Clinical Document representation

Stefan Schulz*, Markus Kreuzthaler**

Institut für Medizinische Informatik, Statistik und Dokumentation

Medizinische Universität Graz

CBMed Biomarker Research, Graz

*stefan.schulz@medunigraz.at

**markus.kreuzthaler@medunigraz.at

Goals

- To optimise and enrich output of NLP analysis of **German**-language **clinical** documents
- To make it compatible with standards:
  - Ontology standards: **SNOMED** CT, LOINC
  - Standardised medical information templates: **FHIR** (provides context to semantic IDs)
- Three examples:
  1. German **Interface terminology** development
  2. Disambiguation of **short forms**
  3. Identification of **semantic relations**

1. German Interface terminology development

- Problem:
  - Diversity and idiosyncrasy of clinical language
  - Generally: ontology labels do not reflect real use of language ("Sekundäre maligne Neoplasie der Leber" vs. "Lebermetastasen")
  - Currently no German translation of SNOMED CT
- Resource:
  - Since 2014, low-resourced activities (paid medical students): token n-gram translations (EN –> DE) and annotations (POS, gender, number) from English SNOMED CT dictionary
  - Algorithmic creation of variants including single-word compounds
  - Scoring and Filtering (corpus occurrence, character sequence patterns)
  - Currently 2.4 Million terms (limit: 6 tokens)
  - Performance: same as English (term matching against annotated parallel corpus)

Schulz, S; Hammer, L; Hashemian-Nik, D; Kreuzthaler, M. Localising the Clinical Terminology SNOMED CT by Semi-automated Creation of a German Interface Vocabulary.
In: Melero, M editors(s). Proceedings of the LREC 2020 Workshop on Multilingual Biomedical Text Processing (MultilingualBIO 2020). Luxemburg: European Language Resources Association; p. 15-20. 2020

Core vocabulary

English	L	Count	German 1	German 2	German 3	German 4
burn	1	1264	Brandverletzung|NN|F	Brandwunde|NN|F	Verbrennung|NN|F	
normal	1	1264	normales|JJ	normenhaftes|JJ		
ankle	1	1254	Knöchel|NN|M			
wrist	1	1251	Handgelenk|NN|N			
drug	1	1244	Wirkstoff|NN|M	Arznei|NN|F	Arzneimittel|NN|N	Droge|NN|F
second	1	1244	zweites|JJ	Sekunde|NN|F	Sekunden-	%VOID% 2. %VOID%
uncertain	1	1227	unsicheres|JJ			
abdominal	1	1222	abdominales|JJ	Bauch-	abdominelles|JJ	
membrane	1	1210	Membran|NN|F			
liver	1	1207	Hepar|NL|N	Leber|NN|F		
microgram	1	1202	%VOID% µg %VOID%	Mikrogramm|NN|N	Mikrogramm|NL|N	
middle	1	1193	mittleres|JJ	Mitte|NN|F	Mittel--	
ulcer	1	1180	Ulzeration|NN|F	Ulkus|NN|N	Geschwür|NN|N	
upper limb	2	1180	oberes|JJ Extremität|NN|F	Arm|NN|M	oberes|JJ Gliedmaße|NN|F	OE|NL|F
fluoroscopic	1	1171	Durchleuchtungs-	durchleuchtungsgestütztes|JJ	fluoroskopisches|JJ	
effect	1	1170	Effekt|NN|M	Auswirkung|NN|F	Wirkung|NN|F	Folge|NN|F
service	1	1158	Service|NN|M	Dienst|NN|M	Service|NN|N	
vehicle	1	1154	Fahrzeug|NN|N			
external	1	1149	äußeres|JJ	externes|JJ	auswärtiges|JJ	
internal	1	1149	inneres|JJ	internes|JJ	internistisches|JJ	
of foot	2	1149	des Fußes	_Fuß_		

