NLP for History

Methods and tools for textual analysis in the historical domain

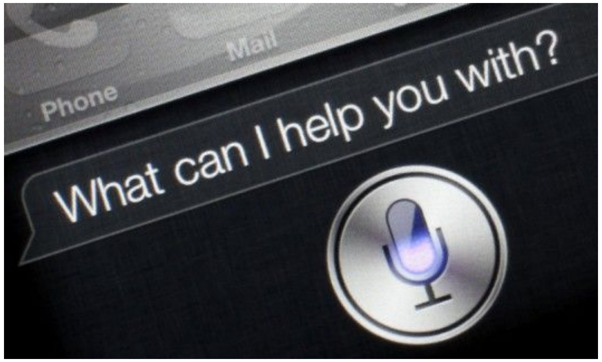
Rachele Sprugnoli

FONDAZIONE BRUNO KESSLER

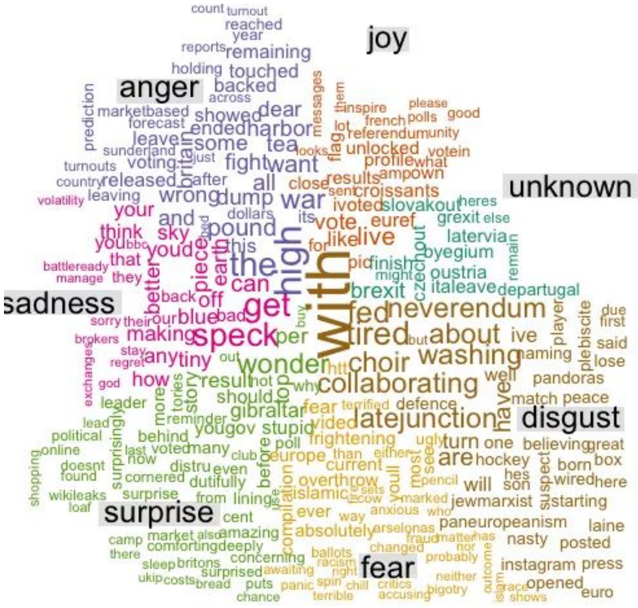
DH DIGITAL HUMANITIES

Natural Language Processing

- Goal: create machines that understand natural languages
- Method: computer science + statistics + linguistics + philosophy of language

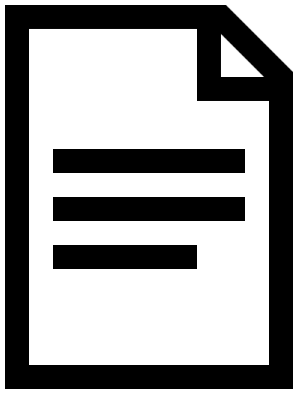


Google Translate



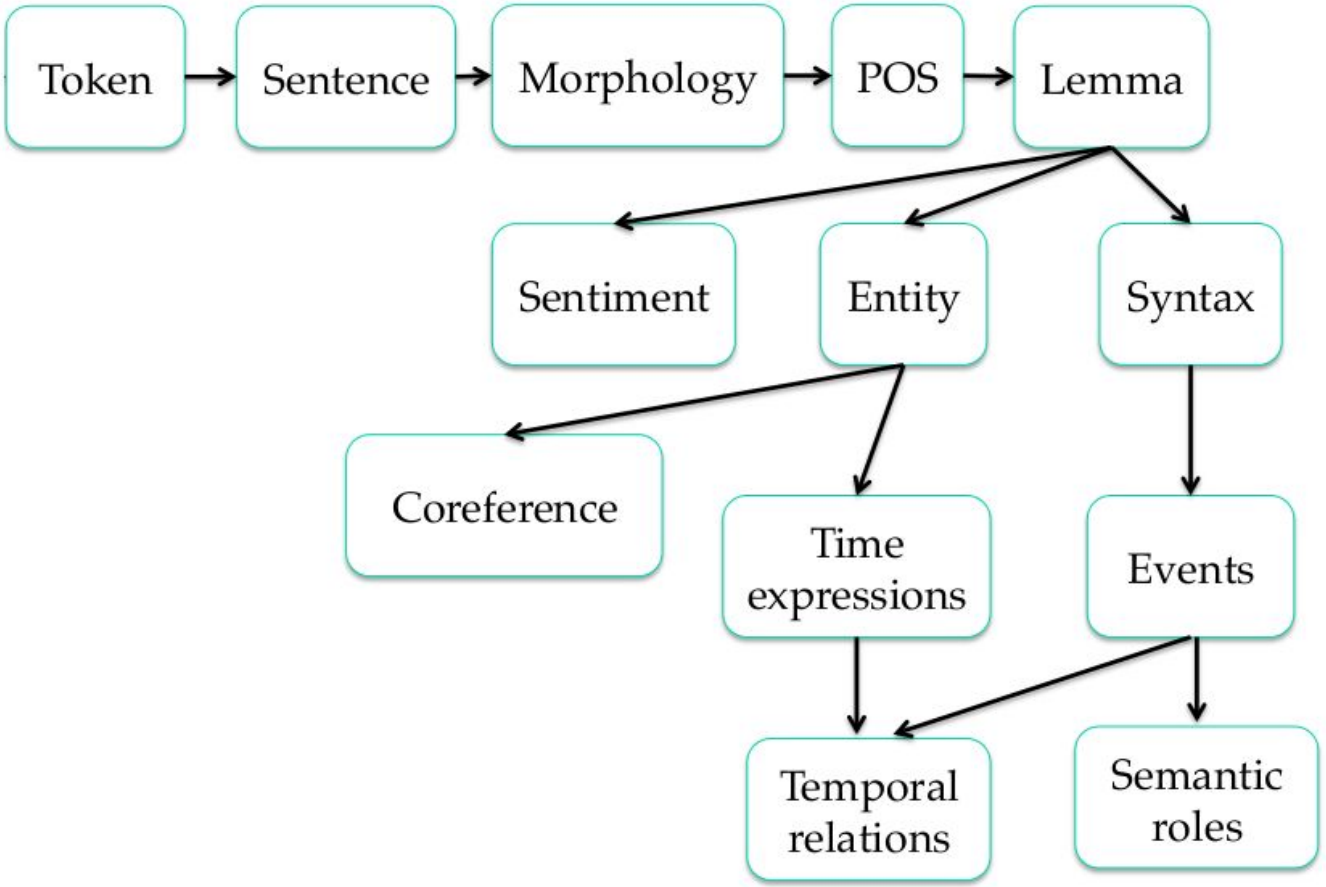
Natural Language Processing

- Oral History and Technology: http://oralhistory.eu/

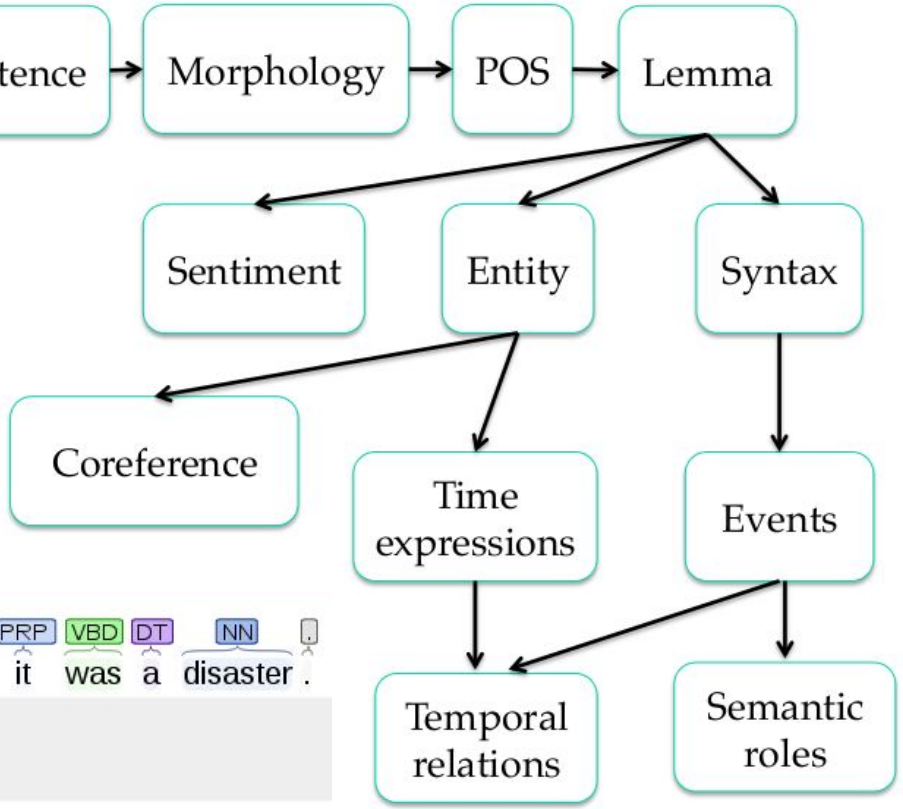


- “Natural Language Processing for Historical Texts” by Michael Piotrowski

How to process the language?

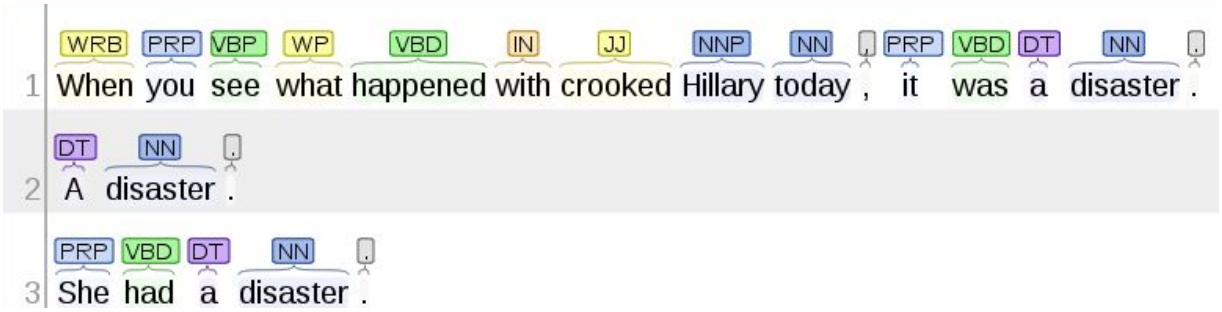


How to process the language?

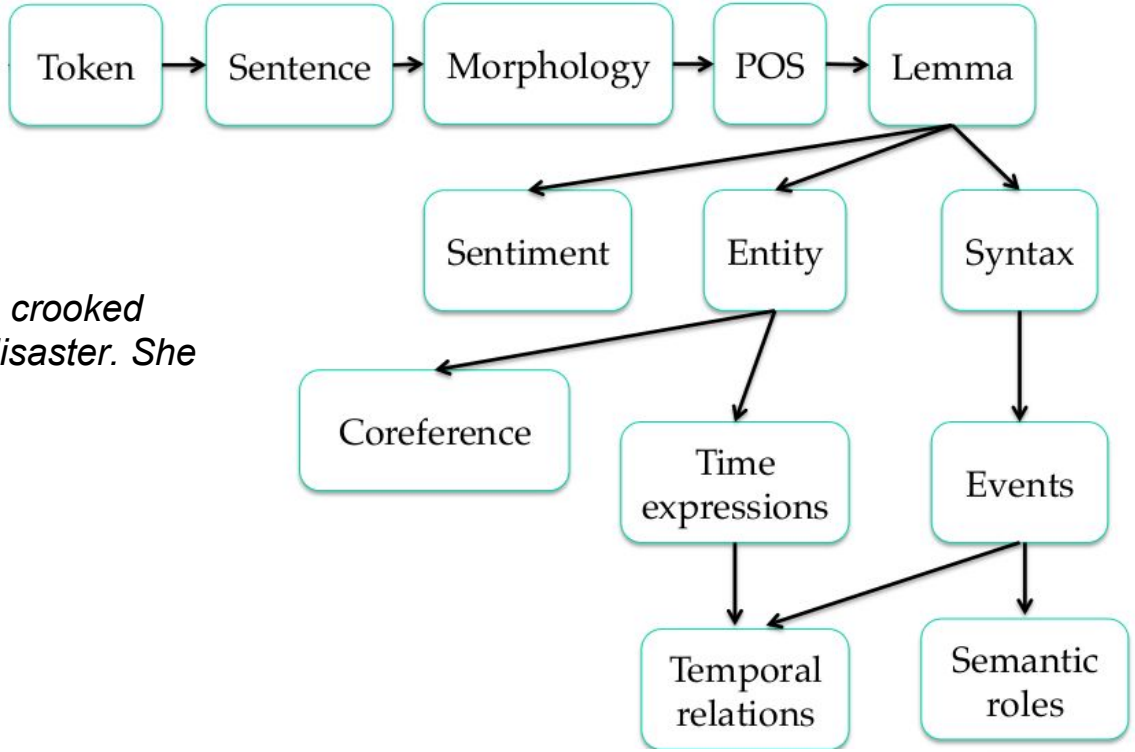


When you see what happened with crooked Hillary today, it was a disaster. A disaster. She had a disaster.
Trump, 2016-08-05

