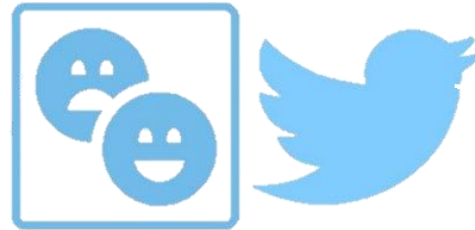


Part I: Intro NLP & Task at Hand



Part I: Intro NLP & Task at Hand

Intro NLP

Outline

- i. Intro NLP
- ii. Working Data
- iii. Task at Hand
- iv. Quanteda Universe

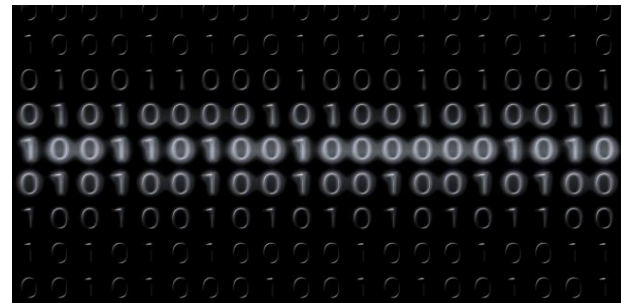
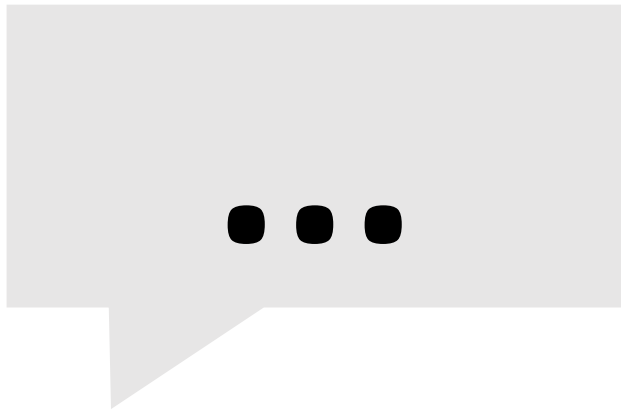
Intro NLP What is NLP?



Natural Language Processing (NLP) is a theoretically motivated range of *computational techniques* for analyzing and representing *naturally occurring texts* at one or more *levels of linguistic analysis* for the purpose of achieving *human-like language processing* for a *range of tasks or applications* (Liddy, 2001).

Intro NLP Human-like Language Processing

- How to make human language comprehensible to machines?
 - Numerical **vector** representation
 - Characterization by **probabilities**




Intro NLP Naturally Occurring Texts

- Basically, any form of human communication
 - Written text
 - Speech
- Different types in different levels of formality
 - News articles
 - Customer reviews
 - Social media posts
 - ...
- Different languages

Intro NLP Levels of Linguistic Analysis

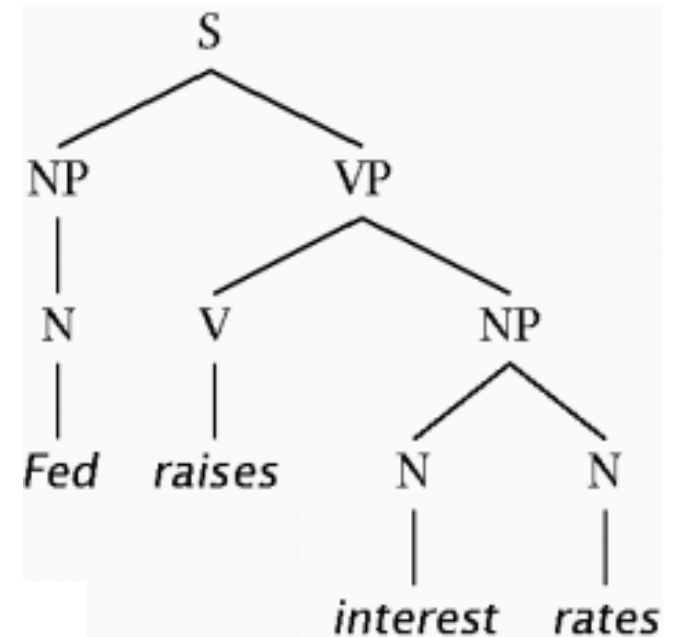
- **Morphological** – how are words composed?
- **Lexical** – what do single words mean?
- **Syntactic** – what is the grammatical structure of a sentence?
- **Semantic** – what meaning does a sentence convey?
- **Discourse** – how do sentences interact to form a text?
- **Pragmatic** – what is there between the lines?

