A Domain-adapted Dependency Parser for German Clinical Text

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Motivation

Overcoming the lack of text corpora of German clinical documents and domain-adapted parser models, which severely hampers NLP applications on German medical texts.

Contributions

1. Building two gold standard clinical corpora: authentic and fictitious.
2. Adapting Stanford Parser to clinical German.
3. Publishing our fictitious corpus and models trained on the authentic corpus.

Approach

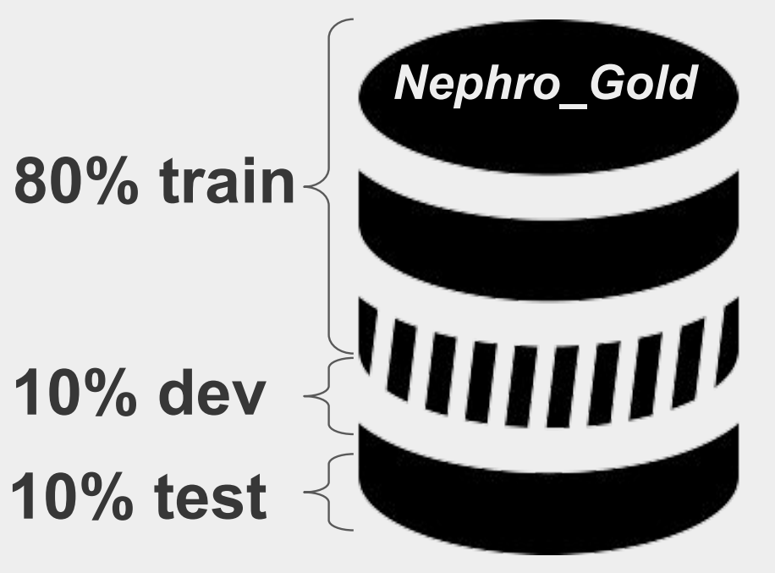
A parser, previously trained on general language data, is (re-)trained with in-domain gold data and tested on it, plus fictitious clinical documents.

LINGUISTIC CHALLENGES

Main features of clinical language problematic for machine-readability		*Examples*
Domain-dependence	Greek- and Latin-rooted terminology	*Appendektomie* ('appendectomy') *thorakal* ('thoracic')
Complexity	Discharge summaries: Complex syntactic embeddings	*In Anbetracht der initial bestehenden Entzündungskonstellation haben wir antibiotisch mit Levofloxacin 500 mg 1-0-1 über 10 Tage behandelt, was sich im Nachhinein nach dem bakteriologischen Resistenzprofil als treffsicher erwies*. ('Given the initial inflammatory constellation, we treated antibiotically with Levofloxacin 500 mg 1-0-1 for 10 days, which turned out to be accurate according to the bacteriological resistance profile.')
Reduction	Ellipses (mostly auxiliary and copula verbs); Sentence boundaries	*Geht gut*. ('Goes well.') *Ödeme rückläufig* ('Edema declining')
	Clinical notes: Poor syntactic structure; Non-standard abbreviations and acronyms; Lack of punctuation marks	*Geht gut RR gut*. ('Goes well RR well.')

TRAINING AND EVALUATION DATA

10-fold cross-validation with equally assigned document types.



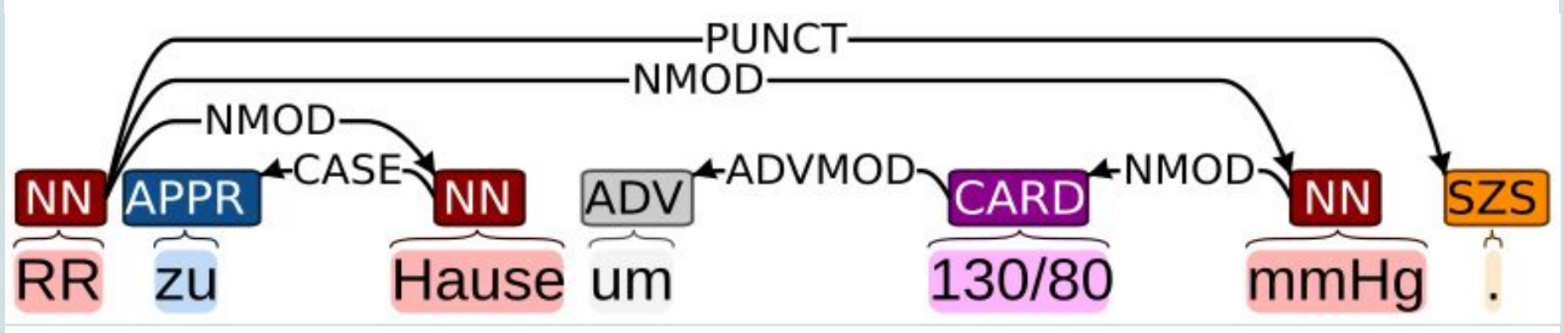
	1) Nephro_Gold		*2) Fictitious documents*	
	authentic, de-identified		synthetic, template-based	
	nephrology documents		diverse clinical data	
	gold-standard PoS and dependencies provided by human annotators		PoS and dependencies automatically parsed and amended by humans	
	clinical notes	*dis. summaries*	*clinical notes*	*dis. summaries*
# of files	44	11	30	5
avg. words (std.)	71.7 (75.2)	948.7 (333.3)	41.1 (12.0)	398.2 (226.6)
IAA	0.9578		0.9686	

