Word Sense Disambiguation and Crowdsourcing

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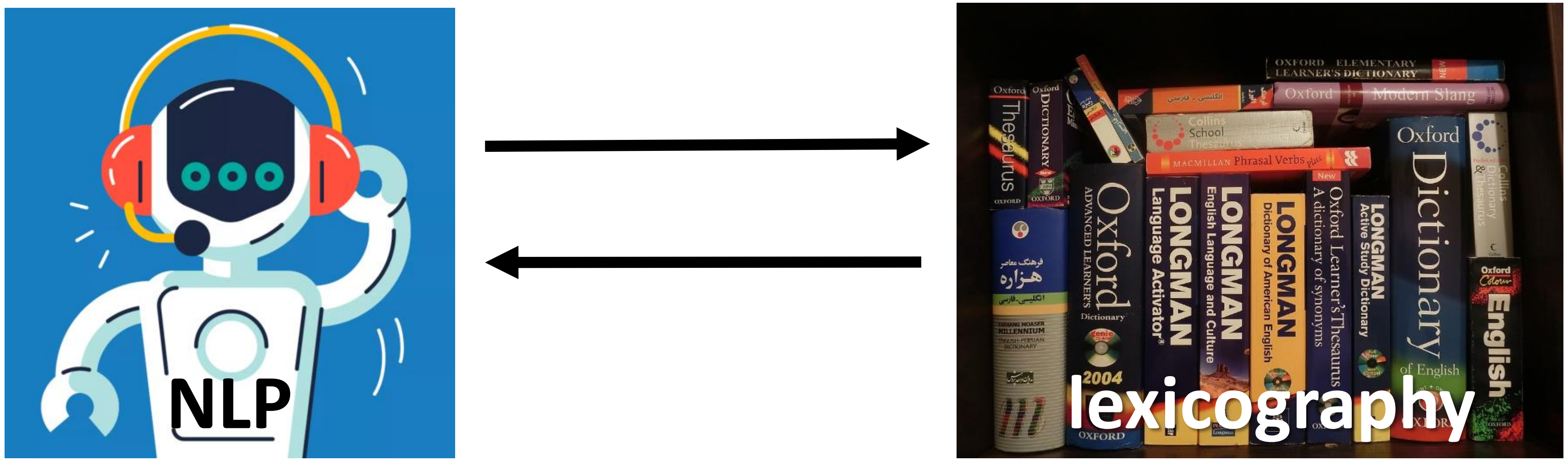
Lexicographic data for Natural Language Processing and vice versa

- We aim to show the **impact of lexicographic data for NLP**
- A paradigmatic task is Word Sense Disambiguation thanks to its need to leverage lexical-semantic knowledge resources
- However, we also aim to show that **NLP can help lexicography**



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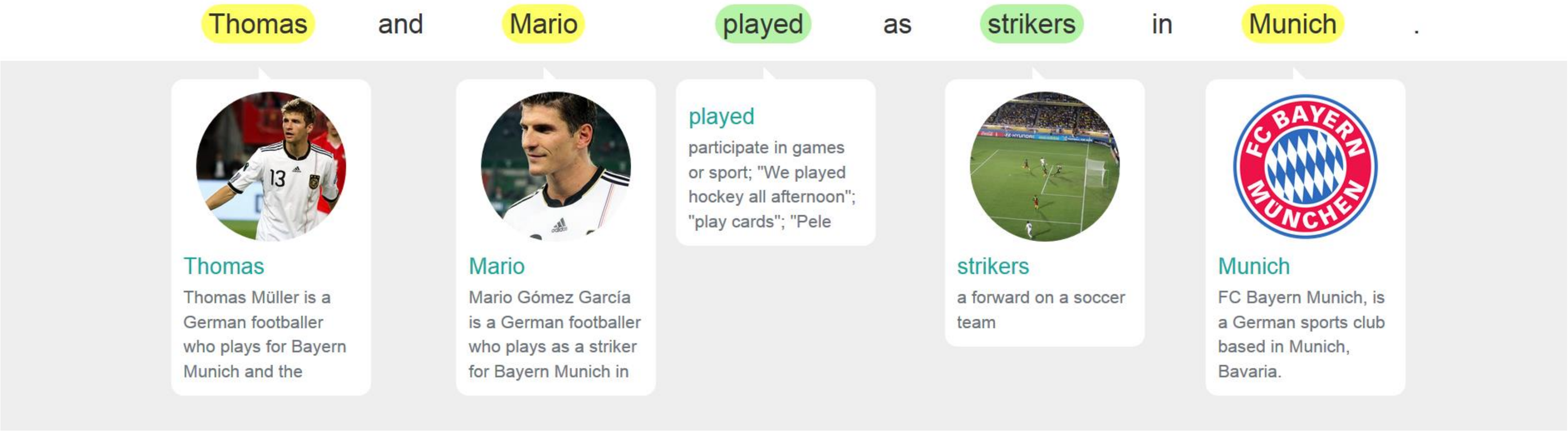
Multilingual Word Sense Disambiguation and Entity Linking

- **Word Sense Disambiguation:** automatic assignment of senses to words in context
- **Entity Linking:** automatic assignment of named entities to mentions in context



Thomas and Mario played as strikers in Munich .

Thomas

Thomas Müller is a German footballer who plays for Bayern Munich and the

Mario

Mario Gómez García is a German footballer who plays as a striker for Bayern Munich in

played

participate in games or sport; "We played hockey all afternoon"; "play cards"; "Pele

strikers

a forward on a soccer team

Munich

FC Bayern Munich, is a German sports club based in Munich, Bavaria.