Intro NLP Tasks




- High-level tasks
 - Speech recognition
 - Word-sense disambiguation (WSD)
 - Named entity recognition (NER)
 - Relationship extraction
 - Error identification and recovery
 - Automatic summarization
 - Machine translation
 - **Topic extraction**
 - **Sentiment analysis**
-  *many more*

Intro NLP Tasks

- Low-level tasks
 - Sentence boundary detection
 - Tokenization
 - Part-of-speech (POS) tagging
 - Stemming
 - Lemmatization
 - Shallow parsing
 - ...

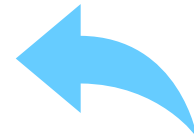


Intro NLP Computational Techniques

- Available techniques largely depending on the task to solve
 - Standard **machine learning** techniques for classification tasks 
→ E.g., sentiment analysis
 - **Generative models** for unsupervised tasks 
→ E.g., topic modeling
 - **Deep learning** models for various tasks
→ E.g., translation with RNN
- State of the art: **transformer models** (BERT, GPT-3) 
 - Idea: teach them as much as possible about the language as a whole (pre-training) and fine-tune to specific tasks

Intro NLP Challenges

- Variety of languages
 - Around 7,000 living tongues
 - Many low-resource languages
 - Large differences in grammatical structure, alphabet, scripting systems
- Irregularities
 - Synonyms
 - Homonyms
 - Genera
 - Cases



„das Wachstum“ vs „der Reichtum“



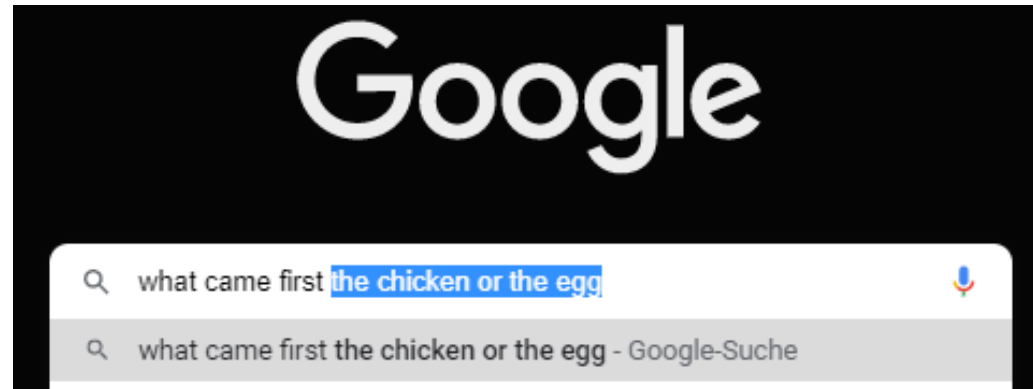
Intro NLP Challenges

- Contextual dependencies
 - Ambiguities
 - Domain-specific vocabulary
 - Varying formality
- Complex constructs
 - Humor
 - Irony
 - Sarcasm
 - Colloquialisms
- Individual expression
 - Style
 - Emotion
- Errors
 - Transcription/translation errors
 - Misspelling