TOKEN - SENTENCE - PART OF SPEECH

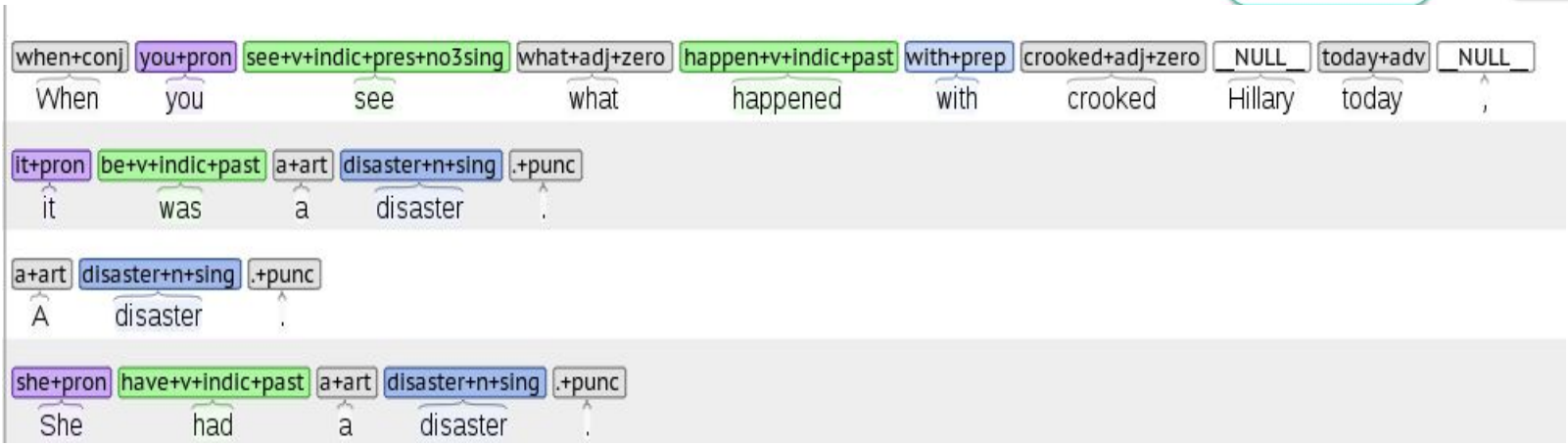


How to process the language?

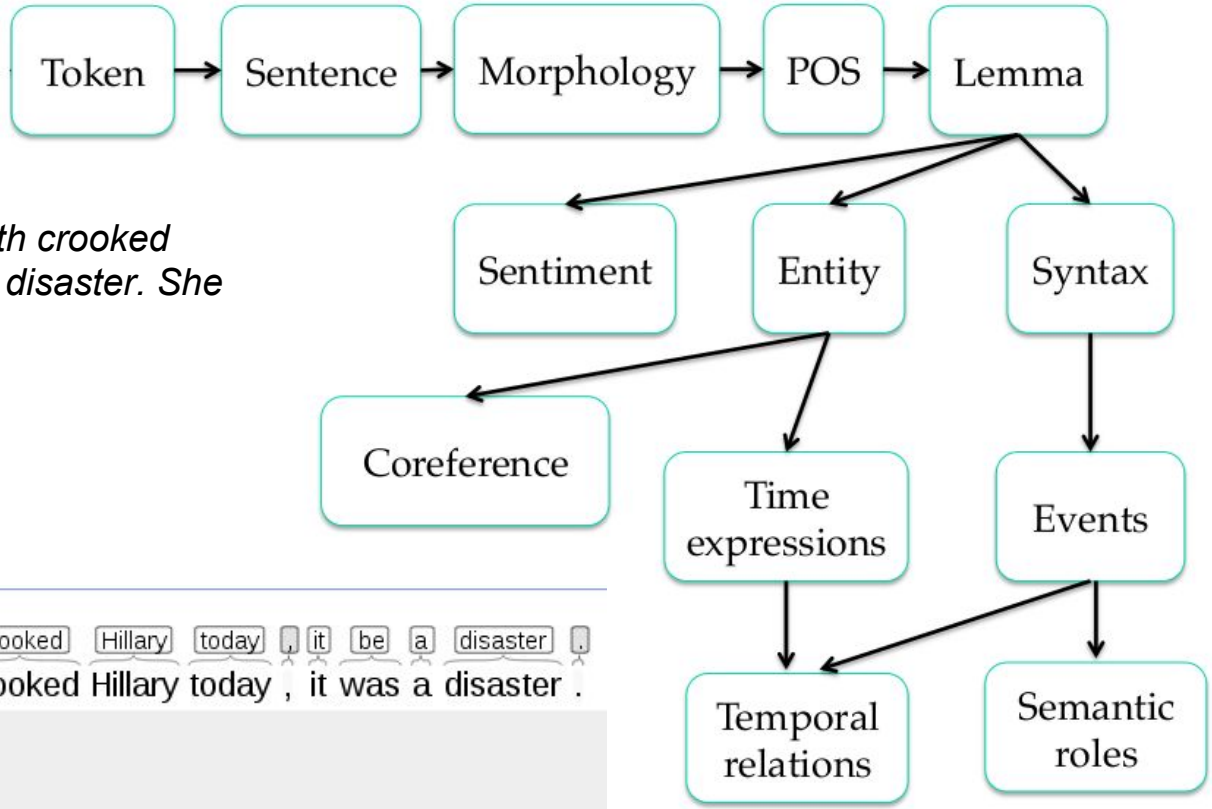


When you see what happened with crooked Hillary today, it was a disaster. A disaster. She had a disaster.
Trump, 2016-08-05

MORPHOLOGY



How to process the language?



When you see what happened with crooked Hillary today, it was a disaster. A disaster. She had a disaster.
Trump, 2016-08-05

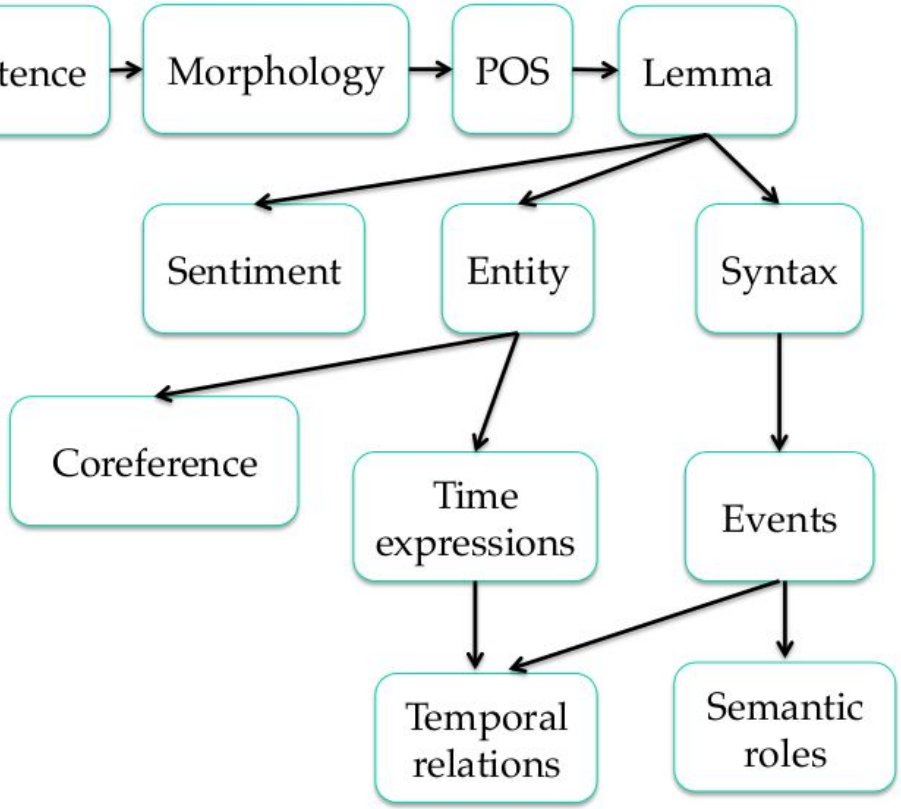
LEMMA

when you see what happen with crooked Hillary today , it be a disaster .
When you see what happened with crooked Hillary today , it was a disaster .

a disaster .
A disaster .

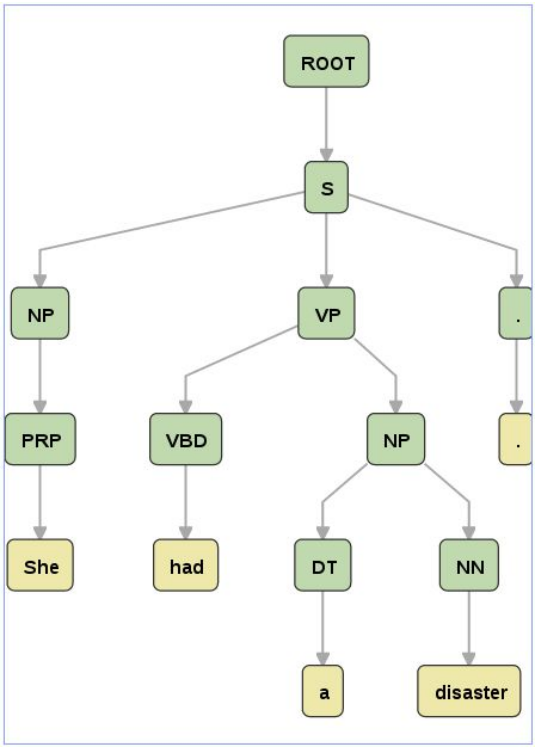
she have a disaster .
She had a disaster .

How to process the language?

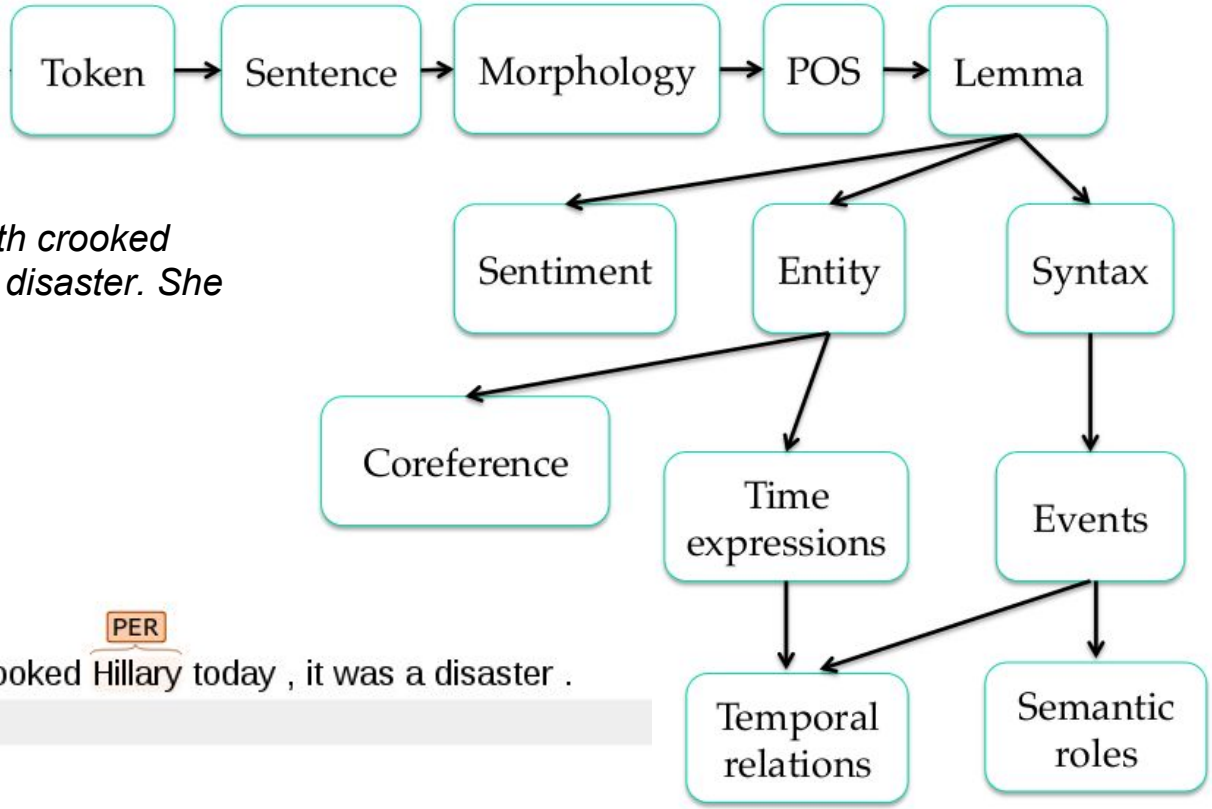


When you see what happened with crooked Hillary today, it was a disaster. A disaster. She had a disaster.
Trump, 2016-08-05

SYNTAX



How to process the language?

