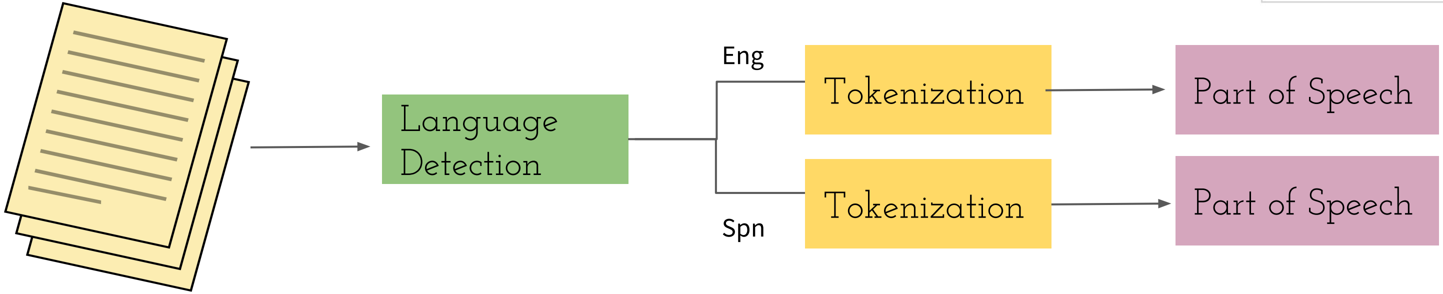
```
[(token, token.pos_) for token in Quixote_spacy]
```

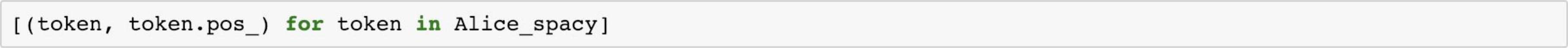
NLP Pipeline

https://universaldependencies.org/u/pos/



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





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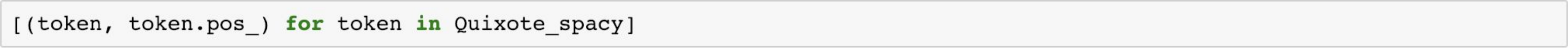
```



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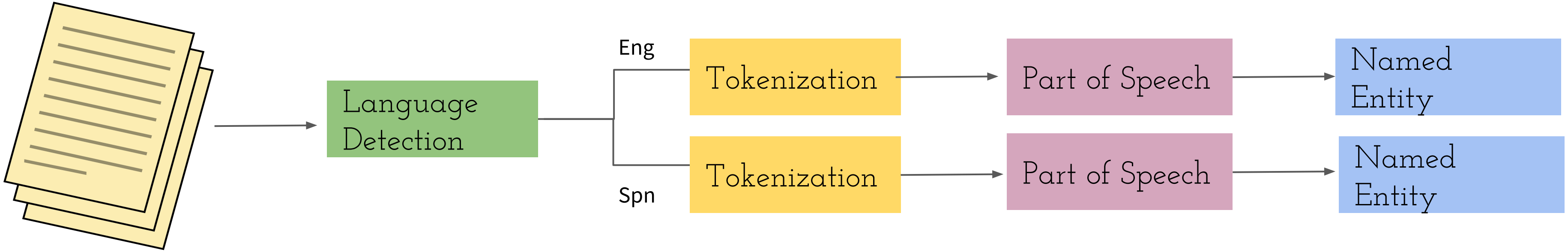
```