Scored interface vocabulary

SNOMED ID	Score	Fully Specified Name (Englisch)	Deutscher Interface-Term
9945100011 9105	0.833	Cerebral infarction due to stenosis of carotid artery (disorder)	Hirninfarkt verursacht durch Stenose der A. carotis
99451000119105	0.833	Cerebral infarction due to stenosis of carotid artery (disorder)	Hirninfarkt verursacht durch Stenose der A. karotis
99451000119105	0.833	Cerebral infarction due to stenosis of carotid artery (disorder)	Schlaganfall wegen Stenose der Halsschlagader
99451000119105	0.833	Cerebral infarction due to stenosis of carotid artery (disorder)	Insult wegen Stenose der Halsschlagader
99451000119105	0.833	Cerebral infarction due to stenosis of carotid artery (disorder)	Schlaganfall wegen Karotisstenose
99451000119105	0.833	Cerebral infarction due to stenosis of carotid artery (disorder)	Insult wegen Karotisstenose
99451000119105	0.800	Cerebral infarction due to stenosis of carotid artery (disorder)	Gehirninfarkt verursacht durch Verengung der Halsschlagader

German Interface terminology development

- Current state
  - Experimental use in Averbis Health Discovery
  - Experimental use by industry partners
- Future directions
  - More automation of
    - synonym / variant detection
    - quality control
    - Periodic updates

    By machine learning using reference corpora (clinical, public)
  - Fuzzy term matching, matching out-of-language terms

2. Disambiguation of short forms

- Clinical texts are "infested" by short forms
  - Acronmys and abbreviations
  - Rarely introduced
  - Highly ambiguous
  - Not lexicalised
  - Confusion with non-abbreviations (roman numbers, capitalised text)
  - Institution-specific, specialty-specific
  - Often never expanded in clinical corpora
- Some attempts
  - Detection and disambiguation of short forms with "."
  - Disambiguation from clinical corpora (embeddings): https://github.com/bst-mug/acres
  - Harvesting acronym definitions + context from Web resources

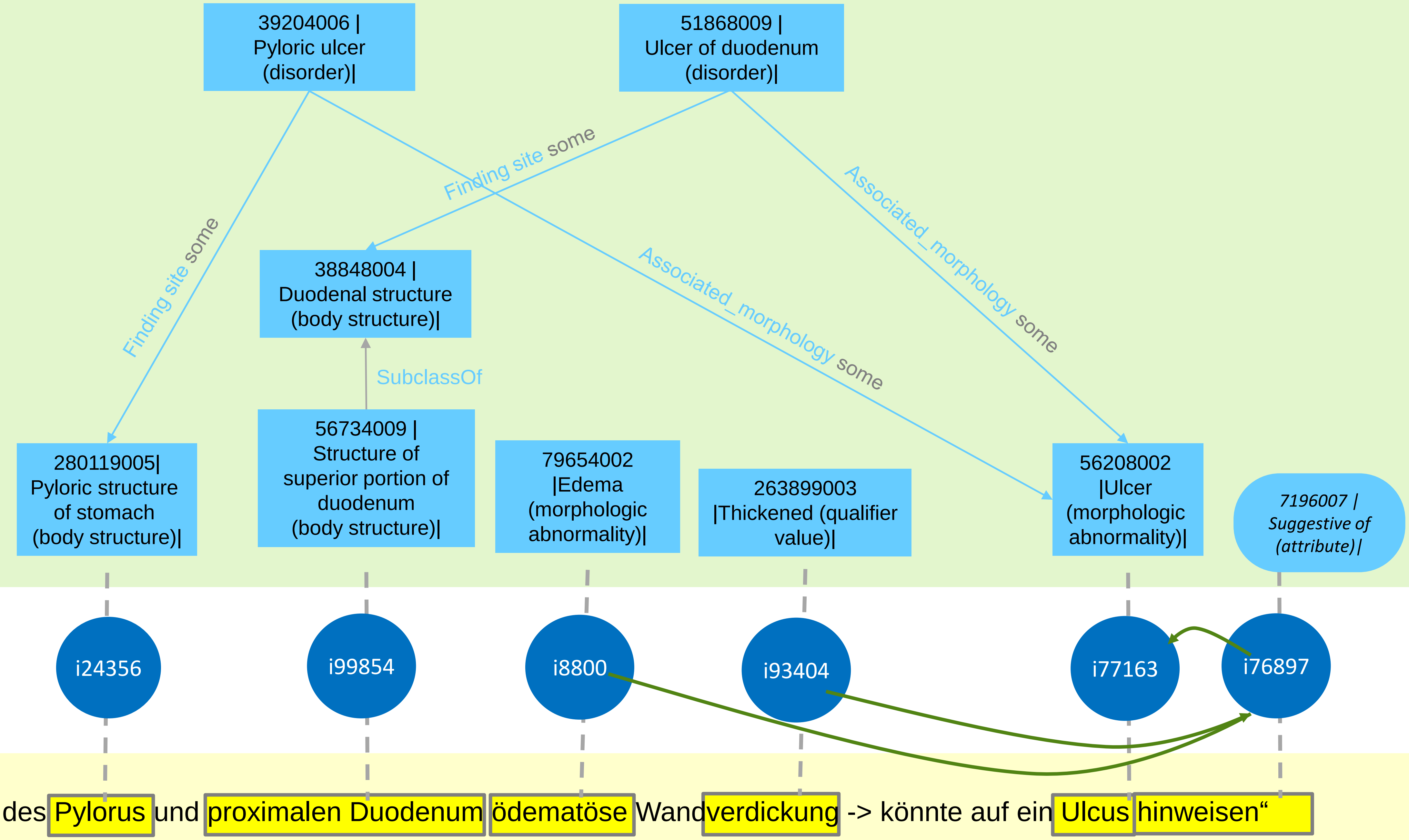
"Z.n. TE eines exulc. sek.knot.SSM li US dors. 5/11 Level IV 2,4mm Tumordurchm. Sentinnel LK ing. li. tumorfr."