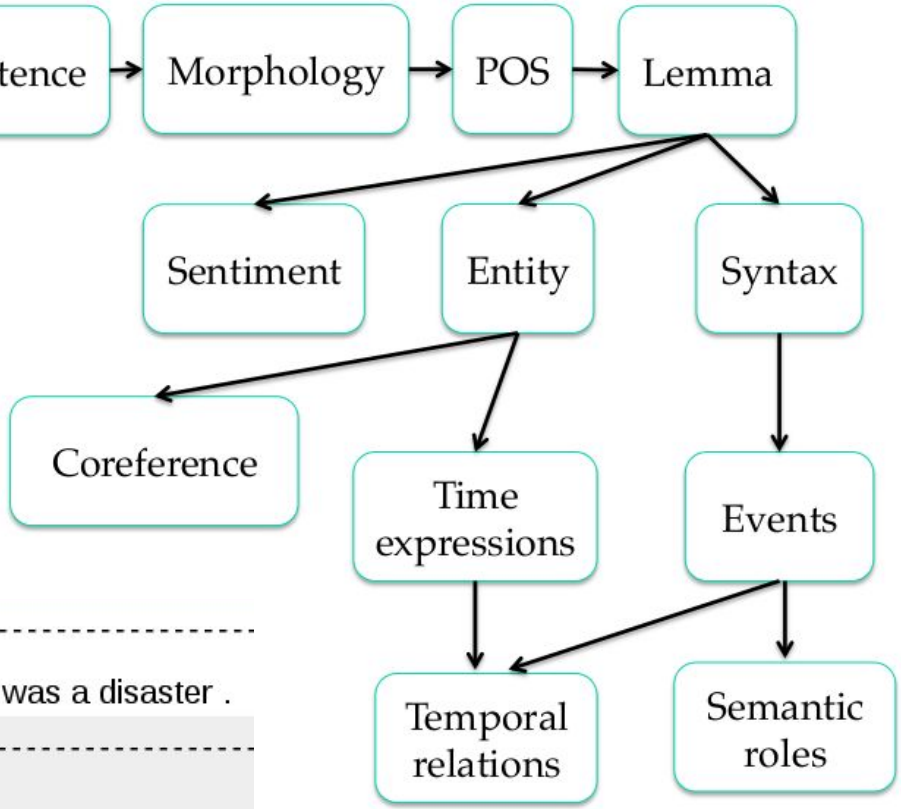


When you see what happened with crooked Hillary today, it was a disaster. A disaster. She had a disaster.
Trump, 2016-08-05

ENTITY

PER
When you see what happened with crooked Hillary today , it was a disaster .
A disaster .
She had a disaster .

How to process the language?



When you see what happened with crooked Hillary today, it was a disaster. A disaster. She had a disaster.
Trump, 2016-08-05

COREFERENCE

Mention

When you see what happened with crooked Hillary today , it was a disaster .

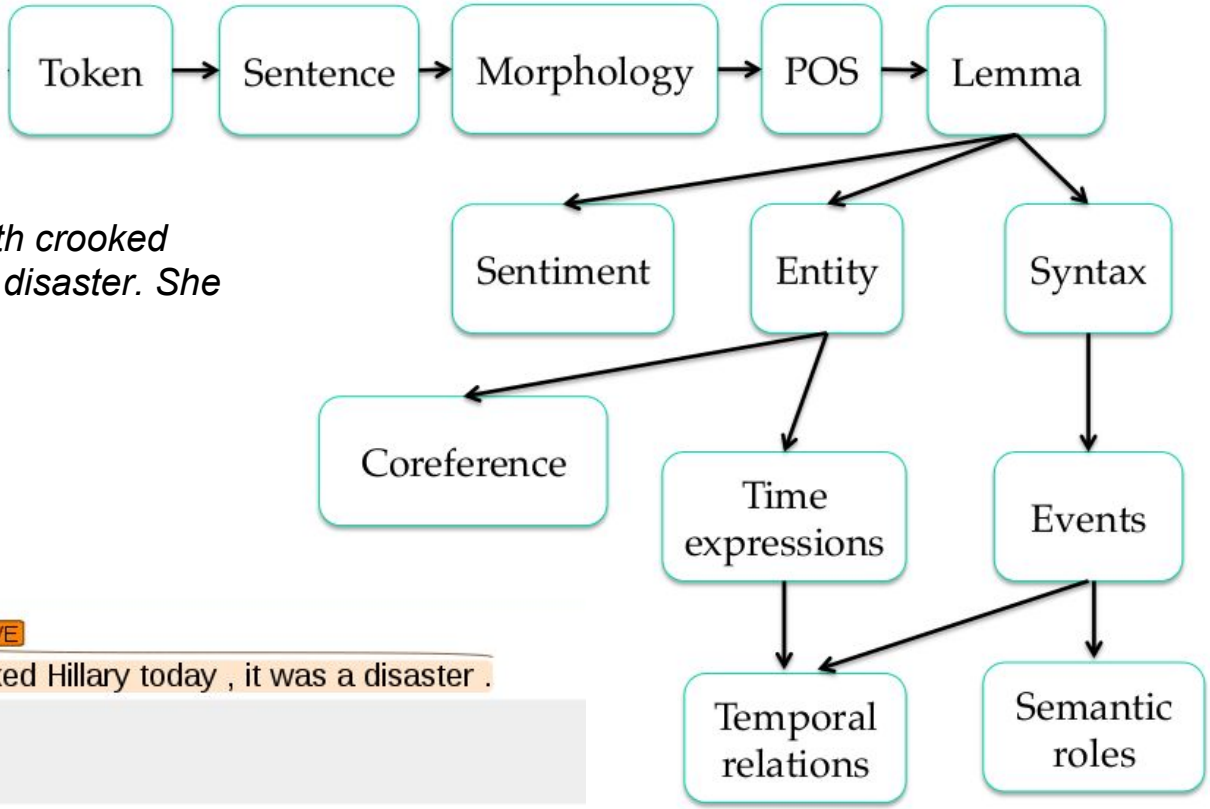
A disaster .

---coref---

Mention

She had a disaster .

How to process the language?



When you see what happened with crooked Hillary today, it was a disaster. A disaster. She had a disaster.
Trump, 2016-08-05

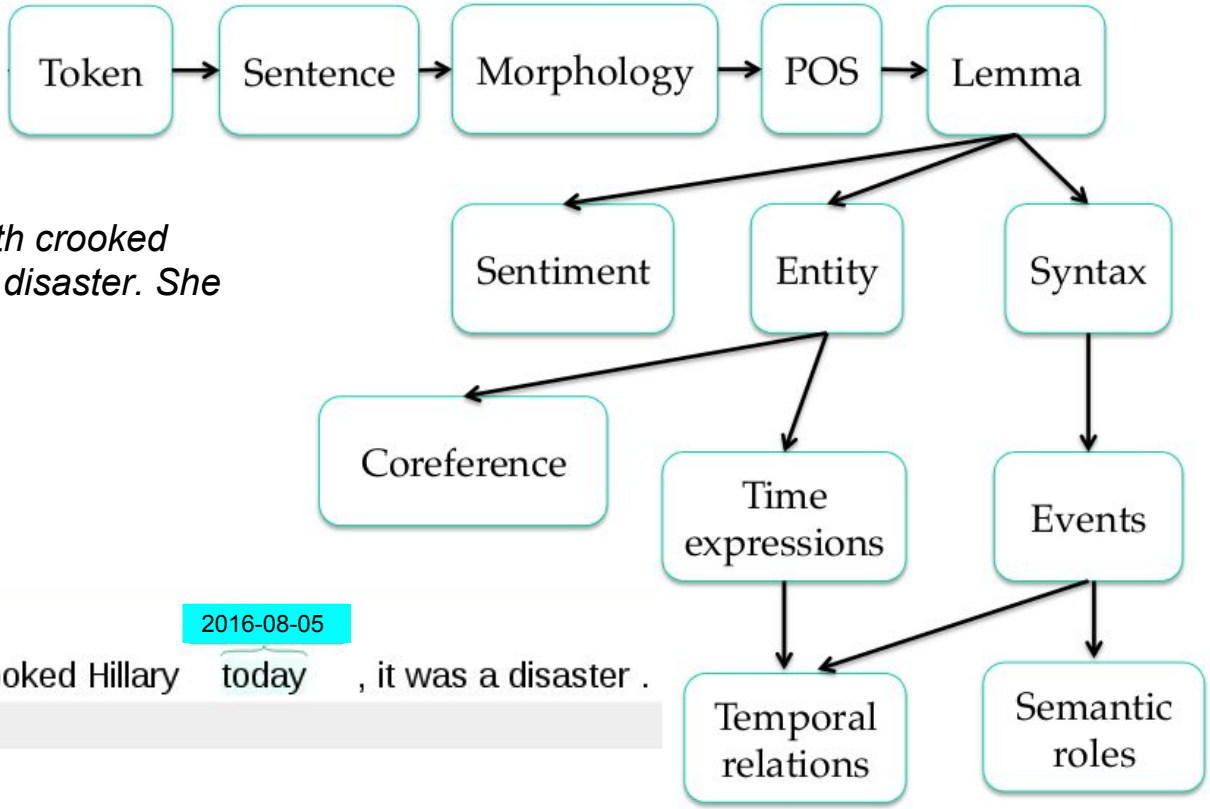
SENTIMENT

NEGATIVE
When you see what happened with crooked Hillary today , it was a disaster .

VERY NEGATIVE
A disaster .

NEGATIVE
She had a disaster .

How to process the language?