NLP Pipeline



Language Detection

Eng

Spn

Tokenization

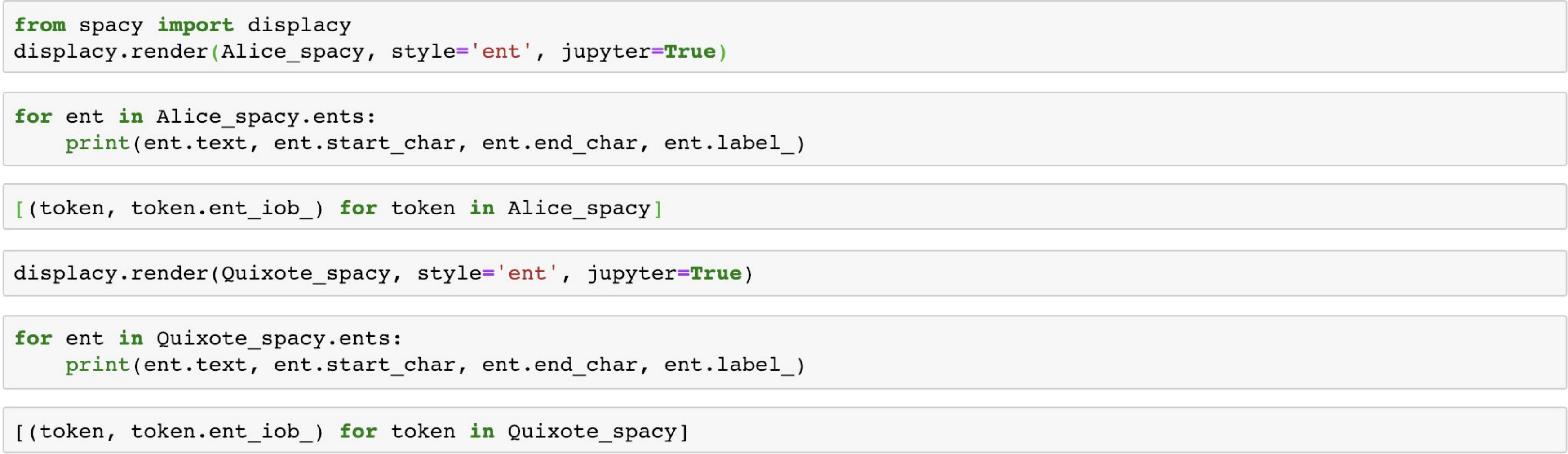
Tokenization

Part of Speech

Part of Speech

Named Entity

Named Entity



```
from spacy import displacy
displacy.render(Alice_spacy, style='ent', jupyter=True)
```

```
for ent in Alice_spacy.ents:
    print(ent.text, ent.start_char, ent.end_char, ent.label_)
```

```
[(token, token.ent_iob_) for token in Alice_spacy]
```

```
displacy.render(Quixote_spacy, style='ent', jupyter=True)
```

```
for ent in Quixote_spacy.ents:
    print(ent.text, ent.start_char, ent.end_char, ent.label_)
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```
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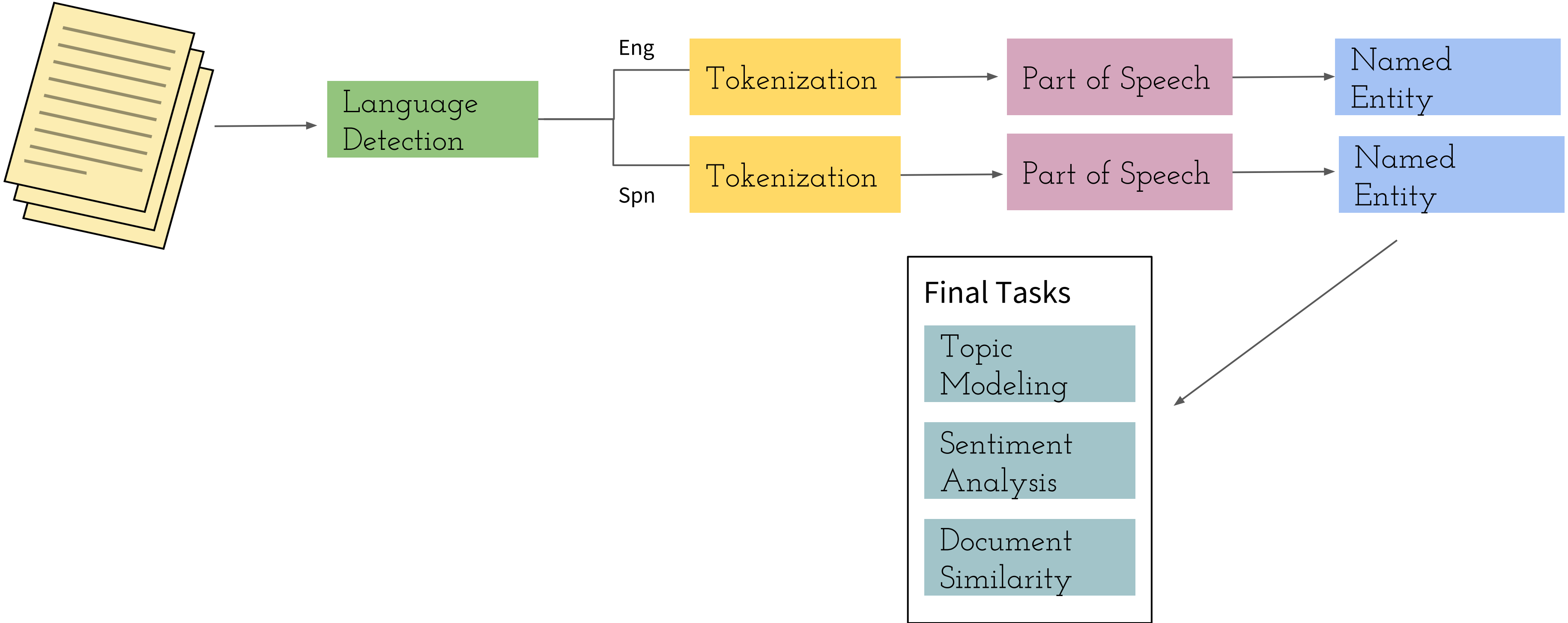
```