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Multilingual Word Sense Disambiguation and Entity Linking

- **Objective 1:** Develop algorithms that will use ELEXIS lexicographic resources to bootstrap disambiguation in a dozen languages
- **Objective 2:** Show high performance in many languages
  - Quantitative evaluation based on standard multilingual datasets (SemEval 2013; 2015 on multilingual WSD; Entity Linking datasets)
  - Perform validation in multiple languages and with different sense inventories: demonstrate **high-quality sense annotations**

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Challenges in WSD and Entity Linking

- **Issues:**
  - **The knowledge acquisition bottleneck:**
    - **Supervised approaches** suffer from **lack of annotated data** (only English and little else)
    - **Knowledge-based approaches** need computational lexicons, semantic collocations, graph-like dictionary structure, etc.
  - **Reference inventories**
    - WordNet is too fine grained
    - Wikipedia is too rich
- The ELEXIS dictionary matrix will prove **important benefits for both issues**

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Workplan (1/2)

- **Textual data** from:
  - the Universal Dependencies project (POS tagged)
  - the *TenTen corpora from Lexical Computing
  - Semantically-annotated corpora from partners
- **Phase 1a (October 2018/February 2019):**
  - **Algorithms:** Babelfy (Uniroma1) + Wikifier (JSI)
  - **Inventory:** use existing inventories (BabelNet, Wikipedia)
  - **Validation:** show the data to lexicographers in ELEXIS + observers
  - **Goal:** prepare the framework
- **Phase 1b (February 2019/June 2019):**
  - **Disambiguation** of the corpora + analysis

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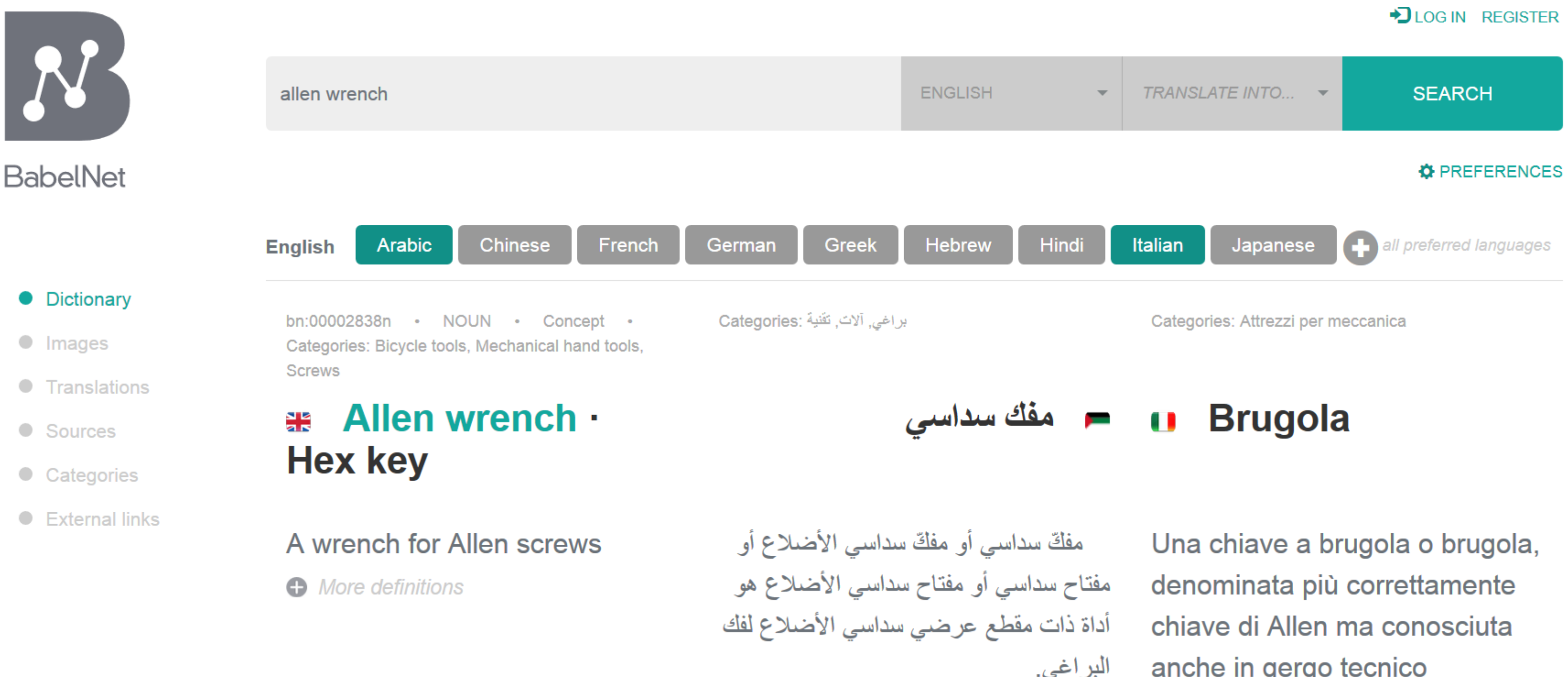
BabelNet: a shared multilingual inventory of meanings

- **Multilingual**: the same concept in tens of languages
- It **integrates different kinds of open resources**, such as WordNet, Wikipedia, Wikidata, Wiktionary, etc.
- **Wide coverage**: 284 languages and 16 million entries!
- Used by **more than 800 universities and research centers**!



bn:00002838n • NOUN • Concept •
Categories: Bicycle tools, Mechanical hand tools, Screws

Allen wrench · **Hex key**

A wrench for Allen screws

Categories: براغي, آلات, تقنية

مفك سداسي

مفكّ سداسي أو مفكّ سداسي الأضلاع أو
مفتاح سداسي أو مفتاح سداسي الأضلاع هو
أداة ذات مقطع عرضي سداسي الأضلاع لفك
البراغي.