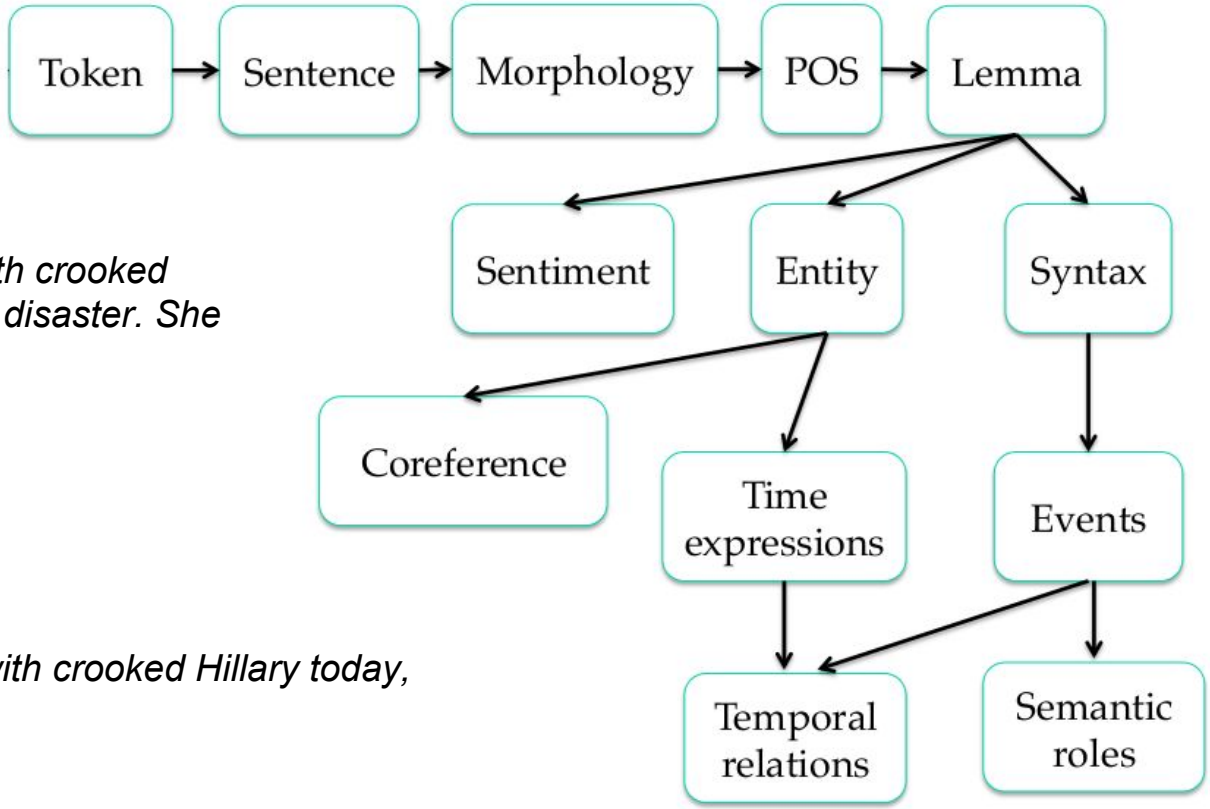
When you see what happened with crooked Hillary today, it was a disaster. A disaster. She had a disaster.
Trump, 2016-08-05

TIME EXPRESSIONS

2016-08-05

When you see what happened with crooked Hillary today , it was a disaster .
A disaster .
She had a disaster .

How to process the language?

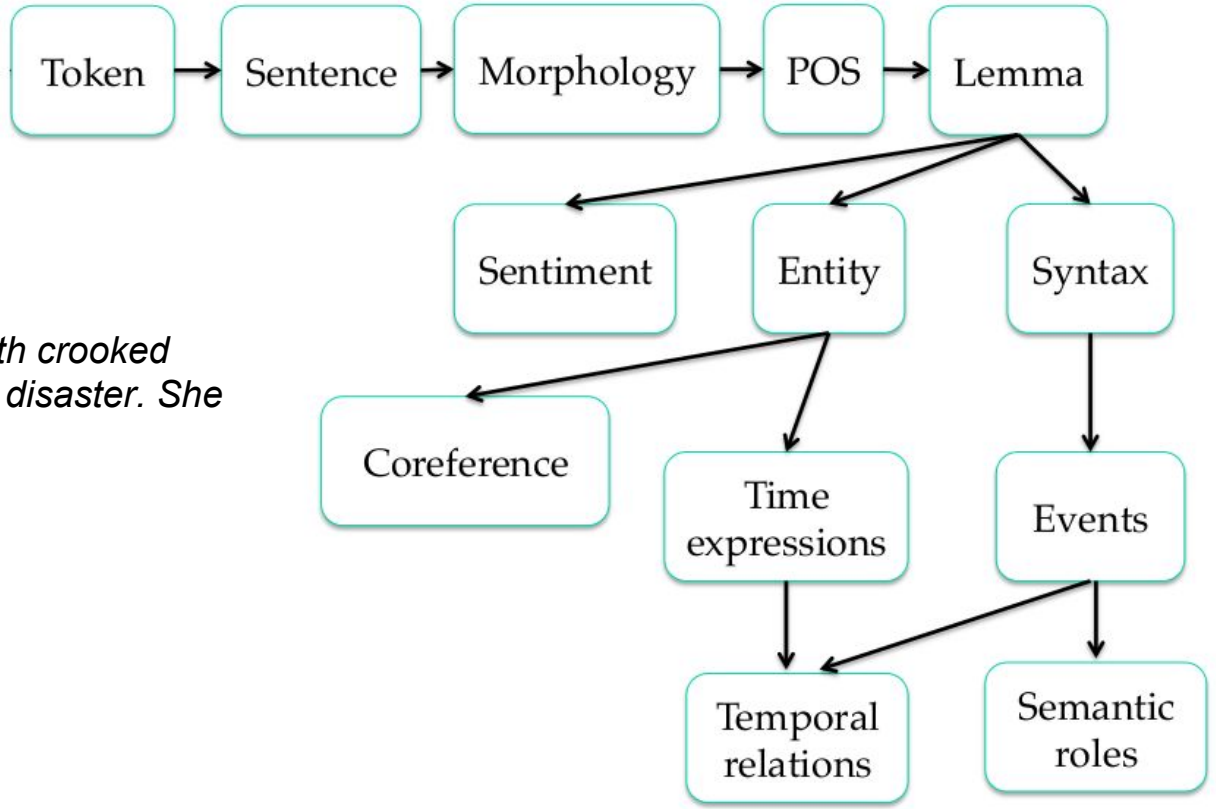


When you see what happened with crooked Hillary today, it was a disaster. A disaster. She had a disaster.
Trump, 2016-08-05

EVENTS

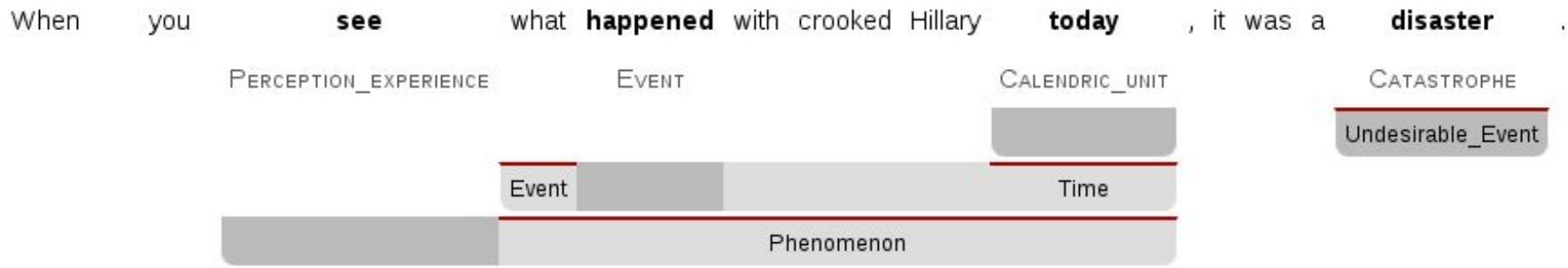
PERCEPTION OCCURRENCE
When you see what happened with crooked Hillary today,
STATE
it was a disaster.

How to process the language?

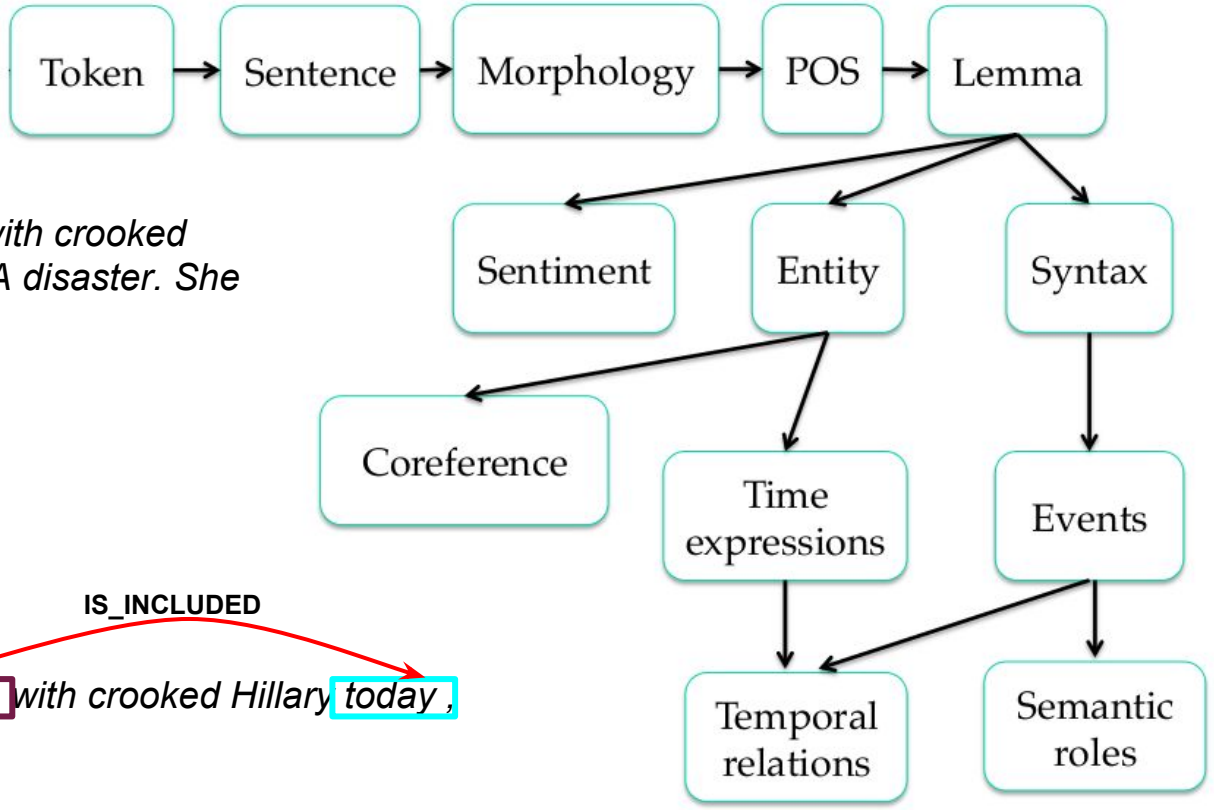


When you see what happened with crooked Hillary today, it was a disaster. A disaster. She had a disaster.
Trump, 2016-08-05

SEMANTIC ROLES



How to process the language?



When you see what happened with crooked Hillary today, it was a disaster. A disaster. She had a disaster.
Trump, 2016-08-05