NLP Pipeline



Language Detection

Eng

Spn

Tokenization

Part of Speech

Named Entity

Tokenization

Part of Speech

Named Entity

Final Tasks

Topic Modeling

Sentiment Analysis

Document Similarity

Language Identification

1. Characters
2. Stop words
3. Character Ngrams

At Document Level

- Ideas? How to identify languages?

Text 1

Hindi

एसोसिएशन फुटबॉल जिसे आमतौर पर सिर्फ फुटबॉल या सॉकर कहा जाता है, दुनिया के सबसे लोकप्रिय खेलों में से एक है । यह एक सामूहिक खेल है और इसे ग्यारह खिलाड़ियों के दो दलों के बीच खेला जाता हैं । फुटबॉल को सामान्यत: एक आयताकार घास या कृत्रिम घास के मैदान पर खेला जाता है जिसके दोनों छोरों पर एक एक गोल होता है। खिलाड़ियों द्‌वारा विरोधी दल के गोल में चालाकी से गेंद को डालना ही इस खेल का उद्‌देश्य है। खेल में गोलरक्षक ही एक मात्र ऐसा खिला\

Text 2

English

Association football, more commonly known as football or soccer, is a team sport played with a spherical ball between two teams of eleven players. It is played by 250 million players in over 200 countries and dependencies, making it the world's most popular sport. The game is played on a rectangular field called a pitch with a goal at each end. The object of the game is to score by moving the ball beyond the goal line into the opposing goal.

Text 3

Spanish

El fútbol es un deporte de equipo jugado entre dos conjuntos de once jugadores cada uno y algunos árbitros que se ocupan de que las normas se cumplan correctamente. Es ampliamente considerado el deporte más popular del mundo, pues lo practican unas 270 millones de personas.

Text 4

Korean

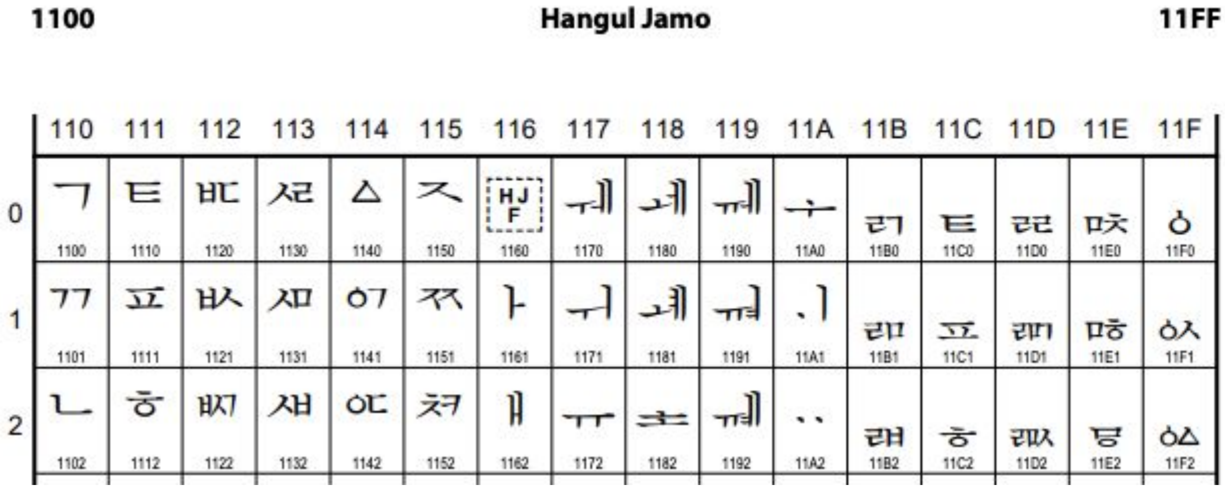
축구는 출전 선수 11명씩 각각 한 팀을 이루어 두 팀이 겨루며, 세계적으로 최고 인기를 누리는 스포츠이다.[1] 경기장은 직사각형이며, 바닥은 천연잔디나 인조잔디, 흙 등으로 이뤄져 있다. 경기장 양 끝에 놓인 상대방 골대 사이로 공을 통과시키면 득점이 된다. 선수 중 골키퍼만 팔과 손으로도 공을 건드릴 수 있으며, 나머지 선수는 팔과 손을 제외한 신체 부위로만 공을 다룰수 있다.