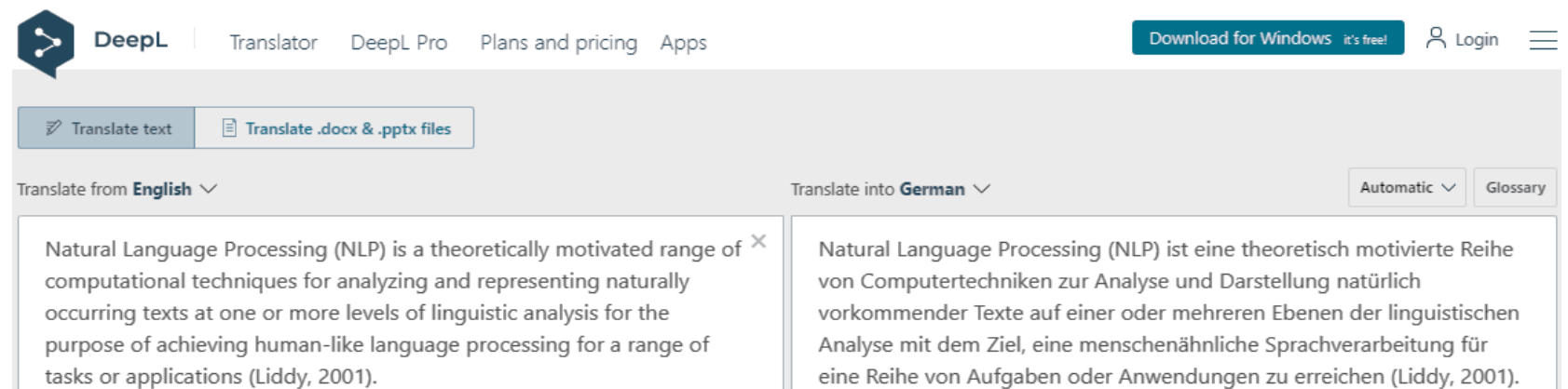


Evaluation of NLP tasks

Intro NLP Applications



 **ad, unpaid**



Part I: Intro NLP & Task at Hand

Working Data

Working Data Generation

- All data generated by **scraping** the web



scraping is legal so long as it does not involve breaking security barriers explicitly in place to guard against such automatic data extraction

- Various sources:
 - <https://www.bundestag.de/abgeordnete>
 - Individual party websites
 - Twitter API

Working Data Structure

- Required information (on MP level)
 - Name
 - Party
 - Electoral district & associated meta data
 - Twitter username
 - Posted tweets
 - Date
 - Text
 - Number of likes, retweets
 - Number of followers



Working Data Structure


Variable	Type	Description
last_name	chr	MP's last name
first_name	chr	MP's first name
wahlkreis_name	chr	MP's electoral district
party	factor	MP's political party
bundesland	factor	Federal state of MP's electoral district
unemployment_rate	num	Unemployment rate in MP's electoral district during 2017 election
share_pop_migration	num	Share of migrant population in MP's electoral district during 2017 election
username	chr	MP's username on Twitter
followers_count	num	MP's number of followers on Twitter at scraping time
created_at	date	Time stamp of tweet creation
text	chr	Tweet text
favorite_count	num	Number of likes for tweet at scraping time
retweet_count	num	Number of retweets for tweet at scraping time

Working Data Example



"Merkel-Regierung geht vor Erdogan in die Knie. Auf meine Frage, ob nach Auffassung der Bundesregierung die Ermordung der Armenier 1915/16 ein „Völkermord“ war, eiert sie nur rum. Ihr sei die Position des Bundestages dazu „bekannt“. Sie selbst hat dazu keine. #erbärmlich #feige <https://t.co/bkwSfICJan>"

Working Data Particularities

- Twitter idiosyncrasies
 - Extremely short texts
 - Often in response to recent event without explicitly naming it
 - Informal language with tendency to containing spelling mistakes
 - Special tokens: emojis, hashtags
 - Political context
 - Specific vocabulary
 - Sometimes rather formal after all (and few emojis)
 - Many solely informative tweets
 - Tendency toward negative sentiment
-  *German language*

Part I: Intro NLP & Task at Hand

Task at Hand

Task Analytical Objective



Twitter + socioeconomic data on German MPs

Pre-processing

Topic extraction

Sentiment classification




Sentiment $s \in \{\text{positive, negative}\}$ toward topic $k \in \{1, 2, \dots, K\}$

Task Topic Extraction



... more on this later

- **Topic extraction** aka **topic modeling**: finding latent thematic clusters within a collection of texts
 - **Goal**: assign each document a topic probability vector / topic label
 - Used for
 - Information retrieval
 - Clustering
 - Supporting upstream tasks
-  *for instance, sentiment analysis*
- **Unsupervised task**: both topics and their number unknown

Task Sentiment Analysis



... more on this later

- **Sentiment analysis:** identifying and analyzing affective states
- Relevant subtask: **polarity detection**
- **Goal:** assign each document a polarity label $\in \{\text{positive, negative}\}$
- Used for
 - Customer relationship management
 - Social media analysis



alternative, rule-based approaches exist

- **Supervised task:** requiring labeled training data (typically)

Task Topic-Specific Sentiment Analysis

- **Idea:** domain- / topic-dependence of sentiment predictors



e.g., „Sozialleistungen“ possibly positively connotated in social security context but negatively connotated in asylum politics

