* * * PGM: Final Project Presentation * * *
POS-Tagging and NER

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TECHNISCHE
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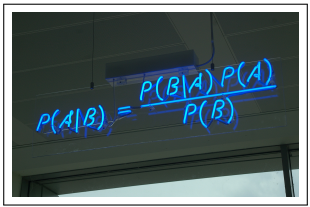
Agenda

Task Description

- The task was to use probabilistic graphical models for:
  - POS-Tagging (Part-of-Speech Tagging)
  - Named Entity Recognition (NER)
- We used the following models:
  - Naïve Bayes (baseline model)
  - HMMs (Hidden Markov models)
  - CRFs (Conditional Random Fields)



Model Overview

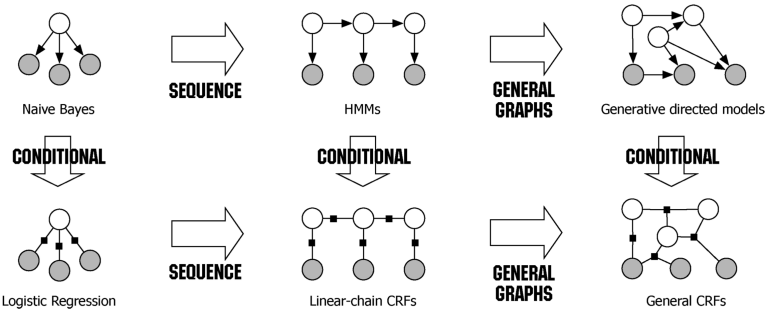


Figure: Model overview

Part of Speech Tagging

Figure: Part of speech tagging

Named Entity Recognition

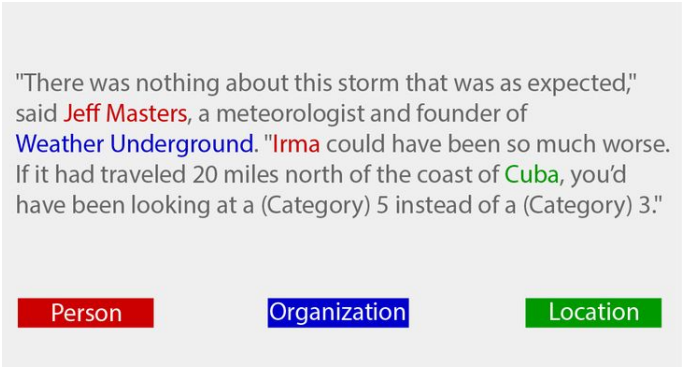


Figure: Named entity recognition

Process and Tools

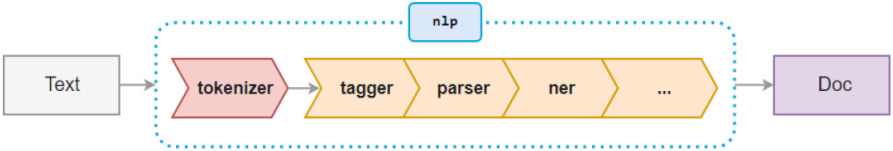


Figure: NLP-Pipeline

- POS tagging is one of the earliest stages in the NLP pipeline and serves as input for most downstream tasks
- E. g. NER: POS tags can be used as a feature

Data Set

- We used the **Groningen Meaning Bank**
- `http://gmb.let.rug.nl/data.php`
- Corpus of public domain texts:
  - 1.4 milion words
  - automatically produced, manually corrected (silver labels)

Tag Distribution

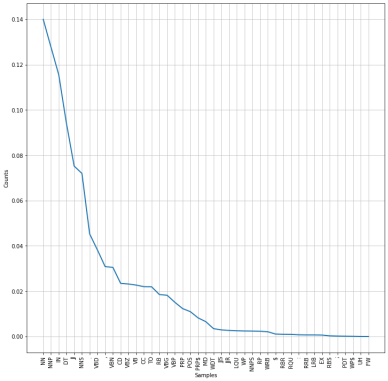


Figure: POS tag distribution

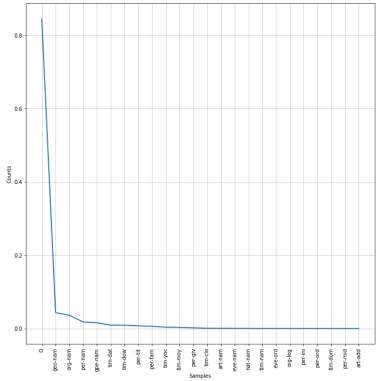


Figure: NER tag distribution

Results
POS Tagging

Naïve Bayes [POS]		
Features	**F1 score**	**Acc (w / s)**
w, l, s	0.927	0.927 / 0.240
w, l, s, uwf	0.928	0.928 / 0.241
w, l, s, bf	0.957	0.957 / 0.467
w, l, s, uwf, bf	0.949	0.949 / 0.369

HMM [POS]		
Features	**F1 score**	**Acc (w / s)**
word sequence	0.837	0.837 / 0.496

Legend:
w: word, **l**: lowercase word, **s**: stem, **uwf**: unknown word features, **bf**: bigram features

Bi-LSTM Baseline: 0.950 [Bjerva et al., 2016]

Results (Ctd.)

