



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

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- 1 Motivation and Introduction
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# Motivation

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- Worldwide, surgical safety is a substantial global public health-concern [Weiser et al., 2008].

# Risk management

- 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.

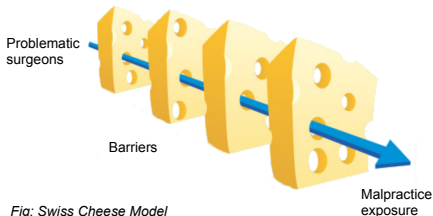


Fig: Swiss Cheese Model



# Operation Report

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- 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].

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# Objectives

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- 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.



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# Background

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Term	Description
Natural Language Processing (NLP)	Major tasks from NLP are, sentence boundary detection, tokenization, part-of-speech (POS) tagging, IR, IE, named entity extraction (NER) etc.
Information Extraction (IE)	Extracting relevant information from data sources.
Information Retrieval (IR)	Process of finding relevant information to a specific search request.
Part-of-speech Tagging (POS)	Process of tagging words with a word category (e.g., noun, verb, adjective).



## Related Work

- 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].

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# Indicators for problematic surgery reports

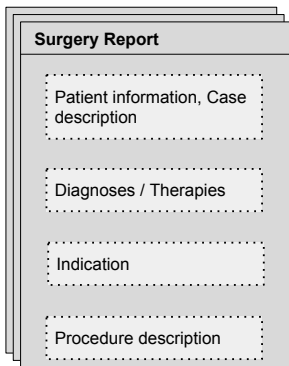
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- Deviation of operation duration
- Deviation of report length
- Emphasis on certain events and risks
- Existence of certain keywords (e.g., death, massive, unfortunately)
- Unanticipated events



# IBM Watson Content Analytics (WCA)

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- 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.

# WCA Structure

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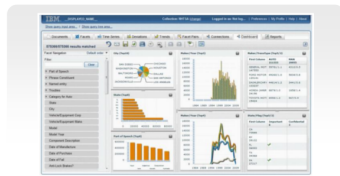
Discussion

**Accident Report**  
 10.08.2013  
 Person: Peter Müller

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.



DocType	Accident Report
Date	10.08.2013
Person	Peter Müller
Brand	Toyota
Model	Prius
Component	break
Problem	was not working
Cause	pothole
Activity	driving
Duration	5 seconds
Adjective	big
Verb	driving, not working





# WCA Pipeline

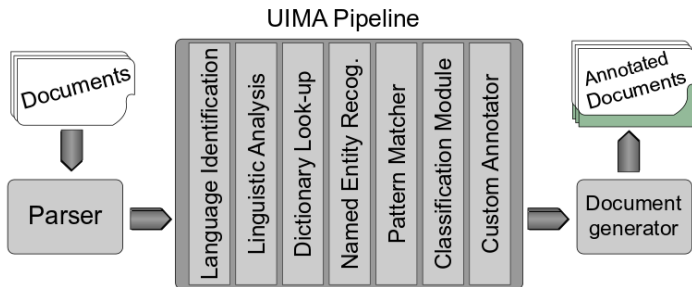
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# Triggered phrases

- 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 (massively), ..
- 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]

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# Interesting phrases in indication and procedure description

- Indication section
  - insbesondere ... potentiell ... Option, insbesondere ... 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

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Facettenavigation Standardreihenfolge ▾

Filter:  Löschen

- Wortarten <sup>2</sup>
- Satzteil <sup>2</sup>
- Operationsdatum
- Operationsdauer
- Einzelne Fälle
- Einzelne Patienten
- Altersgruppen
- Mitwirkende
- Sprachanalyse
- Länge des Gesamtberichts
- Länge der Indikation
- Länge des Befundes
- Unvollständige Daten

	Bereiche	Häufigkeit
<input type="checkbox"/>	1 - 2 Stunden	72
<input type="checkbox"/>	unter 1 Stunde	70
<input type="checkbox"/>	2 - 3 Stunden	58
<input type="checkbox"/>	3 - 4 Stunden	32
<input type="checkbox"/>	4 - 5 Stunden	23
<input type="checkbox"/>	5 - 6 Stunden	14
<input type="checkbox"/>	6 - 7 Stunden	13
<input type="checkbox"/>	über 8 Stunden	2
<input type="checkbox"/>	7 - 8 Stunden	1