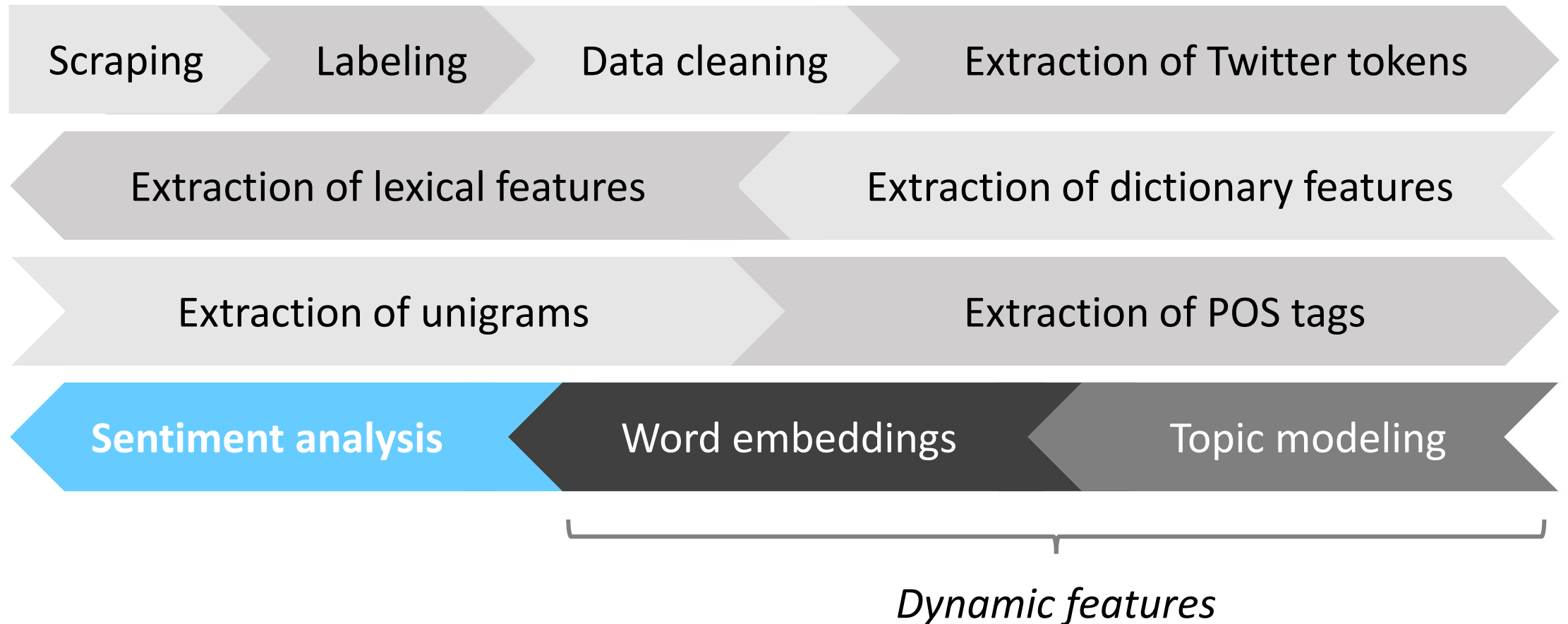
→ Combine topic extraction (1) and sentiment analysis (2)

- Implementation
 - **R:** word embeddings per topic
 - **BERT:** aspect-based sentiment analysis



underlying assumption: one aspect per document

ML Pipeline Analytical Sequence (R)



ML Pipeline Static vs Dynamic Features

- Fundamental principle in machine learning: dichotomy between **training and test sphere**
→ Avoid **bias** in performance estimation



- **Static** features
 - Solely determined on single-observation level
 - E.g., POS tags

*may be computed
before training*

- **Dynamic** features
 - Affected by surrounding observations
 - E.g., topic labels

*must be computed
during training*

Part I: Intro NLP & Task at Hand

Quanteda Universe

Quanteda Universe Package

- Benoit et al. (2018)
- Convenient text handling in R
 - Designated **classes** for textual data (with easy conversion to and from `data.frame` & friends)
 - **User-friendly** syntax
 - **Fast** computation
 - Compatibility with `spacyr` package (Benoit et al., 2020)
 - Wrapper for Python's popular `spaCy` package used for, i.a., **POS tagging**



tutorials for getting started on <https://tutorials.quanteda.io/>

Quanteda Universe Basic Classes

[Word = smallest entity of text → **words**]