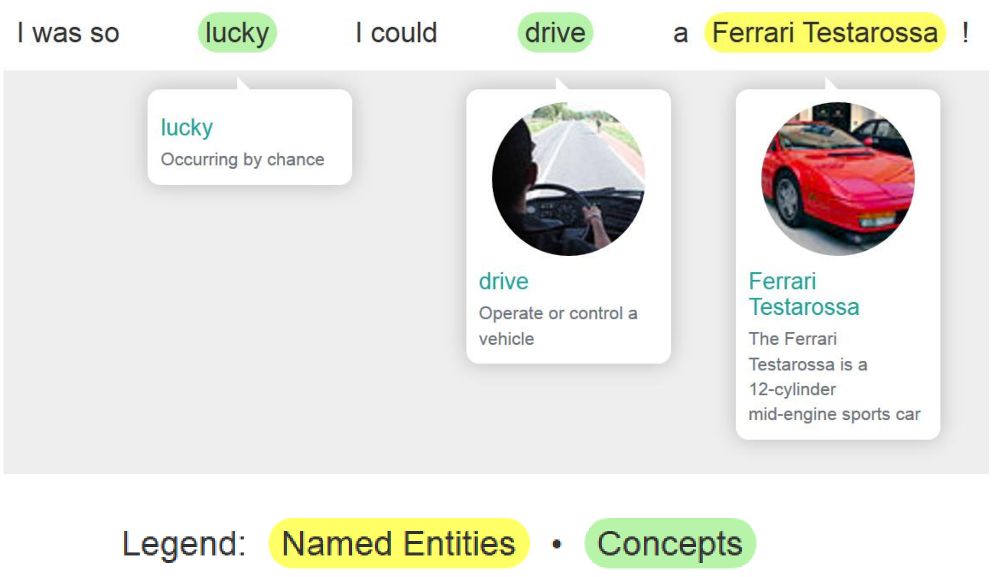
Categories: Attrezzi per meccanica

Brugola

Una chiave a brugola o brugola, denominata più correttamente chiave di Allen ma conosciuta anche in gergo tecnico

Disambiguation: Babelfy

- We used Babelfy for disambiguating the Wikipedia corpus
- Why?
  - The first (and only) system that performs Word Sense Disambiguation (common nouns, verbs, adjectives, adverbs) and Entity Linking (names) **jointly**



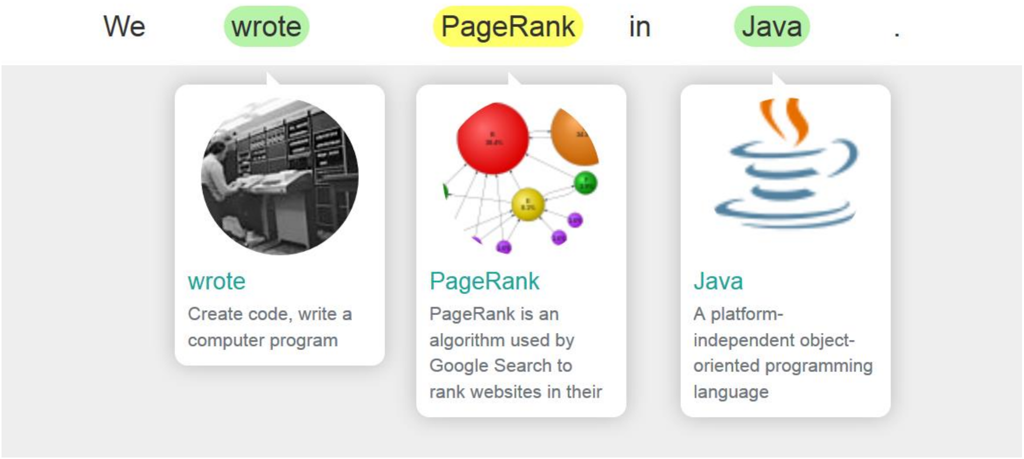
I was so lucky I could drive a Ferrari Testarossa !

lucky
Occurring by chance

drive
Operate or control a vehicle

Ferrari Testarossa
The Ferrari Testarossa is a 12-cylinder mid-engine sports car

Legend: Named Entities • Concepts



We wrote PageRank in Java .

wrote
Create code, write a computer program

PageRank
PageRank is an algorithm used by Google Search to rank websites in their

Java
A platform-independent object-oriented programming language

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Disambiguation: Babelfy

- We used Babelfy for disambiguating the Wikipedia corpus
- Why?
  - The first (and only) system that performs Word Sense Disambiguation (common nouns, verbs, adjectives, adverbs) and Entity Linking (names) **jointly**
  - **Knowledge-based:** does not need millions of sentences annotated in each language
  - Works in **arbitrary languages** (284 languages)
  - Can disambiguate **texts written in mixed languages** (language-agnostic setting)

"Word sense disambiguation and entity linking together!"