Kreuzthaler M, Schulz S. Detection of sentence boundaries and abbreviations in clinical narratives. BMC Med Inform Decis Mak. 2015;15 Suppl 2(Suppl 2):S4.
Oleynik M, Kreuzthaler M, Schulz S. Unsupervised Abbreviation Expansion in Clinical Narratives. Stud Health Technol Inform. 2017;245:539-543

Identification of semantic relations

- Common problems in clinical text:
  - Temporal relations: "Arztbrief vom 5.11.2020"
    "Max Mustermann *13.3.1979"
    "Streptokokkenangina im Kindesalter"
    "Niereninsuffizienz ED 4/2011"
    "dialysepflichtig seit 3 Jahren"
  - Nominal anaphora: "akute Erosionen der Magenschleimhaut …. Die Schleimhautläsionen" (correspond to taxonomic relations in the underlying ontology)
  - Bridging anaphora: "im Bereich proximalen Duodenum … könnte auf ein Ulcus hinweisen“ (correspond to non-taxonomic relations in the underlying ontology, like location, part-of)
  - "Semantic similarity" relations ()
- Converting linear NLP output to graph
  - Using ontological structure of underlying ontology (SNOMED CT EL++ axioms) (inferring "duodenal ulcer" out of "duodenum" an "ulcer")
  - Learning graph embeddings

