Enhancing Patient Safety through Human-Computer Information Retrieval on the Example of German-speaking Surgical Reports

Presentator: Johannes Schantl

Authors: Christof Stocker, Leopold-Michael Marzi, Christian Matula, Johannes Schantl, Gottfried Prohaska, Alberto Brabenetz and Andreas Holzinger

Munich, 04th Sep 2014
Outline

1. Motivation and Introduction
2. Background and Related Work
3. Methods
4. Conclusions and Open Challenges
5. Discussion
Motivation

- Worldwide, surgical safety is a substantial global public health-concern [Weiser et al., 2008].
Assumption: There is a significant number of cases in surgery which lead to harm but are not reported. Reasons could be:
- Mistake was corrected early enough without causing notable harm at the patient.
- In high risk areas e.g., neuro-surgery, adverse events occur but often no legal case.

*Fig: Swiss Cheese Model*
Surgeons reports for the purpose of billing and documentation [Wang et al., 2012], contain information about

- indications of the procedure,
- pre- and post-procedure diagnosis,
- complications,
- findings during the procedure
- and detailed descriptions of the procedure.

Documents are available in electronic form, thus, computational analysis possible.
Identifying problematic surgeries

- Success of surgery influenced by surgeons' skills, techniques used, incision length, supplies used etc.

- Identifying problematic surgeries support surgical (safety) research, decision support, quality improvement etc.

- Large amount of generated reports makes manual review too time extensive [Wang et al., 2012].
Objectives

- Identify indicators for risk factors in surgery reports with domain experts.

- Implement a scalable, extendable Information retrieval system which
  - extracts risk indicators from German operation reports,
  - visualizes data and allows data-interaction.
## Background

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Language Processing (NLP)</td>
<td>Major tasks from NLP are, sentence boundary detection, tokenization, part-of-speech (POS) tagging, IR, IE, named entity extraction (NER) etc.</td>
</tr>
<tr>
<td>Information Extraction (IE)</td>
<td>Extracting relevant information from data sources.</td>
</tr>
<tr>
<td>Information Retrieval (IR)</td>
<td>Process of finding relevant information to a specific search request.</td>
</tr>
<tr>
<td>Part-of-speech Tagging (POS)</td>
<td>Process of tagging words with a word category (e.g., noun, verb, adjective).</td>
</tr>
</tbody>
</table>
Patient Safety Indicators (PSIs) are used to measure adverse events (medical errors) e.g., Failure to Rescue, Postoperative Sepsis [AHRQ 2003].

PSIs are based on structured information in discharge summaries (e.g., ICD codes).

Disadvantage: Ability to code can vary widely between clinicians, this leads to variations in accuracy and completeness [Cresswell et al., 2012].
Outline

1. Motivation and Introduction
2. Background and Related Work
3. Methods
4. Conclusions and Open Challenges
5. Discussion
Indicators for problematic surgery reports

- Deviation of operation duration
- Deviation of report length
- Emphasis on certain events and risks
- Existence of certain keywords (e.g., death, massive, unfortunately)
- Unanticipated events
IBM Watson Content Analytics (WCA)

- The IE system is build using WCA, an existing UIMA based tool and framework including
  - out-of-the-box NLP functionalities (e.g., Language detection, Sentence splitter, custom dictionaries, POS Tagger),
  - an Eclipse NLP development suite with deployment functionality,
  - an end user interface to visualize and interact with data including a facet view,
  - also used in IBM Watson.
I had an accident because of a brake malfunction of my Toyota Prius. After driving over big pothole the break was not working for around 5 seconds.
Triggered phrases

- Triggered phrases used to identify phrases of unanticipated events and heavy emphases.
- Dictionary to identify start of phrase, POS tagger to find end.
- Defining Rules (WCA Parsing Rules) for various allowed in-between POS tags.

Advantages

- no specialist lexicon or ontologie needed (e.g., UMLS),
- lightweight method, promising for unseen documents.
Triggered Phrases

- Trigger word dictionary for unanticipated events, e.g., plötzlich (suddenly), überraschend (surprisingly), ..

- Trigger words dictionary for heavy emphasis, e.g., enorm (enorm), massive (massivly), ..

- Trigger Word + POS Tags e.g., enorme Blutung [trigger word - noun]

- Example of more complex Rule e.g.; massive und komplexe weite Blutung .. [trigger word - conjunction - two adjectives - noun]
Interesting phrases in indication and procedure description

- **Indication section**
  - insbesonders ... potentiell ... Option, inbesonders ... potentiell ... Problematik
  - indicating that the patient was advised to consider alternative options.

- **Procedure description section**
  - plötzlich ... Blutung, enorm ... geschwollen ... Hirn
  - indicating unanticipated events and high emphasis.
WCA - Facet view

Motivation and Introduction
Background and Related Work
Methods
Conclusions and Open Challenges
Discussion

Presentator: Johannes Schantl Munich, 04th Sep 2014 TIR 2014 Paper Presentation
WCA - Phrases in the indication

<table>
<thead>
<tr>
<th>Indikation</th>
<th>Häufigkeit</th>
</tr>
</thead>
<tbody>
<tr>
<td>insbesonders</td>
<td>16</td>
</tr>
<tr>
<td>insbesonders ... Ehegattin</td>
<td>2</td>
</tr>
<tr>
<td>insbesonders ... detaillieren ... Aufklärung</td>
<td>1</td>
</tr>
<tr>
<td>insbesonders ... etwaig alternativ ... Option</td>
<td>2</td>
</tr>
<tr>
<td>insbesonders ... potentiell ... Option</td>
<td>1</td>
</tr>
<tr>
<td>insbesonders ... potentiell ... Problematik</td>
<td>1</td>
</tr>
<tr>
<td>insbesonders ... prinziell ... Problematik</td>
<td>1</td>
</tr>
<tr>
<td>insbesonders ... speziell ... Riske</td>
<td>3</td>
</tr>
<tr>
<td>jedoch</td>
<td>20</td>
</tr>
<tr>
<td>leider</td>
<td>3</td>
</tr>
</tbody>
</table>

Presentator: Johannes Schantl  
Munich, 04th Sep 2014  
TIR 2014 Paper Presentation
WCA - Phrases in the procedure description
WCA - Deviations view

Example:
Weekly deviation of surgeries having different length

![Weekly deviation chart](image-url)
WCA - Trends view

Example:
Time trend of occurrences of trigger words and phrases
WCA - Facetpair view

Example:
Identification of conspicuous length relations between indication and procedure description.

Table:

<table>
<thead>
<tr>
<th>Unterfacetten/Werte</th>
<th>sehr kurz</th>
<th>kurz</th>
<th>mittel</th>
<th>lang</th>
<th>sehr lang</th>
</tr>
</thead>
<tbody>
<tr>
<td>sehr kurz 4</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>kurz 53</td>
<td>0</td>
<td>24</td>
<td>26</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>mittel 131</td>
<td>0</td>
<td>25</td>
<td>80</td>
<td>21</td>
<td>5</td>
</tr>
<tr>
<td>lang 43</td>
<td>0</td>
<td>5</td>
<td>17</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>sehr lange 5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

Example:
Identification of conspicuous length relations between indication and procedure description.
**WCA - Facetpair view**

**Beispiel:**
Automatic recognition of the relation between phrases / trigger in indication and procedure description
Conclusion and Open challenges

- First step in identifying problematic surgery reports done.

- Local indicators (Triggered phrases etc.) combined with data interaction seems to be a promising way.

- Next step: Identifying problems and evaluating the indicators.
Thank you for your attention

Any questions?