# WCA - Phrases in the indication

	Werte	Häufigkeit
<input type="checkbox"/>		3
<input type="checkbox"/>		1
<input type="checkbox"/>		1
<input type="checkbox"/>		1
<input type="checkbox"/>		1
<input type="checkbox"/>	insbesonders	16
<input type="checkbox"/>	insbesonders ... Ehegattin	2
<input type="checkbox"/>	insbesonders ... detaillieren ... Aufklärung	1
<input type="checkbox"/>	insbesonders ... etwaig alternativ ... Option	2
<input type="checkbox"/>	insbesonders ... potentiell ... Option	1
<input type="checkbox"/>	insbesonders ... potentiell ... Problematik	1
<input type="checkbox"/>	insbesonders ... prinzipiell ... Problematik	1
<input type="checkbox"/>	insbesonders ... speziell ... Risiko	3
<input type="checkbox"/>	jedoch	20
<input type="checkbox"/>	leider	3
<input type="checkbox"/>	leider ... werden	1

# WCA - Phrases in the procedure description

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Sprachanalyse		Werte	Häufigkeit	1 ▼
▼ Indikation		<input type="checkbox"/> heftig	1	
Betonungen (Phrasen)		<input type="checkbox"/> auffällig ... .. sein	1	
Betonungen (Schlüsselwörter)		<input type="checkbox"/> stark ... .. Gefäß	1	
Extremfälle (Schlüsselwörter)		<input type="checkbox"/> stark ... .. bluten	1	
Unerwartete Ereignisse (Schlüsselwörter)		<input type="checkbox"/> [redacted]	1	
▼ Befund		<input type="checkbox"/> mächtig ... .. erkennen	1	
Betonungen (Phrasen)		<input type="checkbox"/> massiv ... .. Verklebung	1	
Betonungen (Schlüsselwörter)		<input type="checkbox"/> [redacted]	1	
Extremfälle (Schlüsselwörter)		<input type="checkbox"/> [redacted]	1	
Unerwartete Ereignisse (Schlüsselwörter)		<input type="checkbox"/> massiv ... .. bedrängen	1	
▶ Länge des Gesamberichts		<input type="checkbox"/> völlig ... zufriedenstellend ... Verhältnis	1	
▶ Länge der Indikation		<input type="checkbox"/> völlig ... problemlos ... Blut Stillung	1	
▶ Länge des Befundes		<input type="checkbox"/> speziell ... .. ausgesucht	1	
Unvollständige Daten		<input type="checkbox"/> völlig ... entlasten ... sein	1	



# WCA - Deviations view



**Example:**  
Weekly deviation of surgeries having different length

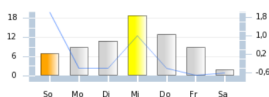
Maximale Zeiteinheiten pro Diagramm:  Indexumfang:



1 - 2 Stunden (72)



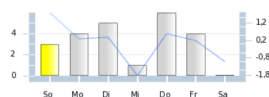
unter 1 Stunde (70)



3 - 4 Stunden (32)



4 - 5 Stunden (23)





# WCA - Trends view

Zeitreihen
  Abweichungen
  Trends
  Facettenpaare
  Verbindungen
  Dashboard

**Example:**

Time trend of occurrences of trigger words and phrases

Maximale Zeiteinheiten pro Diagramm:  Daten anzeigen ab:

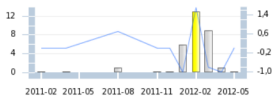
stark (55)



massiv (43)



auffällig (30)



insbesondere (27)





# WCA - Facetpair view



## Example:

Identification of conspicuous length relations between indication and procedure description.

Unterfacetten/ Werte	sehr kurz 3	kurz 54	mittel 124	lang 33	sehr lang 22
sehr kurz 4	3 13,0	0 0,0	1 0,0	0 0,0	0 0,0
kurz 53	0 0,0	24 1,7	26 0,8	3 0,1	0 0,0
mittel 131	0 0,0	25 0,7	80 1,3	21 0,9	5 0,1
lang 43	0 0,0	5 0,2	17 0,6	9 0,8	12 2,0
sehr lange 5	0 0,0	0 0,0	0 0,0	0 0,0	5 4,0

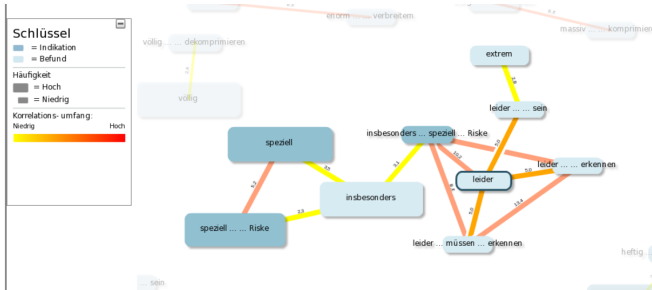


# WCA - Facetpair view



**Beispiel:**

Automatic recognition of the relation between phrases / trigger in indication and procedure description





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# Conclusion and Open challenges

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- 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.



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Thank you for your attention  
Any questions?