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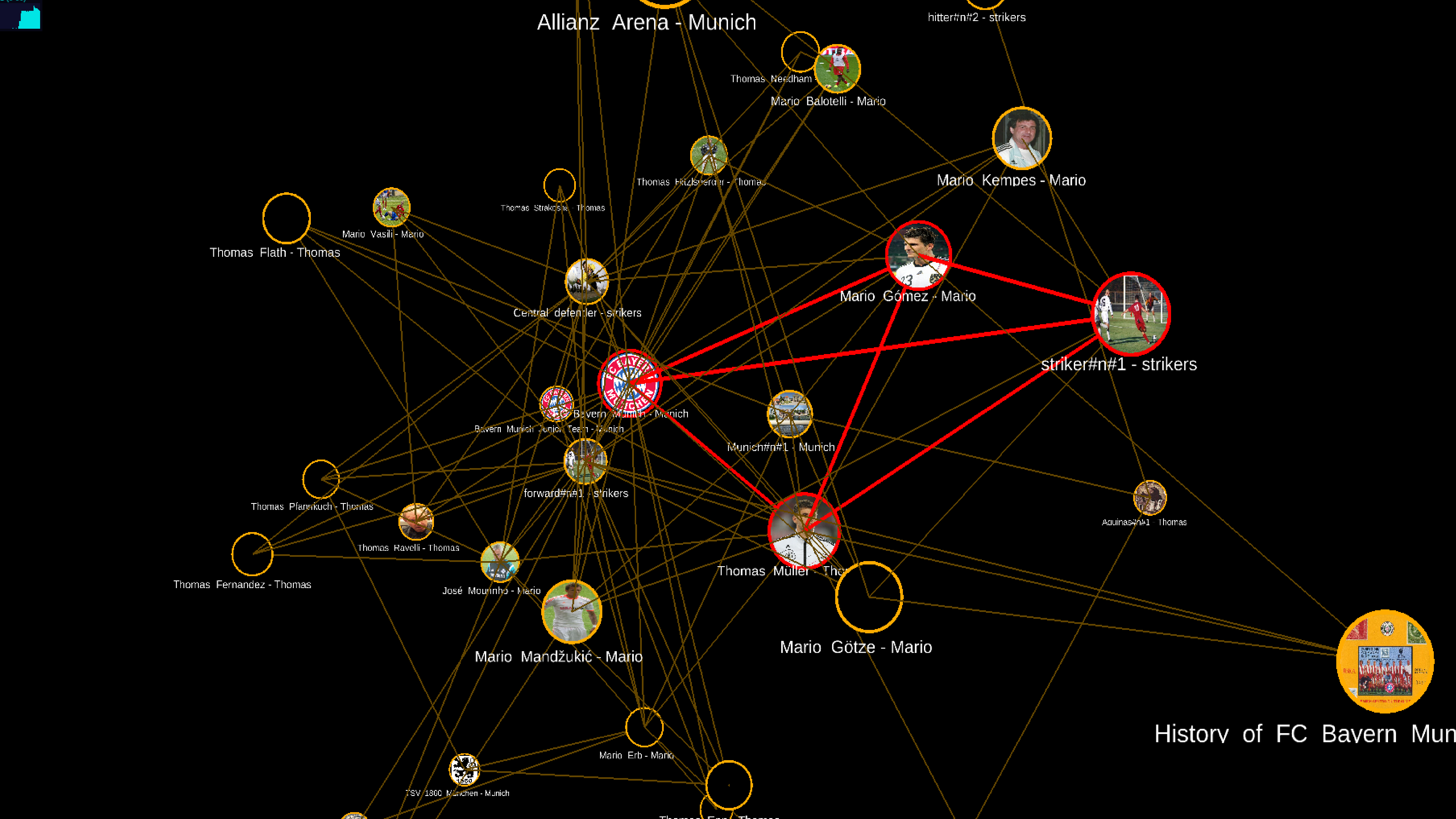
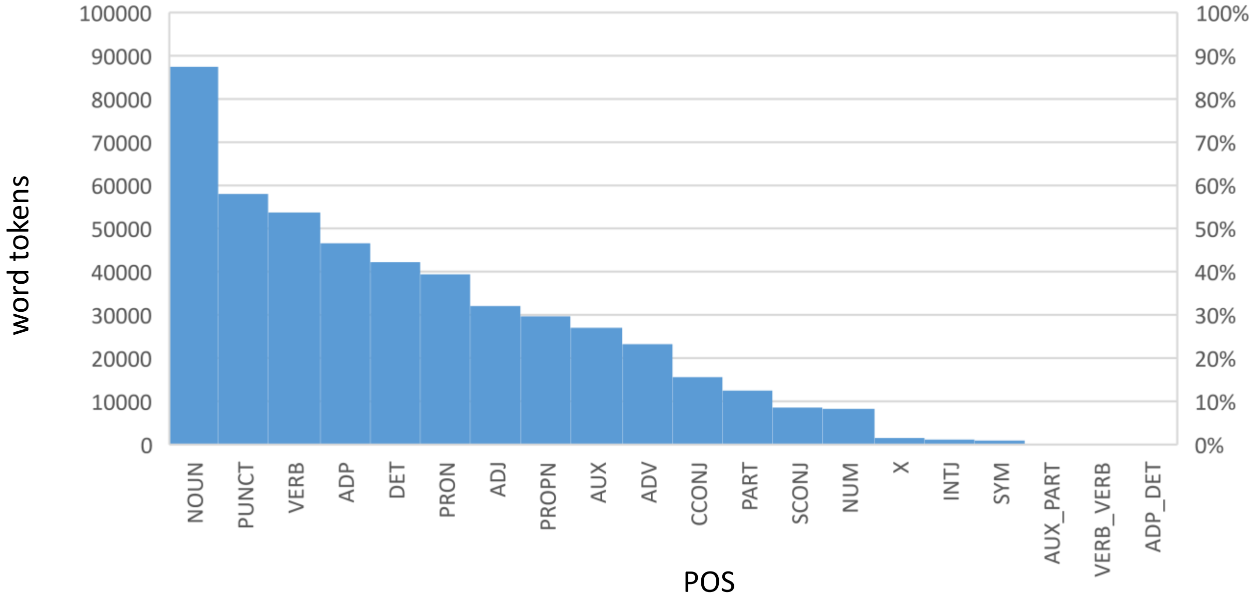

Allianz Arena - Munich
hitter#n#2 - strikers
Thomas Needham
Mario Balotelli - Mario
Mario Kempes - Mario
Thomas Hitzlsperger - Thomas
Thomas Strakosha - Thomas
Mario Vasili - Mario
Thomas Flath - Thomas
Central defender - strikers
Mario Gómez - Mario
striker#n#1 - strikers
FC Bayern Munich - Munich
Bayern Munich Junior Team - Munich
Munich#n#1 - Munich
forward#n#1 - strikers
Thomas Pfannkuch - Thomas
Thomas Ravelli - Thomas
Aquinas#n#1 - Thomas
Thomas Müller - Tho
José Mourinho - Mario
Thomas Fernandez - Thomas
Mario Mandžukić - Mario
Mario Götze - Mario
History of FC Bayern Mun
Mario Erb - Mario
TSV 1860 München - Munich

Statistics on the Babelfied English Datasets from UD

- Total number of word tokens: 488515
- Total number of word types: 26892
- Total number of disambiguated word tokens: 85094
- Total number of disambiguated word types: 24144