TEMPORAL RELATIONS

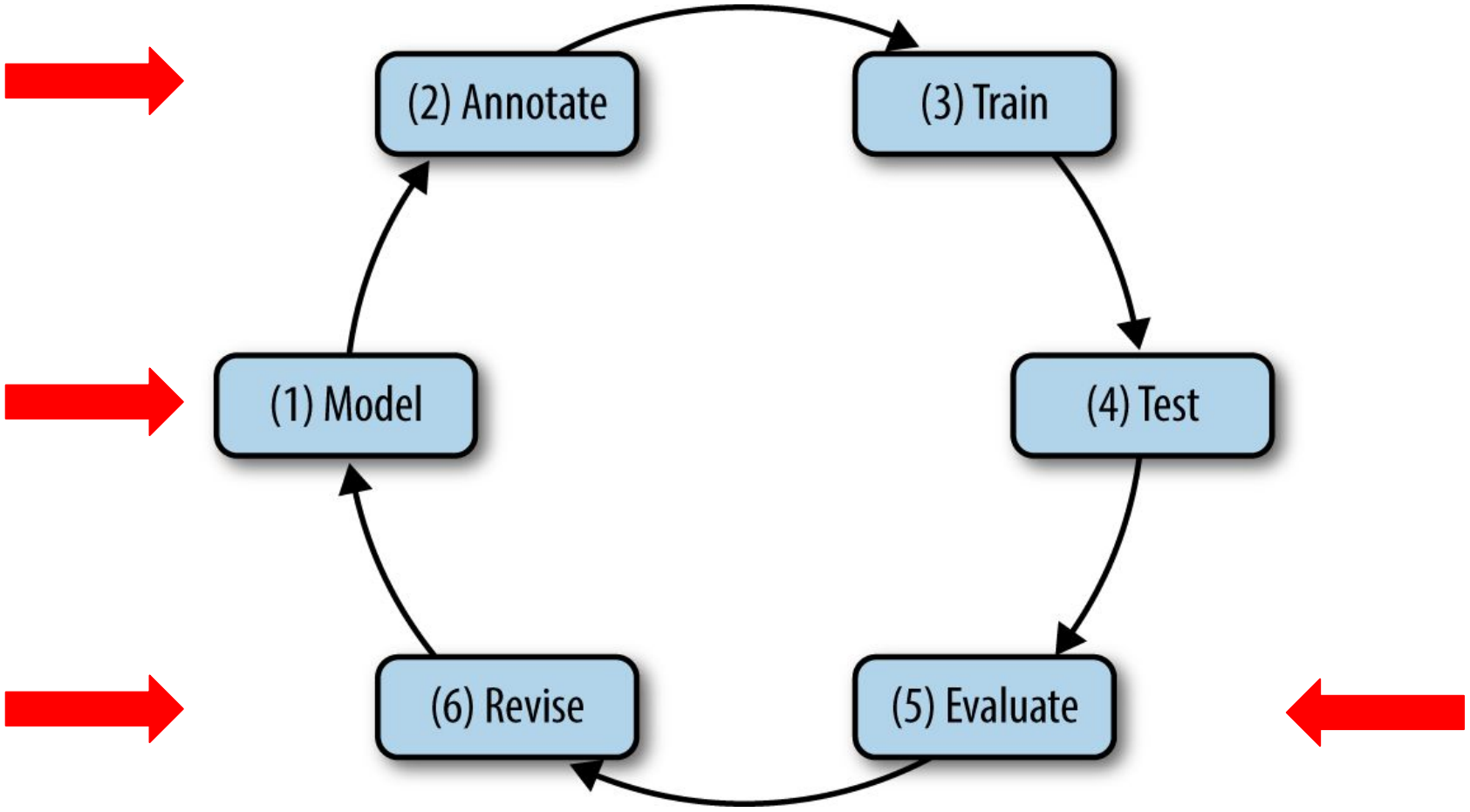
IS_INCLUDED

When you see what happened with crooked Hillary today ,

it was a disaster.

Mission

The MATTER cycle



From model to annotated data to automatic systems

(Pustejovsky and Stubbs, 2012)

Applications

- Digital History applications:

1. ALCIDE
2. RAMBLE ON / LOD NAVIGATOR
3. MARTIN for HISTORY

1) The ALCIDE Platform

ALCIDE: *Analysis of Language and Content In a Digital Environment*

ISIG
ISTITUTO STORICO ITALO-GERMANICO
ITALIENISCH-DEUTSCHES HISTORISCHES INSTITUT

- **General goal**: give means to investigate who, where, when, what and how in large Humanities corpora

http://celct.fbk.eu:8080/Alcide_Demo/

- Moretti, G., Sprugnoli, R., Menini, S., & Tonelli, S. (2016). ALCIDE: Extracting and visualising content from large document collections to support humanities studies. *Knowledge-Based Systems*, *111*, 100-112.
- Sprugnoli, R., Moretti, G., Tonelli, S., & Menini, S. (2016). Fifty years of European history through the Lens of Computational Linguistics: the De Gasperi Project. *Italian Journal of Computational Linguistics.*
- Cau, M., & Largaiolli, M. (2017). La piattaforma ALCIDE per l'analisi del discorso politico. Un progetto di ricerca transdisciplinare. *Storicamente*, 12.

2) RAMBLE ON

- Tracing Movements of Popular Historical Figures

"Perhaps people will soon be persuaded that there is no patriotic art and no patriotic science. Both belong, like everything good, to the whole world and can be promoted only through general, ***free interaction among all who live at the same time****."*

Goethe, 1826

- Movements of notable individuals can affect social organization and culture

- Menini, S., Sprugnoli, R., Moretti, G., Bignotti, E., Tonelli, S., & Lepri, B. (2017). RAMBLE ON: Tracing Movements of Popular Historical Figures. *EACL 2017*, 77.

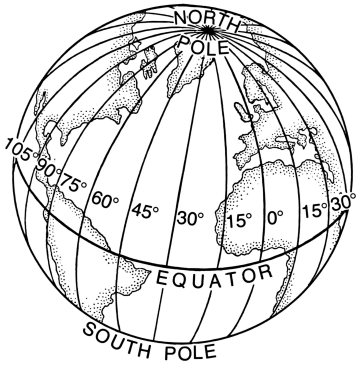
2) RAMBLE ON

- Our approach: automatic extraction of motion trajectories from Wikipedia biographies

In 1914, the couple separated; **Einstein** moved to Berlin

He settled in the U.S., becoming an American citizen in 1940

In 1946 **Einstein** visited Lincoln University



http://dh.fbk.eu/technologies/rambleon

2) RAMBLE ON

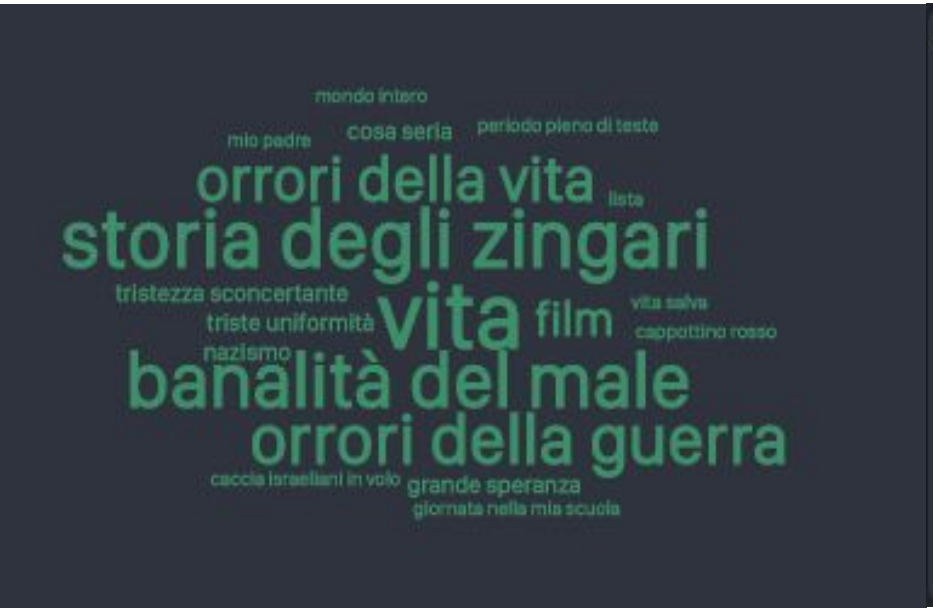
- LOD NAVIGATOR

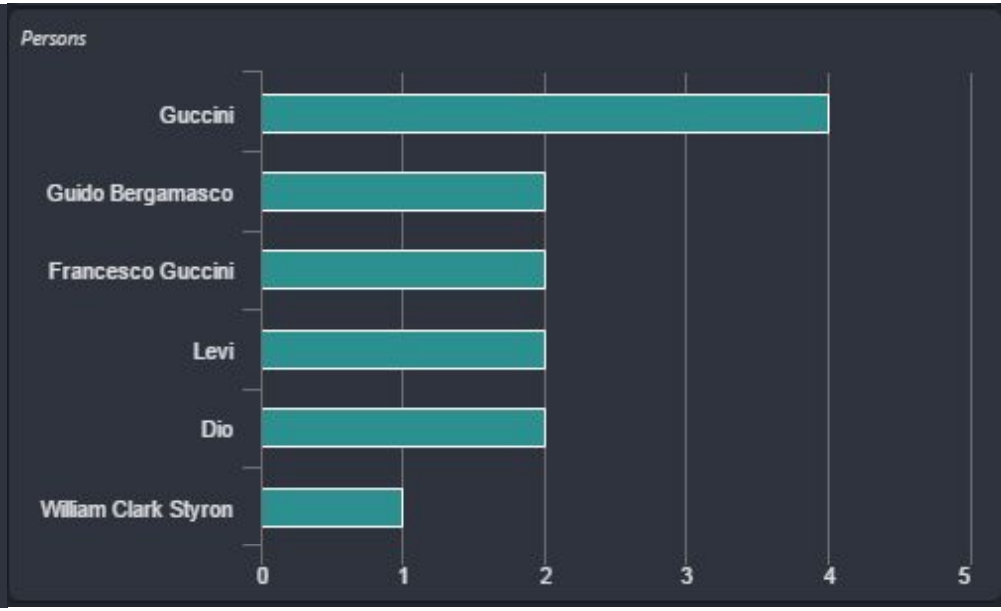
https://youtu.be/OxGob8INbtM

3) MARTIN

- *Monitoring and Analysing Real-time Tweets in Italian Natural language*

#giornatadellamemoria





- Sprugnoli, R., Moretti, G., Tonelli, S.. (2017). Twitter Data Exploration for Italian History. AIUCD 2017.

Hands-on Session

- Topic modeling
- Key-concept extraction
- Domain identification

+

- Data visualization for dissemination

Corpus: goo.gl/yQqvVA

Data Visualization

- From words to numbers to visualizations

  - D3.js: https://d3js.org/

    Examples: networks in ALCIDE
    other dynamic and interactive graphs

  - RAW Graphs: http://rawgraphs.io/

    Examples: with topic modeling, keyphrase extraction, domain identification

Topic Modeling

- What topics a corpus of documents contain?

But to fix our immigration system, we must change our leadership in Washington and we must change it quickly. Sadly, sadly there is no other way. The truth is our immigration system is worse than anybody ever realized. But the facts aren't known because the media won't report on them. The politicians won't talk about them and the special interests spend a lot of money trying to cover them up because they are making an absolute fortune. That's the way it is. Today, on a very complicated and very difficult subject, you will get the truth. The fundamental problem with the immigration system in our country is that it serves the needs of wealthy donors, political activists and powerful, powerful politicians.

Trump, 31 August 2016

Topic Modeling

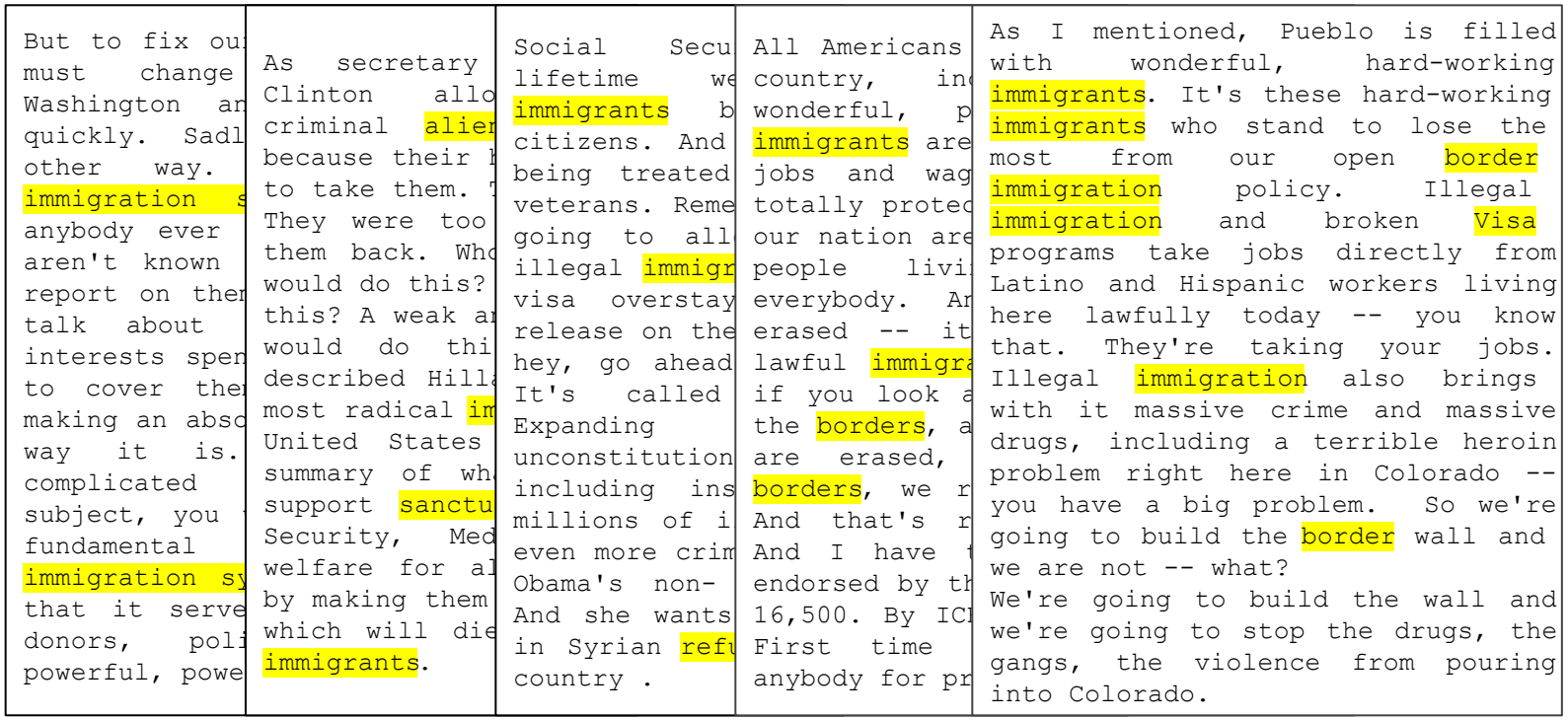
- What topics a corpus of documents contain?