SNOMED CT classes and relations



39204006 | Pyloric ulcer (disorder)|

51868009 | Ulcer of duodenum (disorder)|

Finding site some

Finding site some

Associated_morphology some

Associated_morphology some

38848004 | Duodenal structure (body structure)|

SubclassOf

280119005| Pyloric structure of stomach (body structure)|

56734009 | Structure of superior portion of duodenum (body structure)|

79654002 |Edema (morphologic abnormality)|

263899003 |Thickened (qualifier value)|

56208002 |Ulcer (morphologic abnormality)|

7196007 | Suggestive of (attribute)|

i24356

i99854

i8800

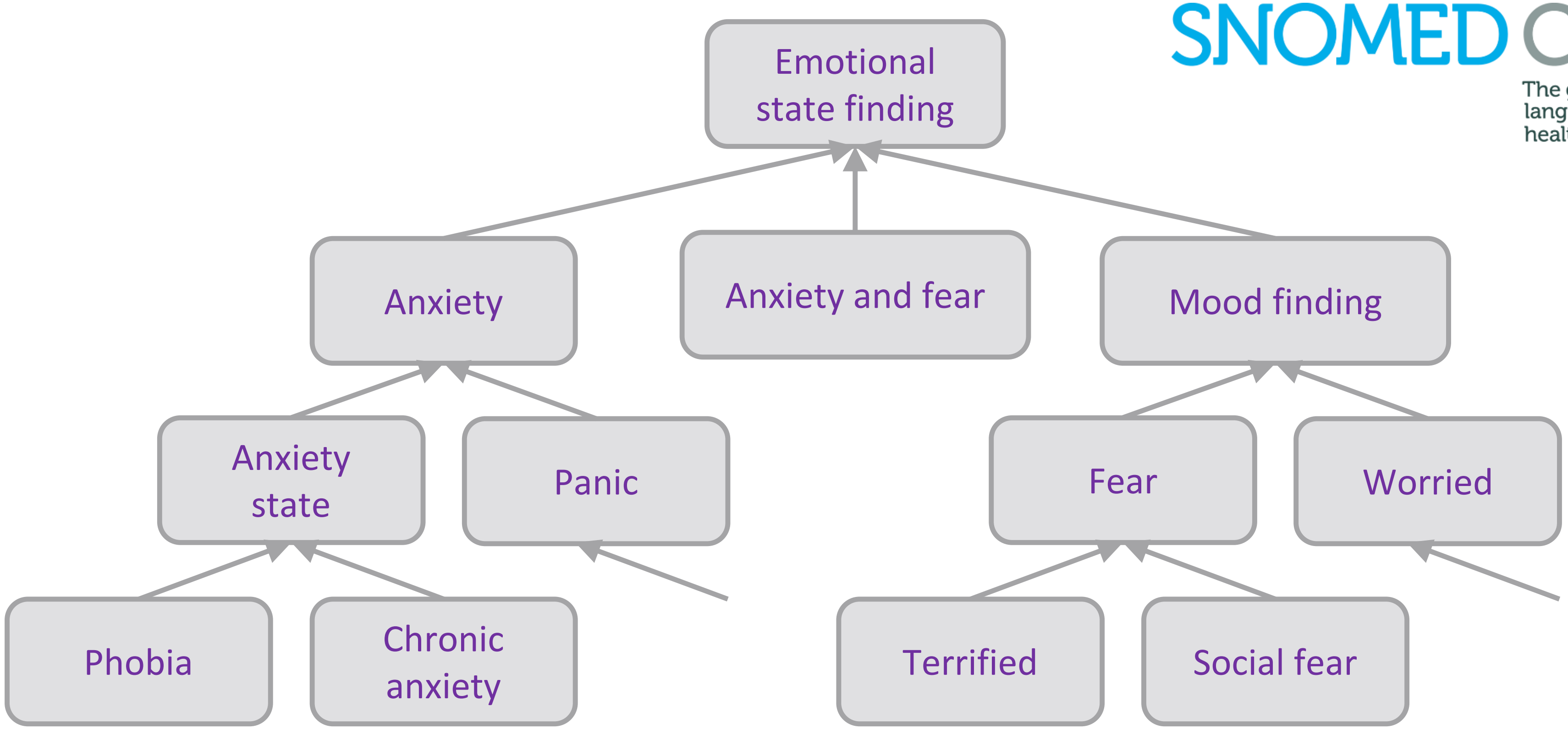
i93404

i77163

i76897

im Bereich des Pylorus und proximalen Duodenum ödematöse Wandverdickung -> könnte auf ein Ulcus hinweisen“

Semantically close primitive concepts



SNOMED CT
The global language of healthcare