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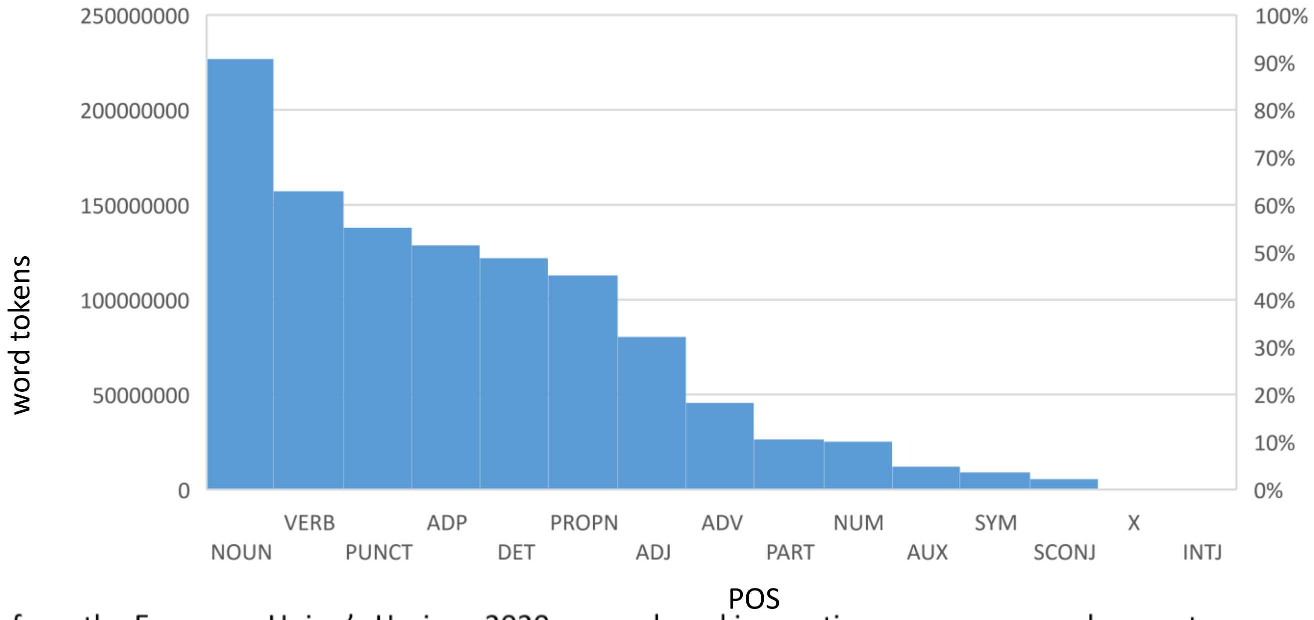
Statistics on the Babelfied English Datasets from the *TenTen Corpora

- Total number of word tokens: 1170202338
- Total number of word types: 5454205
- Total number of disambiguated word tokens: 295783220
- Total number of disambiguated word types: 844705



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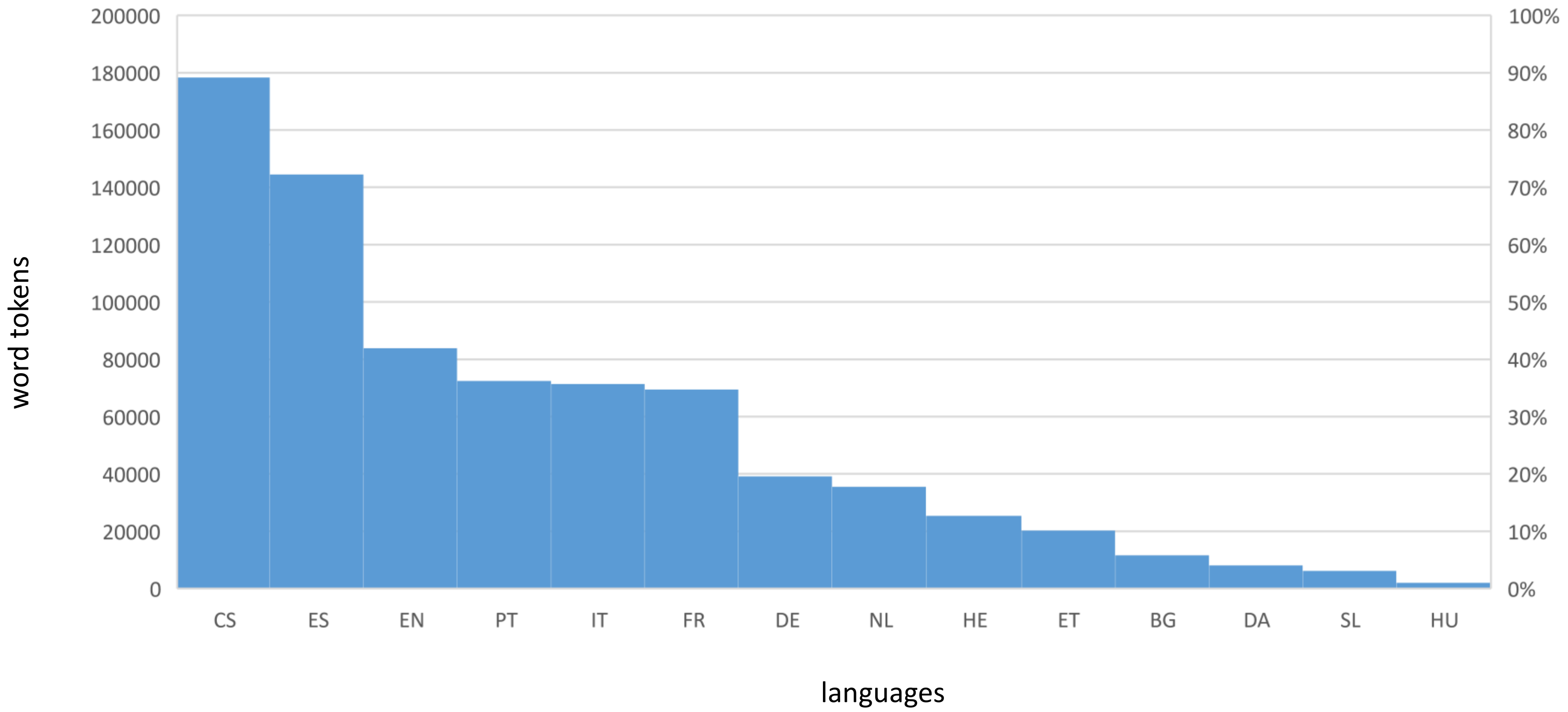
Overall statistics on words Babelfied across languages of UD Corpora



