Using Keyqueries to Reduce Misinformation in Health-Related Search Results

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Challenges in Health-Related Searches

Example Information Need
[Clarke et al.; TREC'21]

Does selenium help prevent cancer?
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- Medical use-cases of selenium:
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![Periodic Table]

Search results for selenium cancer:

- Vitamins E and C and Selenium do Not Protect Against Cancer
  
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  Vitamin E and selenium are ineffective in preventing cancer and there's a hint of risk.
Automatic Approaches for Health-Related Searches?

Fully Automatic Approaches Seem “Utopical”

- Scientific knowledge changes rapidly
- Distinguishing helpful and harmful documents is difficult
  - maybe not possible using only the documents text?

We Take a Step Back

Can explicit relevance feedback by experts guide query expansion methods to formulate queries that return fewer misleading or wrong results?

- Approach:
  - Simulate expert providing explicit relevance feedback
  - Explicit relevance feedback is input for query expansion approach
  - Return ranking for expanded query
Baselines

Query Expansion with RM3

[Jaleel et al.; TREC’04]

- Adds new terms with weights to a query
- Exploits information from feedback documents

- Step 1 (i.e., RM1): Estimate relevance model for feedback documents
  - Each term gets an score.
  - E.g., for feedback documents $R$ for the original query $q$, a term $t$ obtains:

$$
\sum_{d \in R} P(t|d) \frac{score(q, d)}{\sum_{d' \in R} score(q, d')} ,
$$

- Step 2 (i.e., RM3): Linearly combine original query weight with RM1

Observation: RM3 might be ineffective for explicit relevance feedback

- RM3 does not consider ranks of feedback documents
- RM3 does not check whether all expansion terms are actually needed
- Result: Costly relevance feedback by experts is maybe not fully leveraged
Can We Make Better Use of Explicit Feedback From Experts?

The key are ...
Can We Make Better Use of Explicit Feedback From Experts?

The key are ... keyqueries
Query Expansion with Keyqueries

What is a keyquery? [Hagen et al.; ECIR’16]

Query \( q \) is a keyquery for a set \( D \) of target documents against a search engine iff

1. Every \( d \in D \) is in the top-\( k \) results. \hspace{1cm} \text{(specificity)}
2. Query \( q \) has at least \( l \) results. \hspace{1cm} \text{(generality)}
3. No subquery \( q' \subset q \) satisfies the above. \hspace{1cm} \text{(minimality)}

Remark: For small \( |D| \leq 5 \), typically \( l \geq 10 \) and \( k = 10 \).
Query Expansion with Keyqueries

Example: Keyquery for a paper \( (l \geq 1000, k = 3) \)

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**Elastic ChatNoir:**
**Search Engine for the ClueWeb and the Common Crawl**

Janek Bevendorff, Benno Stein, Matthias Hagen, and Martin Potthast

Bauhaus-Universität Weimar and Leipzig University

<first name>.<last name>@uni-weimar.de and martin.potthast@uni-leipzig.de

**Abstract** Elastic ChatNoir\(^1\) is an Elasticsearch-based search engine offering a freely accessible search interface for the two ClueWeb corpora and the Common Crawl, together about 3 billion web pages. Running across 130 nodes, Elastic ChatNoir features subsecond response times comparable to commercial search engines. Unlike most commercial search engines, it also offers a powerful API that is available free of charge to IR researchers. Elastic ChatNoir’s main purpose is to serve as a baseline for reproducible IR experiments and user studies for the coming years, empowering research at a scale not attainable to many labs beforehand, and to provide a platform for experimenting with new approaches to web search.
Query Expansion with Keyqueries

Example: chatnoir is a keyquery for Google Scholar

ChatNoir: a search engine for the ClueWeb09 corpus
M Potthast, M Hagen, B Stein, J Graßegger... - Proceedings of the 35th ..., 2012 - dl.acm.org
We present the ChatNoir search engine which indexes the entire English part of the ClueWeb09 corpus. Besides Carnegie Mellon's Indri system, ChatNoir is the second publicly available search engine for this corpus. It implements the classic BM25F information ... 🌟 59 Cited by 54 Related articles All 7 versions

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Le Chat Noir: A Montmartre cabaret and its artists in turn-of-the century Paris
A Fields - 1993 - openbibart.fr
Help. Search. XML. Title: Le Chat noir: a Montmartre cabaret and its artists in turn-of-the-century Paris ... Includes discussion of some of the shadow theater productions. ; Pagination/Size: 54 ; 54 p. ill. (some col) ; Topic: 530 - BIBLIOGRAPHIE D'HISTOIRE DE ... 🌟 28 Cited by 28 Related articles

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Example: ... but not for Google
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Simulation of explicit relevance feedback

- First $k$ relevant and helpful documents that appear in the BM25 ranking

Implementation Details

- Generate vocabulary $V$ of $<$term, weight$>$ expansion terms with RM3
- $Q = 2^V \setminus \{\emptyset\}$ are the meaningful queries over $V$
- Relaxation of the first keyquery criteria if necessary:
  - Retrieve $|R| - 1, |R| - 2, \ldots$ target documents
- Selection of expanded query if there are multiple keyqueries
  - Candidate with the highest nDCG@$k$ for the target documents
- We use a simple brute-force implementation
Evaluation

Setup: TREC 2019–2021 Decision and Health Misinformation Tracks

- Helpful qrels: Documents are relevant and helpful
- Harmful qrels: Documents are relevant but harmful
- Effectiveness measured as difference: Helpful - Harmful

Results on the TREC 2019 Decision Track

- Corpus: ClueWeb12 category B
- 50 judged Topics. E.g.:
  
  Does hypnotherapy help people quit smoking?
Evaluation

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- Helpful qrels: Documents are relevant and helpful
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Results on the TREC 2020 Decision Track

- Corpus: Common Crawl News Crawl
- 46 judged Topics. E.g.:
  
  Can ibuprofen worsen COVID-19?

- VERA (1st@TREC)
  
  [Pradeep et al.; SIGIR'21]
  
  – Answer as explicit feedback
  – Predict with T5 whether the document supports the answer
  – Interpolated with Mono/DuoT5

![Graph showing nDCG@10 (Diff) for different models against Feedback]
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Results on the TREC 2021 Decision Track

- Corpus: noclean subset of C4
- 35 judged Topics. E.g.:

  Does selenium help prevent cancer?

- VERA (1st@TREC) [Pradeep et al.; SIGIR’21]
  - Difference to
    - BM25+KQ-RM3 not significant
    - BM25+RM3 is significant

![Feedback vs nDCG@10 (Diff)](chart)
Conclusions

Summary

- RM3 query expansions can be enhanced with the concept of keyqueries
  - Leads to more effective BM25 queries: Increased help, decreased harm
- Explicit feedback is important for health-related searches
  - VERA is the state of the art
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Future work

- Expand study:
  - More relevance feedback approaches, query expansion approaches, retrieval models
- Replace brute-force implementation
  - Efficient enumeration or reverted indexes
- Replace costly relevance feedback with information available on the Web?
  - E.g., schema.org/ClaimReview
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thank you!