POS Tagging

CRF [POS]		
Features	**F1 score**	**Accuracy (w / s)**
w, l, s	0.974	0.974 / 0.607
w, l, s, uwf	0.980	0.980 / 0.749
w, l, s, bf	0.978	0.978 / 0.669
w, l, s, uwf, bf	0.985	0.985 / 0.740

Legend:
w: word, **l**: lowercase word, **s**: stem, **uwf**: unknown word features, **bf**: bigram features

POS: Confusion Matrix CRF (all features)

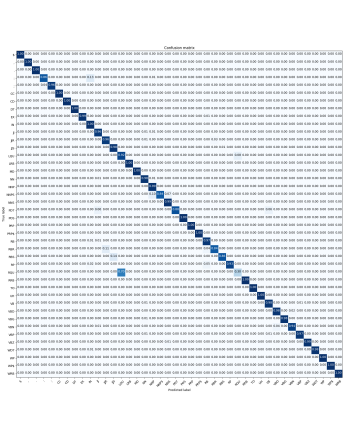


Figure: Named entity recognition

Results (Ctd.)

Named Entity Recognition

Naïve Bayes [NER]		
Features	**F1 score**	**Acc (w / s)**
w, l, s	0.921	0.921 / 0.262
w, l, s, uwf	0.922	0.922 / 0.237
w, l, s, uwf, pos	0.921	0.921 / 0.240
w, l, s, uwf, pos, bf	0.929	0.929 / 0.288

HMM [NER]		
Features	**F1 score**	**Acc (w / s)**
word sequence	0.946	0.946 / 0.523

Legend:
w: word, **l**: lowercase word, **s**: stem, **uwf**: unknown word features, **bf**: bigram features, **pos**: part of speech tags

LSTM Baseline: 0.931 [Akbik et al., 2018], different data set: **CoNLL03**

Results (Ctd.)

Named Entity Recognition

CRF [NER]		
Features	**F1 score**	**Accuracy (w / s)**
w, l, s	0.965	0.965 / 0.604
w, l, s, uwf	0.969	0.969 / 0.639
w, l, s, uwf, pos	0.969	0.969 / 0.645
w, l, s, uwf, pos, bf	0.974	0.974 / 0.693

Legend:
w: word, **l**: lowercase word, **s**: stem, **uwf**: unknown word features, **bf**: bigram features, **pos**: part of speech tags

NER: Confusion Matrix CRF (all features)

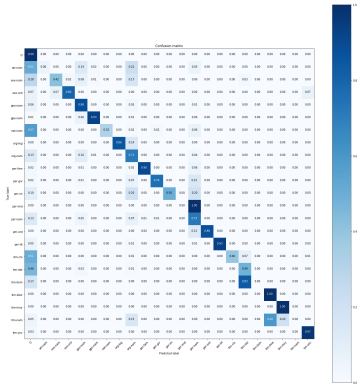


Figure: Named entity recognition

NER: Random Search for CRF

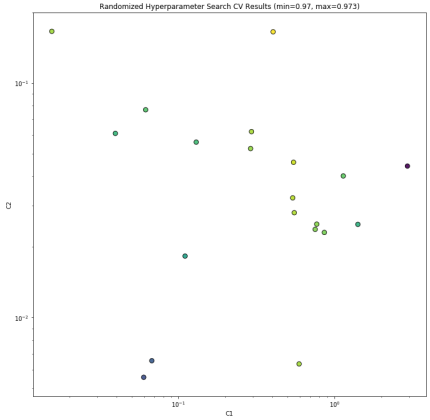


Figure: Random Search CRF

- c1: L_1-regularization
- c2: L_2-regularization
- Best parameters found:
  - c1: 0.40431785916906465
  - c2: 0.16525290148249140

Result Comparison

- Naive Bayes confuses `per-ord` with `eve-ord`, but HMM does not
  $\Rightarrow$ context knowledge!
- Naive Bayes predicts `per-tit` very often
- Naive Bayes confuses `tim-clo` and `tim-dat` often
- HMM incorrectly predicts `DET` tag (POS) and `O` tag (NER) very often
- **POS tagging**
  - Likely transitions: `MD` $\Rightarrow$ `VB`; `NNS` $\Rightarrow$ `VBP`
  - Unlikely transitions: `DT` $\Rightarrow$ `DT`; `VBD` $\Rightarrow$ `VBD`
- **NER**
  - Likely transitions: `per-giv` $\Rightarrow$ `per-fam`
  - Unlikely transitions: `per-giv` $\Rightarrow$ `tim-dat`

What we have learned...

- Feature engineering is 'dirty work' but **crucial** for later model performance
- POS tagging is **easier** than NER
- Using less training data **hurts performance**, especially on sentence level (e. g. POS: foreign words misclassified, mistakes interjection with adjective)
- CRF mostly works **'out-of-the-box'**; we conducted a random search and noticed only tiny differences ($\leqslant 0.03$)
- We tried word embeddings (GloVe) for POS tagging with limited success
- **Little data:** On approx. 1,000 ($= 2\,\%$) training sentences, we got a word accuracy of 0.952 (frequency of majority tag `NN` ≈ 0.14)
- Sentence level accuracy volatile (≈ 0.50)

Thank you very much for the attention!

Topic: * * * PGM: Final Project Presentation * * * POS-Tagging and NER
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Contact:
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Do you have any questions?