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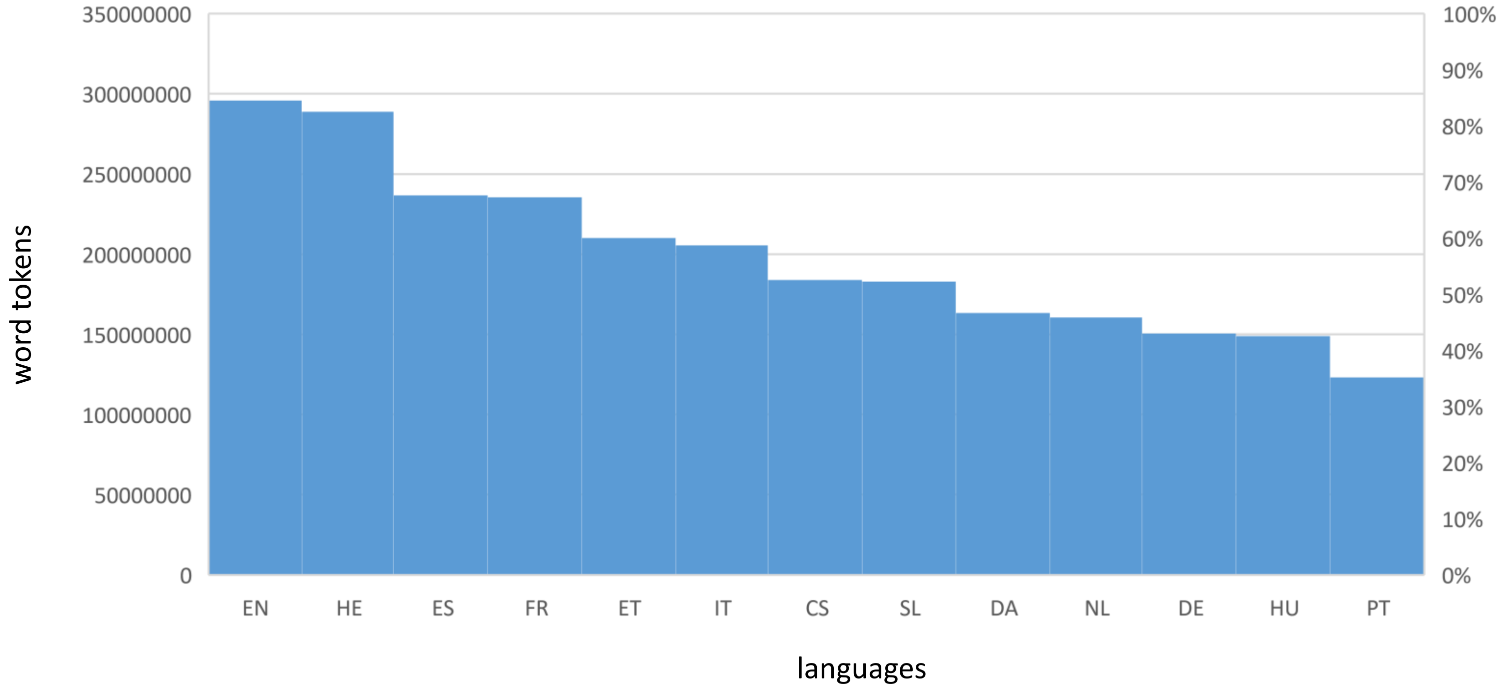
Overall statistics on words Babelfied across languages of *TenTen Corpora



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Qualitative analysis + decisions about lexicographic evaluation

- We are in the process of defining the evaluation process
- Shall we check if the best option was chosen among those in the inventory?
- Annotations (potential options: correct, so and so, wrong?)
- Evaluation measures

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Workplan (2/2)

- **Phase 2 (June 2019-2021):**
  - **Algorithms:** New algorithm with multilingual sense embeddings + semantic graphs (Uniroma1)
  - **Inventory:** use the ELEXIS dictionary matrix from WP2
  - **Validation:** show the data to lexicographers in ELEXIS + observers
  - **Goals:**
    1. show we can now disambiguate in arbitrary languages with reputable dictionaries
    2. show improvements coming from the dictionary matrix resulting from WP2

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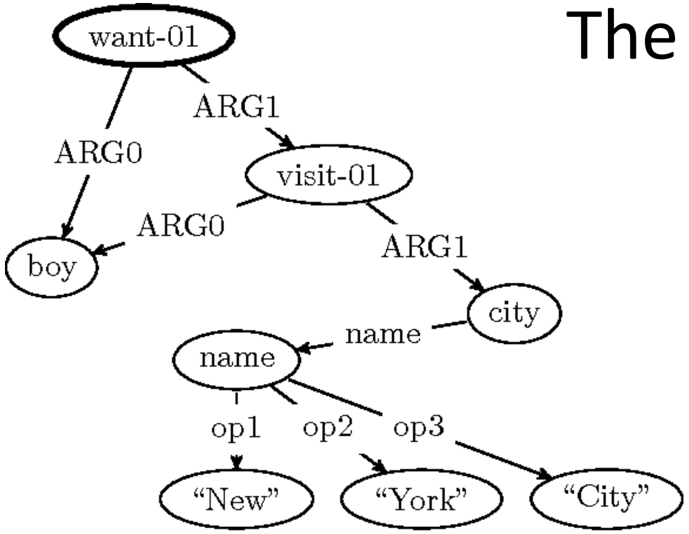
Multilingual semantic parsing

- Semantic parsing is the task of mapping sentences to a formal representation
  - Abstract Meaning Representation (AMR)
  - Universal Conceptual Cognitive Annotation (UCCA)
  - CCG-based like Discourse Representation Structures (DRS)



The boy wants to visit New York City

```
(w / want-01
   :ARG0 (b / boy)
   :ARG1 (g / visit-01
            :ARG0 b
            :ARG1 (c / city
                     :name (n / name
                              :op1 "New"
                              :op2 "York"
                              :op3 "City"))))
```

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Multilingual semantic parsing

- Semantic parsing is the task of mapping sentences to a formal representation
- **Objective 1:** develop algorithms for semantic parsing in multiple languages which take advantage of ELEXIS lexicographic data
- **Objective 2:** exploit bilingual and multilingual data to innovate semantic parsing algorithms
- **Expectations from other partners:** creation of a multilingual test set benchmark (à la SemEval) for the task; curation/validation of verb frames for parsing in different languages based on ELEXIS data