But to fix our immigration system, we must change our leadership in Washington and we must change it quickly. Sadly, sadly there is no other way. The truth is our immigration system is worse than anybody ever realized. But the facts aren't known because the media won't report on them. The politicians won't talk about them and the special interests spend a lot of money trying to cover them up because they are making an absolute fortune. That's the way it is. Today, on a very complicated and very difficult subject, you will get the truth. The fundamental problem with the immigration system in our country is that it serves the needs of wealthy donors, political activists and powerful, powerful politicians.

Trump, 31 August 2016

- IMMIGRATION
- POLITICS
- ECONOMY

Topic Modeling



"That's how topic modeling works in practice. You assign words to topics randomly and then just keep improving the model, to make your guess more internally consistent, until the model reaches an equilibrium that is as consistent as the collection allows."

Ted Underwood, 2012

Topic Modeling : Pros and Cons

“Essentially, all models are wrong, but some are useful.”

George Box, 1987

- No easy method to evaluate the output
- No way to automatically determine the best number of topics for a corpus
- Too ambiguous and configurable

- Good starting point to explore data
- Generates new way of looking to big amount of texts

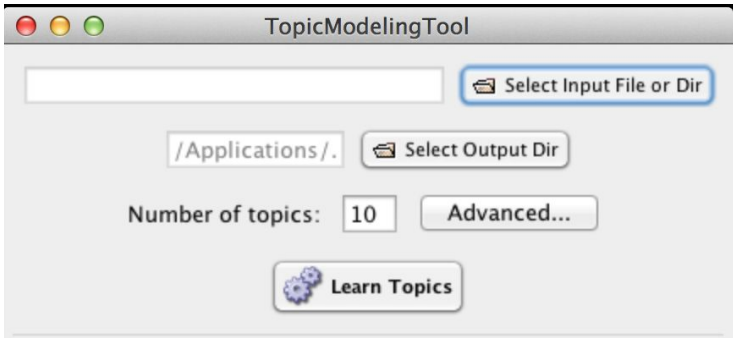
Topic Modeling : Tools

- MALLET:

http://mallet.cs.umass.edu/

- Topic-modeling-tool:

https://code.google.com/archive/p/topic-modeling-tool/



Let's try it!

Topic-modeling-tool

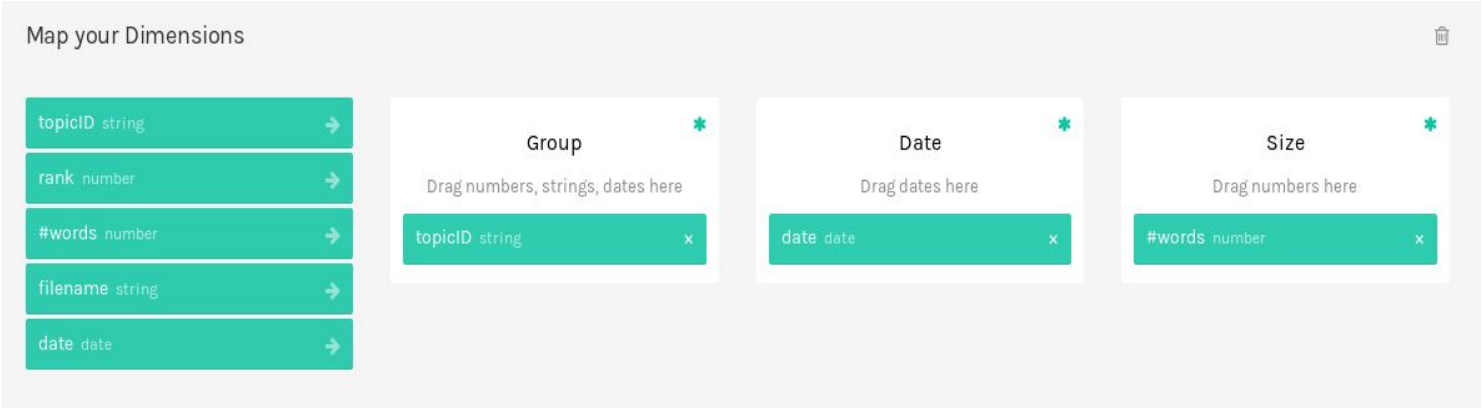
- Run the tool on Trump folder and then on Clinton folder (be careful not to overwrite the output folders) obtaining 30 topics for each folder
- Open all_topics.html using a browser and check the topics
- Select two topics in common between Trump and Clinton: e.g. **immigration / work / terrorism**
- Click on the list of keywords associated to those topics; another file opens up
- Copy the content of this file and paste it in a spreadsheet
- Repeat with the other topics both for Trump and Clinton

Topic-modeling-tool + RAW

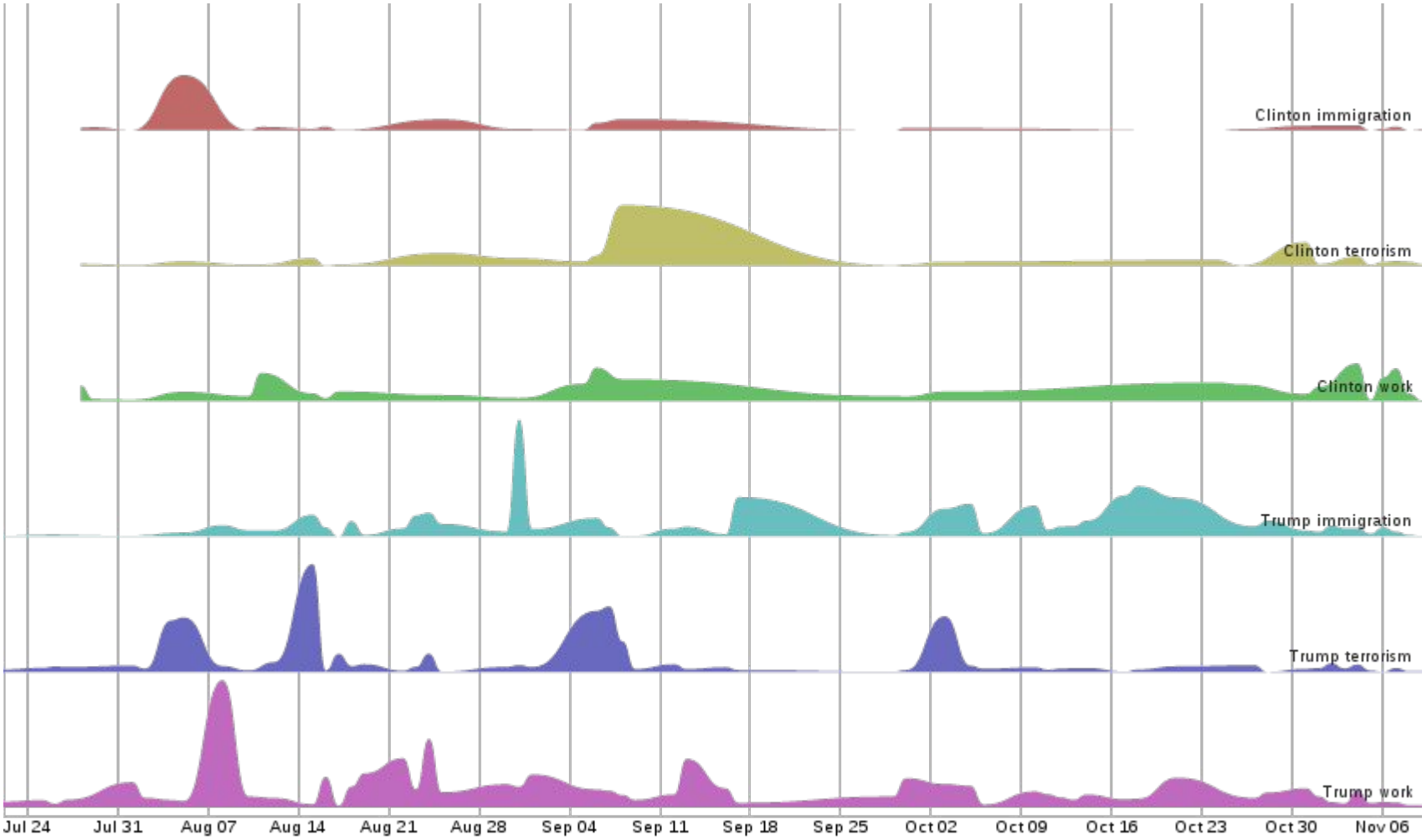
- Manipulate the content of the spreadsheet so to obtain something like this:

	A	B	C	D	E	F
1	speaker	topicID	rank	#words	filename	date
2	Trump	terrorism	2.	621	Trump_2016-08-15.txt	2016-08-15
3	Trump	terrorism	3.	376	Trump_2016-09-07-A.txt	2016-09-07
4	Trump	terrorism	4.	314	Trump_2016-08-05.txt	2016-08-05
5	Trump	terrorism	5.	300	Trump_2016-09-06-A.txt	2016-09-06

- Go to RAW: http://app.rawgraphs.io/
- Copy the content of the spreadsheet, select the **area chart** and map the dimensions as follows:



Topic-modeling-tool + RAW



Keyphrase Extraction

- Keyphrases (or key-concepts) = n-grams capturing the main concepts of documents

But to fix our **immigration system**, we must change our **leadership in Washington** and we must change it quickly. Sadly, sadly there is no other way. The truth is our **immigration system** is worse than anybody ever realized. But the facts aren't known because the **media** won't report on them. The **politicians** won't talk about them and the special interests spend a **lot of money** trying to cover them up because they are making an absolute **fortune**. That's the way it is. Today, on a very complicated and very difficult subject, you will get the truth. The fundamental problem with the **immigration system** in our **country** is that it serves the needs of **wealthy donors**, **political activists** and powerful, **powerful politicians**.