wikipedia.com

Characters

- Unicode
  - Industry standard
  - Contains a repertoire of 137,439 characters covering 146 modern and historic scripts
  - Each abstract character has a “code point”
  - Different scripts use unique range of code points
  - Code points U+0000 to U+007F (0-127) were the same as ASCII
  - http://www.unicode.org/charts/
- Character Encoding
  - UTF-8 - capable of encoding all valid code points in Unicode
  - ASCII - capable of encoding only 127 code points (Roman alphabet)

http://www.unicode.org/charts/



1100 **Hangul Jamo** **11FF**

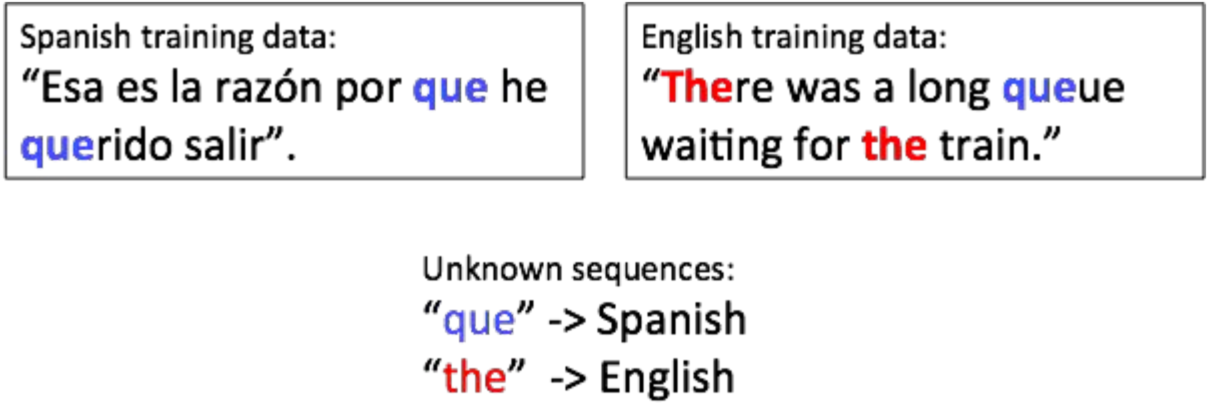
	110	111	112	113	114	115	116	117	118	119	11A	11B	11C	11D	11E	11F
0	ᄀ 1100	ᄐ 1110	ᄠ 1120	ᄰ 1130	ᅀ 1140	ᅐ 1150	HJF 1160	ᅰ 1170	ᆀ 1180	ᆐ 1190	ᆠ 11A0	ᆰ 11B0	ᇀ 11C0	ᇐ 11D0	ᇠ 11E0	ᇰ 11F0
1	ᄁ 1101	ᄑ 1111	ᄡ 1121	ᄱ 1131	ᅁ 1141	ᅑ 1151	ᅡ 1161	ᅱ 1171	ᆁ 1181	ᆑ 1191	ᆡ 11A1	ᆱ 11B1	ᇁ 11C1	ᇑ 11D1	ᇡ 11E1	ᇱ 11F1
2	ᄂ 1102	ᄒ 1112	ᄢ 1122	ᄲ 1132	ᅂ 1142	ᅒ 1152	ᅢ 1162	ᅲ 1172	ᆂ 1182	ᆒ 1192	ᆢ 11A2	ᆲ 11B2	ᇂ 11C2	ᇒ 11D2	ᇢ 11E2	ᇲ 11F2

Stop Words

- Short function words
  - She, is, who, what, are, in, before…
- https://www.mostlymaths.net/2012/06/language-detection-in-python-with-nltk.html

Character N-grams

- What’s the probability that a given word is English? Spanish?
  - *queche* ?
  - *thamin* ?