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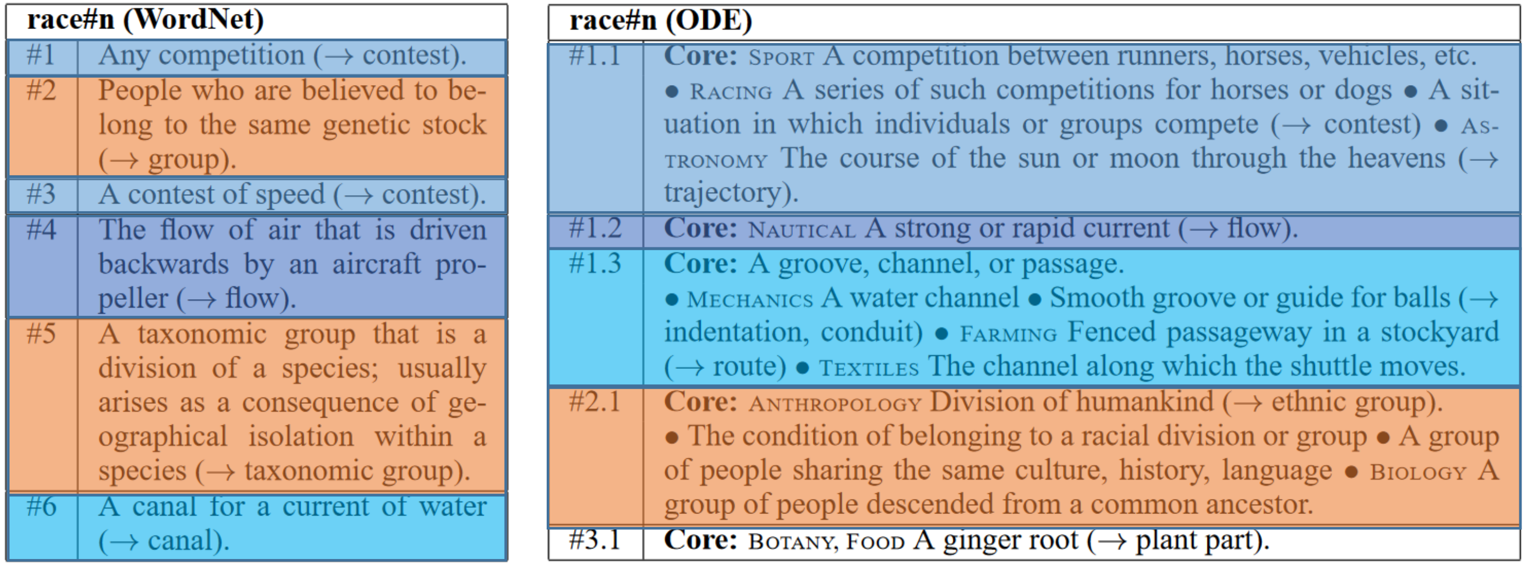
Lexical-semantic analytics for NLP

- Based on analytics computed on the ELEXIS resources for words, phrases, collocations, senses, domains, etc. we will explore three directions:
  - **T3.3.1 Sense clustering:** semi-automatic algorithms to group fine-grained sense distinctions, also across languages



race#n (WordNet)	
#1	Any competition (→ contest).
#2	People who are believed to belong to the same genetic stock (→ group).
#3	A contest of speed (→ contest).
#4	The flow of air that is driven backwards by an aircraft propeller (→ flow).
#5	A taxonomic group that is a division of a species; usually arises as a consequence of geographical isolation within a species (→ taxonomic group).
#6	A canal for a current of water (→ canal).

race#n (ODE)	
#1.1	**Core:** SPORT A competition between runners, horses, vehicles, etc. • RACING A series of such competitions for horses or dogs • A situation in which individuals or groups compete (→ contest) • ASTRONOMY The course of the sun or moon through the heavens (→ trajectory).
#1.2	**Core:** NAUTICAL A strong or rapid current (→ flow).
#1.3	**Core:** A groove, channel, or passage. • MECHANICS A water channel • Smooth groove or guide for balls (→ indentation, conduit) • FARMING Fenced passageway in a stockyard (→ route) • TEXTILES The channel along which the shuttle moves.
#2.1	**Core:** ANTHROPOLOGY Division of humankind (→ ethnic group). • The condition of belonging to a racial division or group • A group of people sharing the same culture, history, language • BIOLOGY A group of people descended from a common ancestor.
#3.1	**Core:** BOTANY, FOOD A ginger root (→ plant part).

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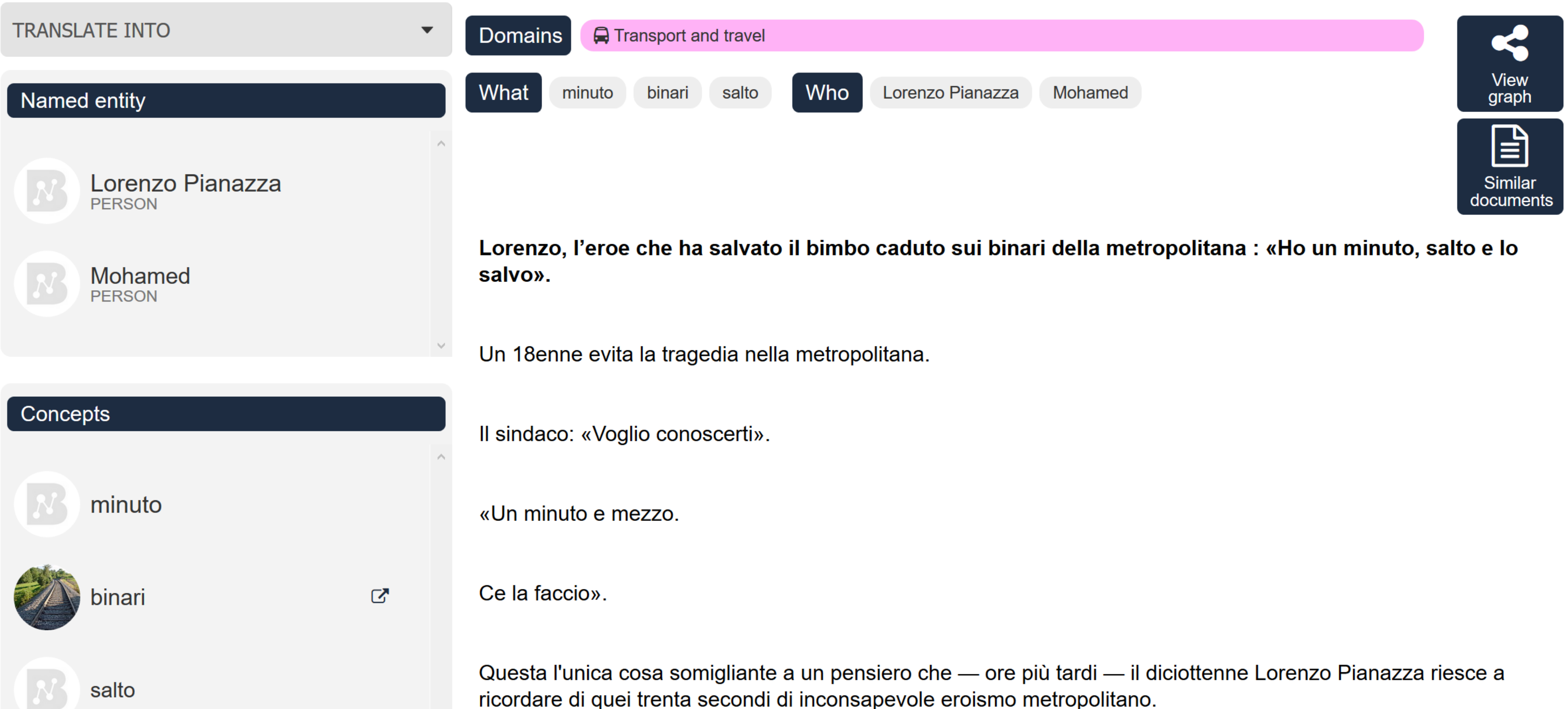
Lexical-semantic analytics for NLP