Both single words and multi-token expressions

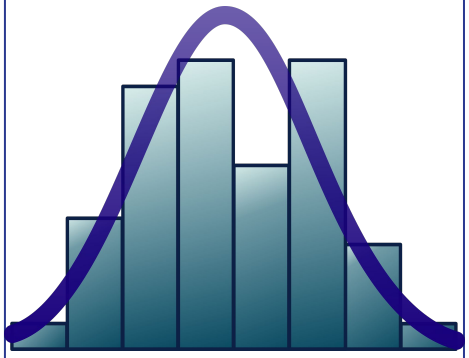
Both single documents and whole corpora

Keyphrase Extraction: Tool

- KD = Keyphrase Digger

http://celct.fbk.eu:8080/KD_KeyDigger/

STATISTICAL MEASURES



+

LINGUISTICS INFORMATION

=

WEIGHTED LIST OF KEYPHRASES

rank	keyword synonyms	frequency	score
1	kd	33	43.07
2	types of texts	2	23.24
3	kx	17	22.36
4	multi-token expressions	4	14.04
5	level of customizability	2	12.64
6	keyphrase extraction	5	9.55
7	humanities scholars	2	8.31
8	document collections	4	7.08
9	configuration	4	6.87
10	set of key-concepts	2	6.63

KD

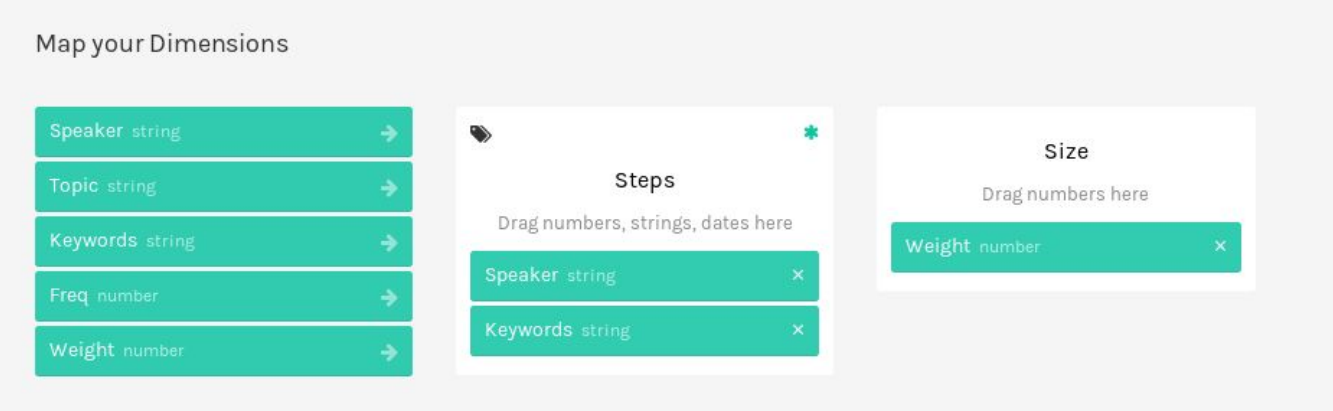
- Open the most relevant document for the immigration topic in Trump: *Trump_2016-08-31.txt*
- Run the demo and check the results: how to deal with “country - countries”? http://textanalysisonline.com/spacy-word-lemmatize
- Download the results of KD in tsv format by clicking on the “Download Data” link under the word cloud
- Do the same process for Clinton’s most relevant file for the immigration topic: *Clinton_2016-08-05.txt*

KD+RAW

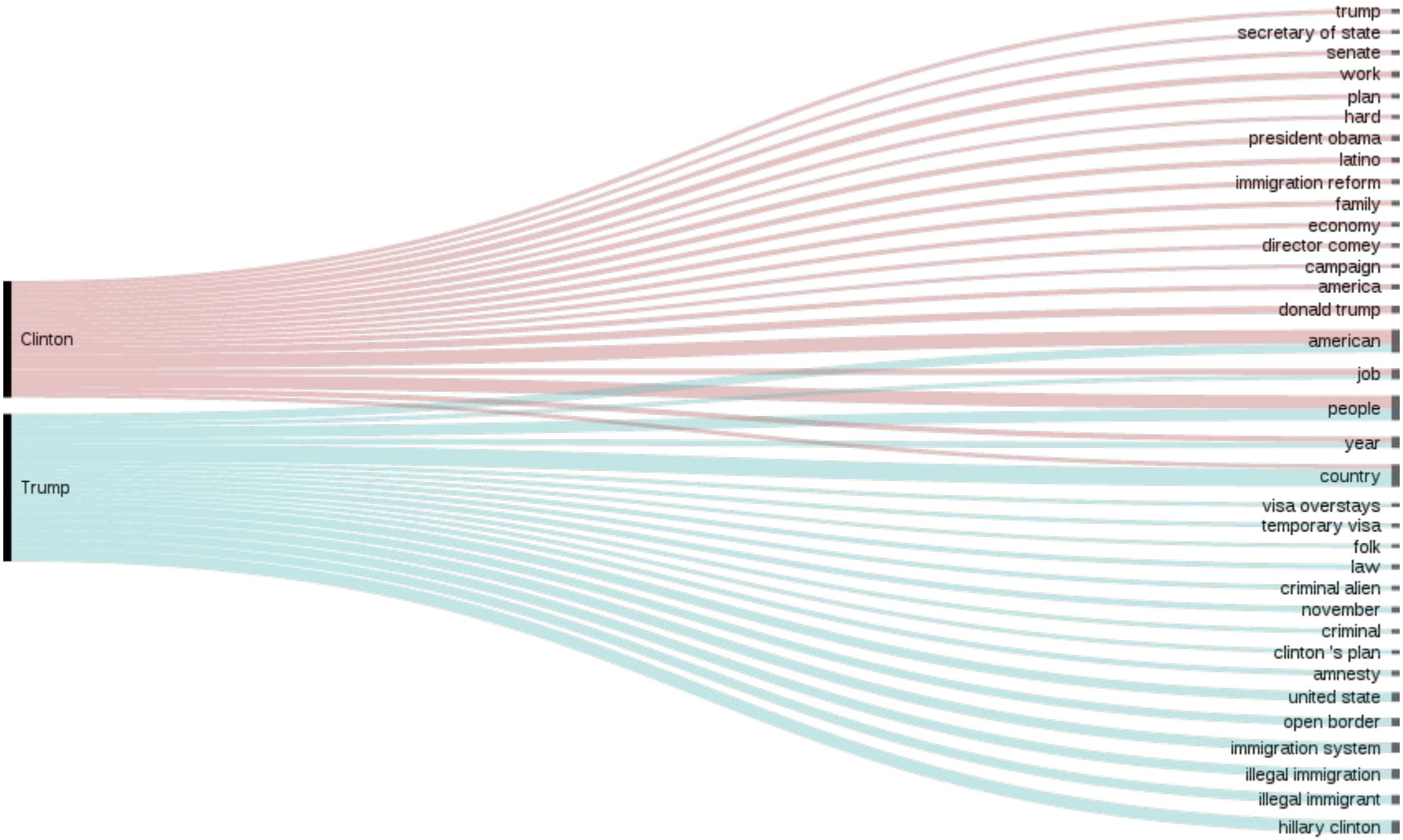
- Copy the content of each tsv file in a spreadsheet and create a file like the following:

	A	B	C	D	E
1	Speaker	Topic	Keywords	Freq	Weight
2	Trump	immigration	country	54	6.7323276399452325
3	Trump	immigration	hillary clinton	19	4.737563896963101
4	Trump	immigration	people	34	4.2388729584840235

- Copy the content of the spreadsheet and paste it in RAW
- Select the **Alluvial Diagram** chart with the following dimensions:

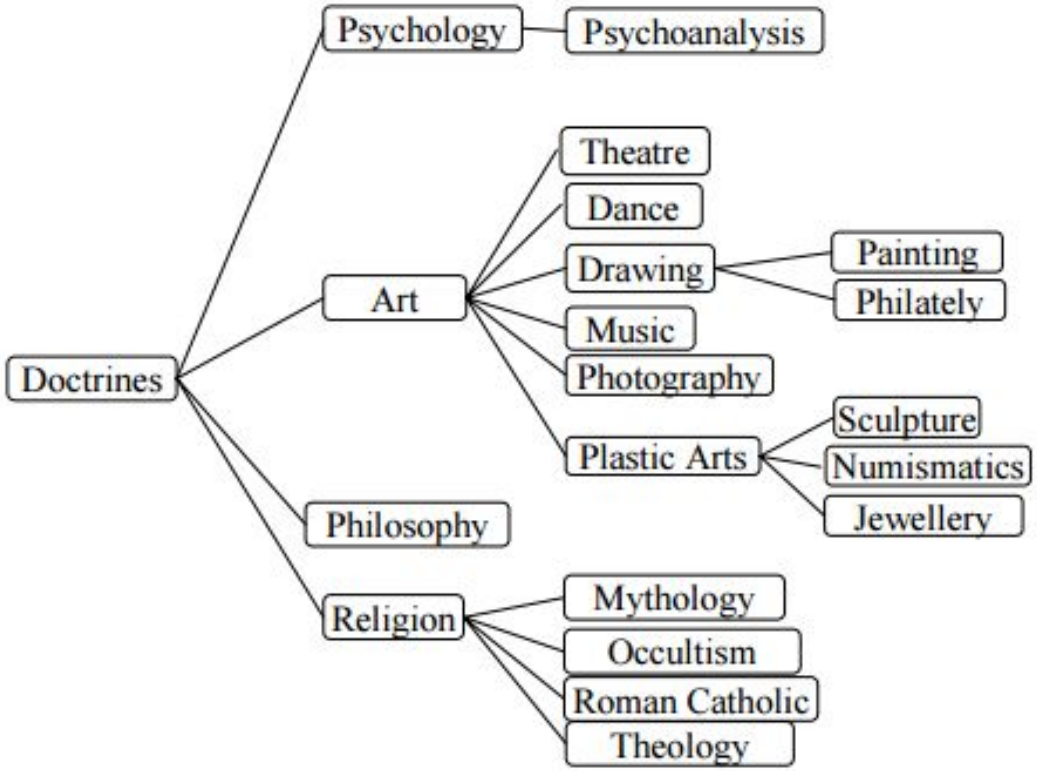


KD + RAW


Clinton
Trump
trump
secretary of state
senate
work
plan
hard
president obama
latino
immigration reform
family
economy
director comey
campaign
america
donald trump
american
job
people
year
country
visa overstays
temporary visa
folk
law
criminal alien
november
criminal
clinton 's plan
amnesty
united state
open border
immigration system
illegal immigration
illegal immigrant
hillary clinton

Domain Identification

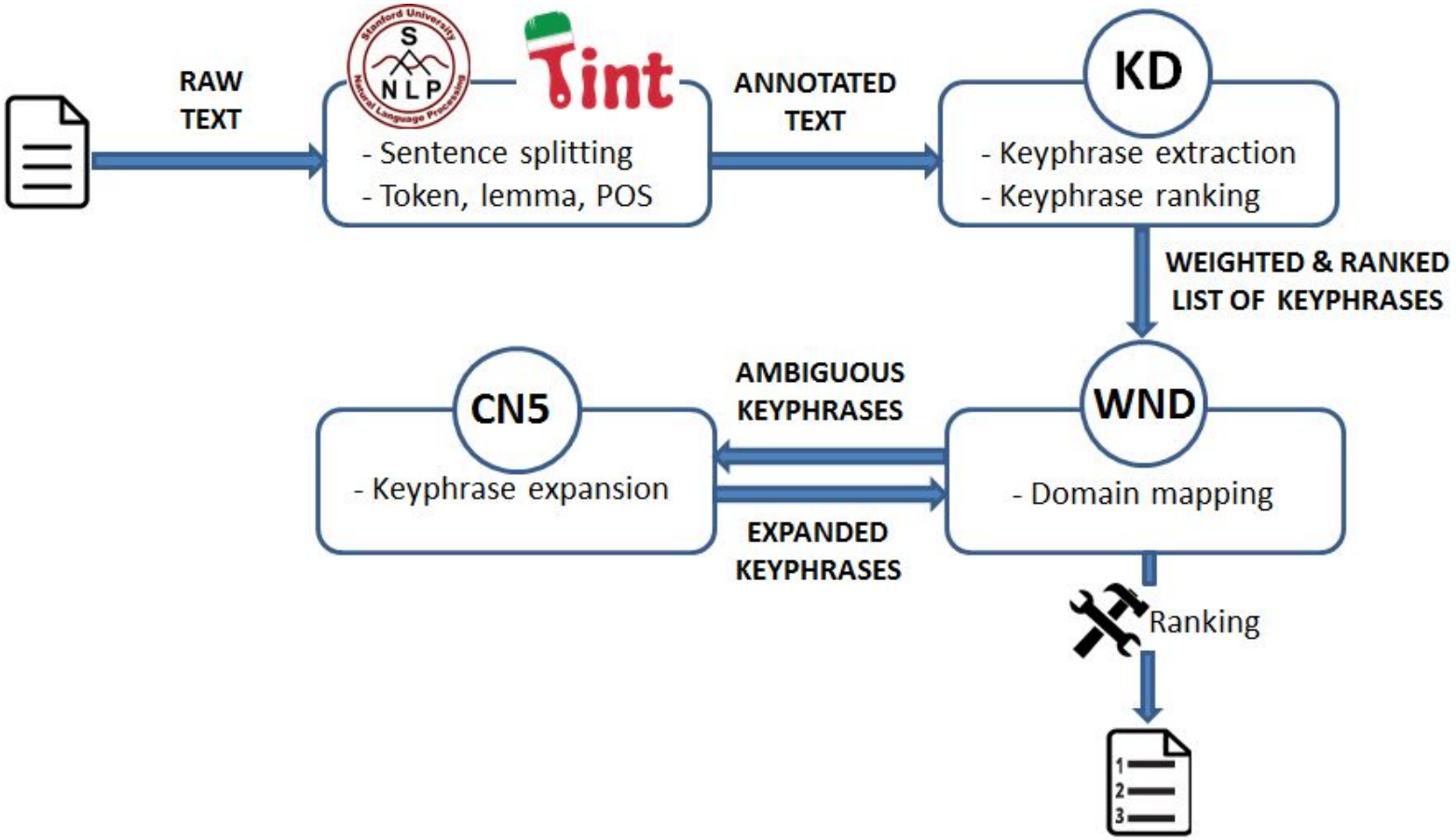
- Create clusters of keyphrases labelled by domain