ANNOTATION SCHEMA

PoS tagging:
Stuttgart-Tübingen-TagSet (STTS)

Dependency annotation:
Universal Dependencies (UD)

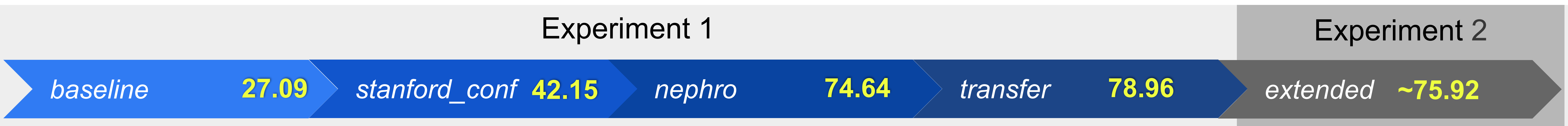
Exemplary sentence parse



Translation:
'RR (Riva-Rocci – 'blood pressure') at home about 130/80 mmHg'.

EXPERIMENT ARCHITECTURE

All results are given as LAS[1]



	baseline 27.09	*stanford_conf* 42.15	*nephro* 74.64	*transfer* 78.96	*extended* ~75.92
	Performance of **Stanford Parser** and **Tagger** on nephrological text, tested out-of-the-box.	Performance of **Stanford Parser** on nephrological text. Elimination of potential errors caused by false PoS annotation.	Performance of **Stanford Parser** on nephrological text, **trained solely on in-domain data**.	Performance of **Stanford Parser** with the default model, **re-trained** with nephrological data.	Performance of **Stanford Parser** with the *transfer* model on a **fictitious dataset** of more clinical subdomains.
Test data	*Nephro_Gold*	*Nephro_Gold*	*Nephro_Gold*	*Nephro_Gold*	fictitious documents
PoS	Stanford PoS tagger	manual pre-processing	manual pre-processing	manual pre-processing	JPOS [3]
Parser	Stanford Parser	Stanford Parser	Stanford Parser	Stanford Parser	Stanford Parser
Training data	default [2]	default [2]	*Nephro_Gold*	default [2] + *Nephro_Gold*	default [2] + *Nephro_Gold*

	eval-1	*eval-2*	avg.
clinical notes	75.96	81.75	78.86
dis. summaries	69.69	76.26	72.98
avg.	72.83	79.01	75.92

[1] LAS: Labeled Attachment Score (a given dependency is scored as correct only if both the syntactic head and the label are identical)
[2] The default model of the Stanford Parser was trained on the Universal Dependencies (UD) treebank for German – a large dataset of heterogeneous nature
[3] JPOS: PoS-tagger trained on medical data

CONCLUSION

- Re-training a general language model with specific in-domain data yields better performance on nephrology texts than the Stanford Parser's default model.
- Plus, the model performs well on other clinical subdomains.
- Our fictitious gold standard corpus as well as models trained on the manually annotated, authentic data are published, bypassing German legal restrictions.

OUTLOOK

- Testing and evaluating the model on larger in-domain datasets as well as on data from more clinical subdomains.
- Increasing the quality and quantity of German clinical data.
- Reconsidering the substitutability of authentic and synthetic clinical documents for the purpose of advancing research.

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