- Based on analytics computed on the ELEXIS resources for words, phrases, collocations, senses, domains, etc. we will explore three directions:
  - **T3.3.2 Domain labeling of text:** ELEXIS resources shown to improve domain labeling across languages



Lorenzo, l'eroe che ha salvato il bimbo caduto sui binari della metropolitana : «Ho un minuto, salto e lo salvo».

Un 18enne evita la tragedia nella metropolitana.

Il sindaco: «Voglio conoscerti».

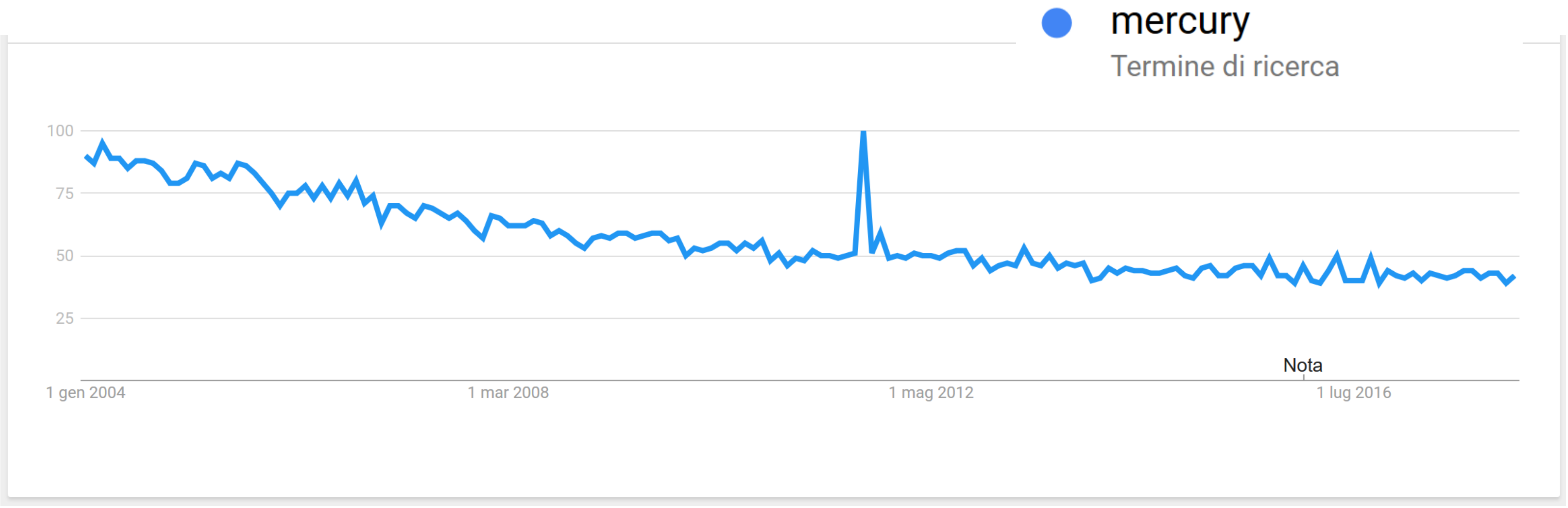
«Un minuto e mezzo.

Ce la faccio».

Questa l'unica cosa somigliante a un pensiero che — ore più tardi — il diciottenne Lorenzo Pianazza riesce a ricordare di quei trenta secondi di inconsapevole eroismo metropolitano.

Lexical-semantic analytics for NLP

- Based on analytics computed on the ELEXIS resources for words, phrases, collocations, senses, domains, etc. we will explore three directions:
  - **T.3.3.3 Diachronic distribution of senses:** sense frequency ranking over time across resources (Most Frequent Sense is a strong baseline in WSD)



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Challenges in lexical-semantic analytics

- **Sense clustering:**
  - Fine granularity
  - Not obvious what a good cluster of senses is
- **Domain labeling of text:**
  - Elicit information from ELEXIS resources (what is a good set of domain labels? which resources provide domain-specific content?)
  - Work in dozens of languages
- **Diachronic distribution of senses:**
  - Create reliable distributions of senses in many languages
  - Leverage such distributions in WSD and Entity Linking
- **See interaction with WP4**

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elexis

Crowdsourcing and gamification

- Objectives:
  - Validating the output of WP2 (links between resources, the dictionary matrix)
  - Validating and improving the data produced by WP3 and WP4

- Proposal for a crossword game developed jointly with Babelscape
- Other crowdsourcing efforts are on-going

- Goal: collect experiences from the consortium and observers

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Questions?

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