Domain Identification: Tool

- L-KD: Labelled Keyphrase Digger

http://dhlab.fbk.eu:8080/L_KD/



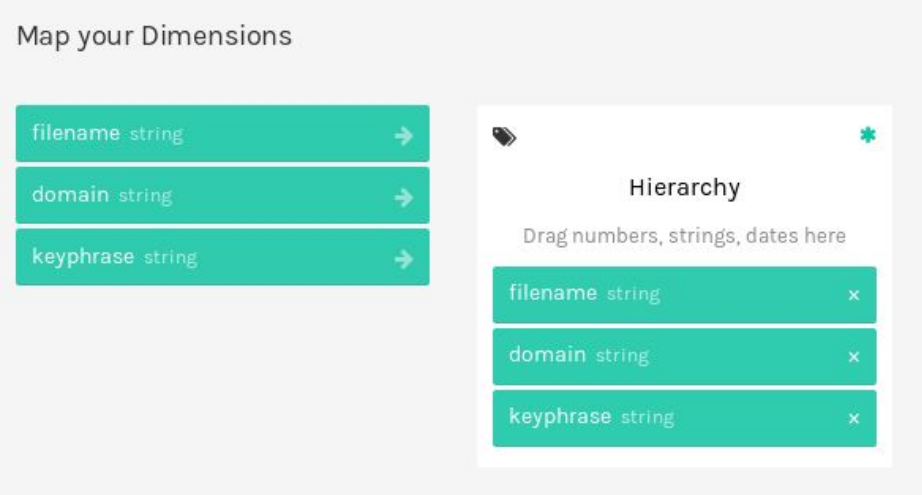
L-KD

- Open the most relevant document for the immigration topic in Trump: *Trump_2016-08-31.txt*
- Copy the text and paste it in the L-KD online demo: http://celct.fbk.eu:8080/L_KD/
- Copy the output and paste it in a spreadsheet creating a file like the following:

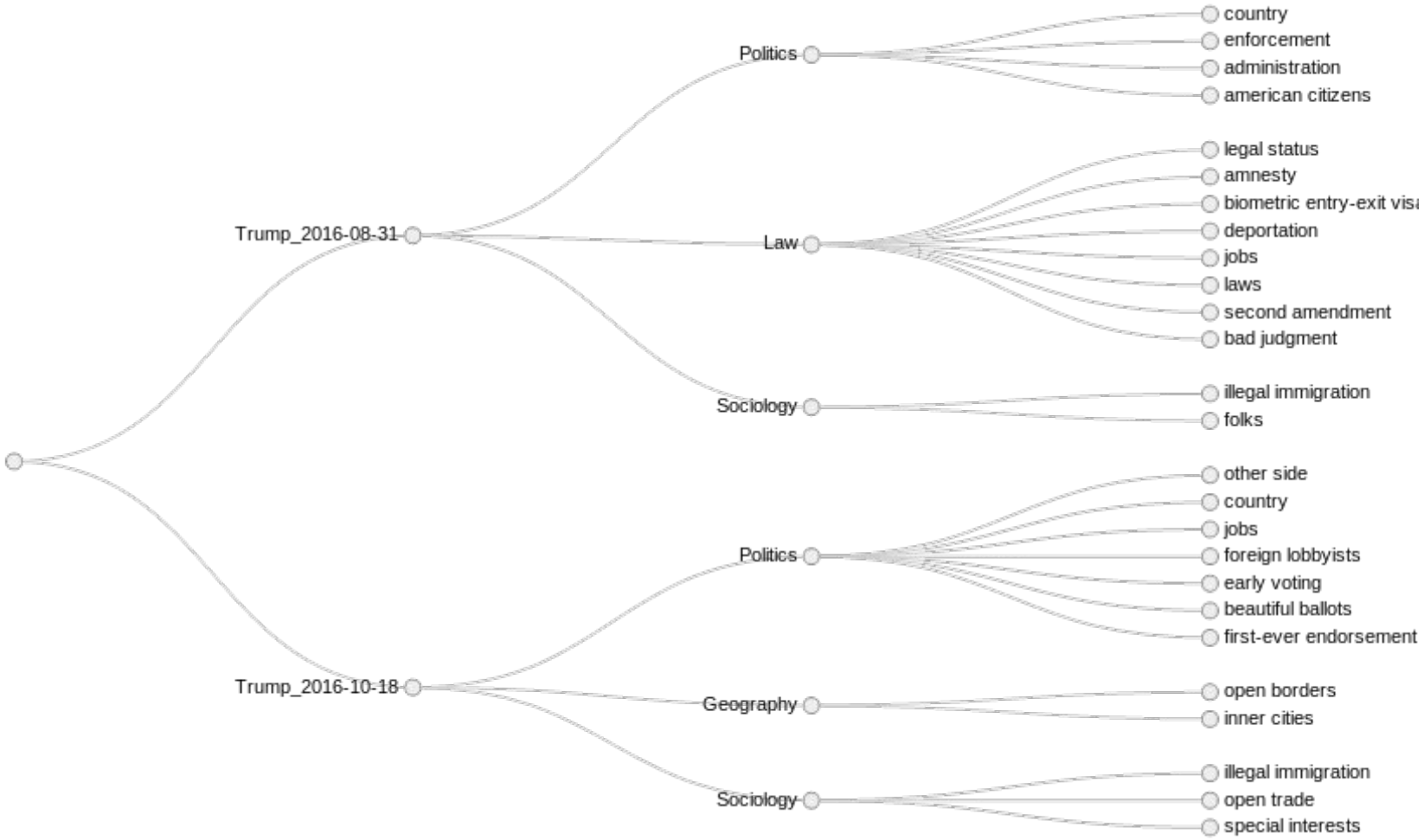
	A	B	C
1	filename	domain	keyphrase
2	Trump_2016-08-31	Politics	country
3	Trump_2016-08-31	Politics	enforcement
4	Trump_2016-08-31	Politics	administration
5	Trump_2016-08-31	Politics	american citizens
6	Trump_2016-08-31	Law	legal status
7	Trump_2016-08-31	Law	amnesty

L-KD + RAW

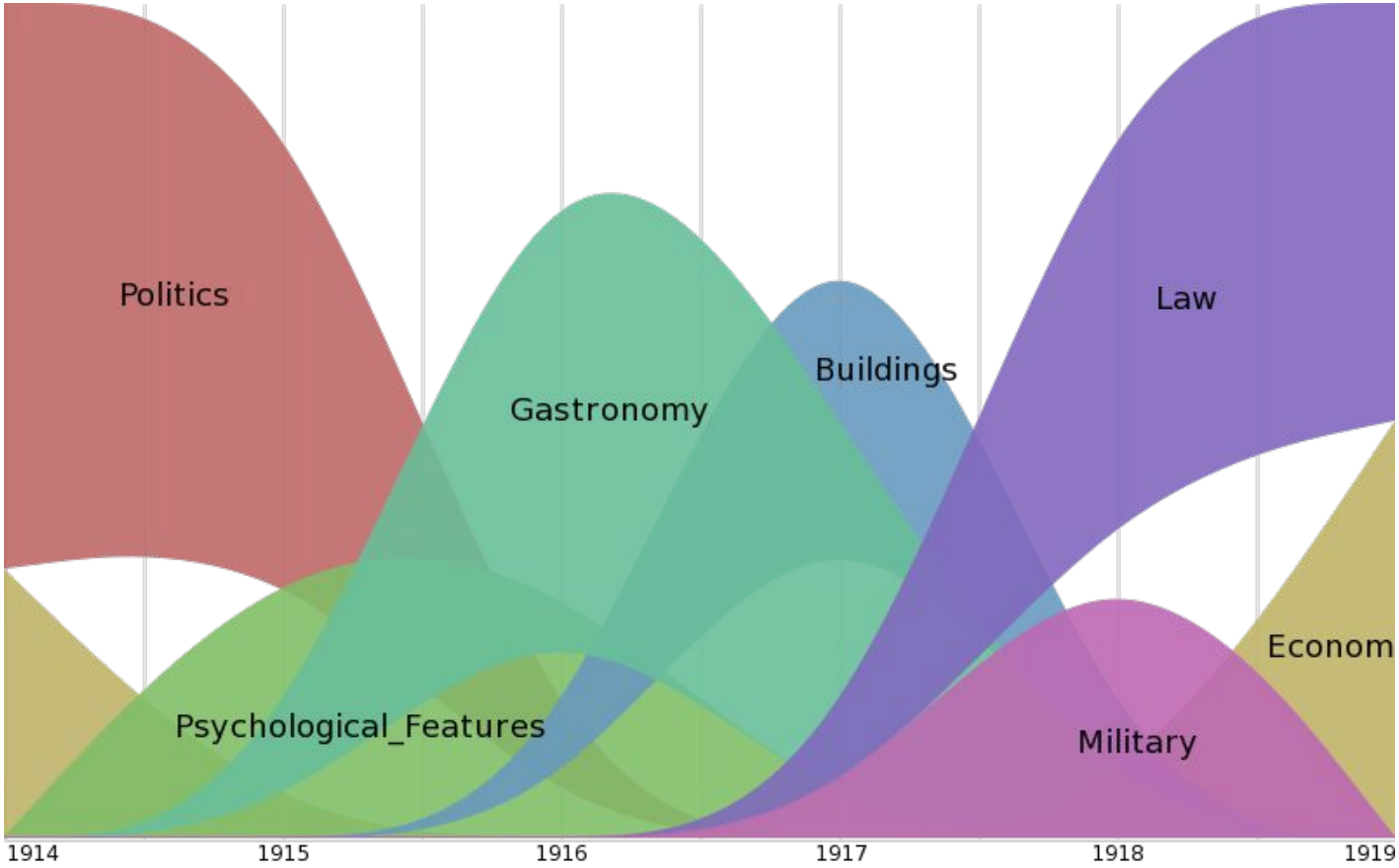
- Repeat for other files, eg. *Trump_2016_10_18.txt*
- Copy the content of the spreadsheet in RAW, select the Cluster Dendrogram with the following dimensions:



L-KD + RAW


Trump_2016-08-31
Politics
country
enforcement
administration
american citizens
Law
legal status
amnesty
biometric entry-exit visa
deportation
jobs
laws
second amendment
bad judgment
Sociology
illegal immigration
folks
Trump_2016-10-18
Politics
other side
country
jobs
foreign lobbyists
early voting
beautiful ballots
first-ever endorsement
Geography
open borders
inner cities
Sociology
illegal immigration
open trade
special interests

Domain Identification: Use Case



Top domains in De Gasperi's documents from 1914 to 1918

Conclusions

- In “traditional” NLP research, final users are not in the loop. In Digital Humanities, final users (scholars/historians) play a central role

- Friendly suggestions:
  - Be curious
  - Stay updated
  - Look for interdisciplinary collaborations

THANK YOU!

Email: sprugnoli@fbk.eu
Web Site: http://dh.fbk.eu
Twitter: https://twitter.com/DH_FBK

FONDAZIONE BRUNO KESSLER

DH DIGITAL HUMANITIES