[Sentence = sequence of w words → **sentences**]

[Paragraph = sequence of s sentences → **not relevant**]

[Document = sequence of p paragraphs → **tweets**]

- **corpus**

- Most basic class to handle text data
- Collection of documents + document-level variables → **tweets + meta data**



lower-level corpora, e.g., as collections of paragraphs, also possible

Quanteda Universe Basic Classes

- tokens

- Representing documents as a collection of tokens
→ **tokens per tweet + meta data**
- **Token:** sequence of characters grouped together as a useful semantic unit
→ Single words, n-grams, ...
- During tokenization, we will often
 - Remove punctuation
 - Remove stopwords
 - Omit cases (e.g., lowercase everything)
 - Perform stemming / lemmatization
- **Goal:** representation of texts by tokens that co-occur across documents

*text normalization –
to be continued*

Quanteda Universe Basic Classes

doc_id	text	author	nationality
1	Politics have no relation to morals.	Niccolo Machiavelli	Italian
2	Politics is too serious a matter to be left to the politicians.	Charles de Gaulle	French
3	In politics stupidity is not a handicap.	Napoleon Bonaparte	French



```
Corpus consisting of 3 documents and 2 docvars.  
1 :  
"Politics have no relation to morals."  
  
2 :  
"Politics is too serious a matter to be left to the politica..."  
  
3 :  
"In politics stupidity is not a handicap."
```



```
Tokens consisting of 3 documents and 2 docvars.  
1 :  
[1] "Politics" "relation" "morals"  
  
2 :  
[1] "Politics" "serious" "matter" "left" "politicians"  
  
3 :  
[1] "politics" "stupidity" "handicap"
```

Quanteda Universe Basic Classes

- **dfm**
 - **Document-feature matrix**
 - Token count per document → **word occurrence per tweet + meta data**
 - **Methods**
 - **Weighting** schemes, such as tf-idf
 - Counting **matches** with a list of words
 - Extracting **top** features
 - Performing dictionary **look-ups**

```
Document-feature matrix of: 3 documents, 9 features (59.3% sparse) and 2 docvars.  
features  
docs politics relation morals serious matter left politicians stupidity handicap  
1          1          1          1          0          0          0          0          0          0  
2          1          0          0          1          1          1          1          0          0  
3          1          0          0          0          0          0          0          1          1
```


Quanteda Universe Basic Classes

- fcm
 - Feature co-occurrence matrix
 - Tokens co-occurrence count across corpus → co-occurrence across tweets

Feature co-occurrence matrix of: 9 by 9 features.

features	politics	relation	morals	serious	matter	left	politicians	stupidity	handicap
politics	0	1	1	1	1	1	1	1	1
relation	0	0	1	0	0	0	0	0	0
morals	0	0	0	0	0	0	0	0	0
serious	0	0	0	0	1	1	1	0	0
matter	0	0	0	0	0	1	1	0	0
left	0	0	0	0	0	0	1	0	0
politicians	0	0	0	0	0	0	0	0	0
stupidity	0	0	0	0	0	0	0	0	1
handicap	0	0	0	0	0	0	0	0	0

Quanteda Universe Basic Classes

- **dictionary**
 - Essentially, named list
 - Specifying dimensions with associated items
 - Look-up on document level → **dictionary item count per tweet**

```
Dictionary object with 2 key entries.  
- [political]:  
  - politics, politicians  
- [critical]:  
  - morals, stupidity, handicap
```



```
Document-feature matrix of: 3 documents, 2 features (16.7% sparse) and 2 docvars.  
      features  
docs political critical  
  1         1         1  
  2         2         0  
  3         1         2
```

Quanteda Universe Scope

- Purpose of quanteda: handling text corpora and performing basic analysis of their components

- **Within scope**

- Organizing text documents
- Tokenization
- Descriptive analyses

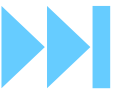
*pre-processing with
quanteda*



- **Out of scope**

- Higher-level text analysis, such as topic modeling or sentiment analysis

*downstream analyses
with other tools*



Part I: Intro NLP & Task at Hand

Literature and References

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