Spanish training data:
“Esa es la razón por **que** he **que**rido salir”.

English training data:
“**The**re was a long **que**ue waiting for **the** train.”

Unknown sequences:
“que” -> Spanish
“the” -> English

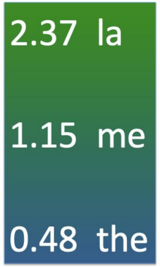
Character Ngram Model

1. Construct ngram model from two monolingual corpora
2. Calculate ratio of probability of a word in each

$$\frac{p(word|\ Spanish)}{p(word|\ English)}$$

Character Ngram Model

3. Label each word with most probable language except if ratio is near 1.0 ⇒ treat as ambiguous



2.37	la
1.15	me
0.48	the

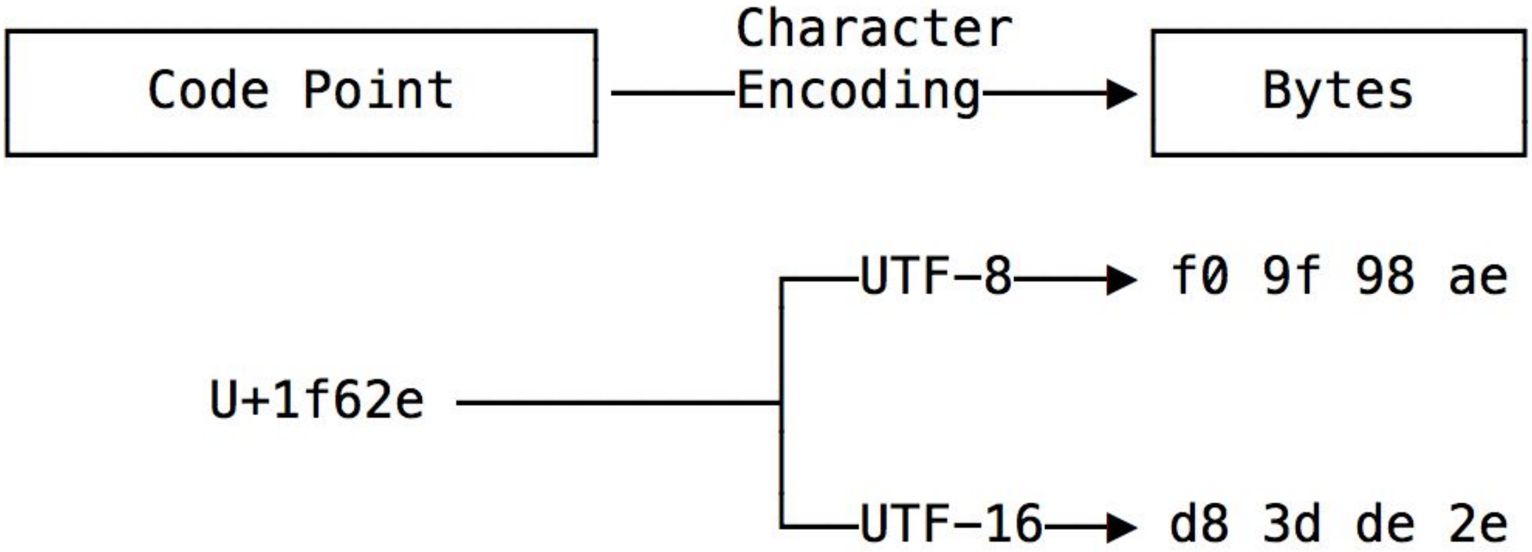
From Constantine Lignos and Mitch Marcus (University of Pennsylvania, Johns Hopkins University)

4. Ambiguous words are assigned the language tag of the previous word
    a. Functional Head Constraint (Belazi et al. 1994)
5. Performance of Codeswitchador = 96.9%

More to tackle

- POS tagging for CS data
- Syntactic parsing for CS data
- Measuring degrees of CS → language metrics

Token	Language
Thank	English
you	English
and	English
muchas	Spanish
gracias	Spanish



Code Point

Character Encoding

Bytes

U+1f62e

UTF-8

f0 9f 98 ae

UTF-16

d8 3d de 2e

https://medium.freecodecamp.org/a-beginner-friendly-guide-to-unicode-d6d45a903515