Axiomatic Retrieval Experimentation with **`ir_axioms`**

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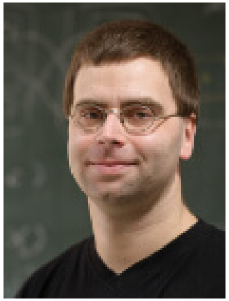
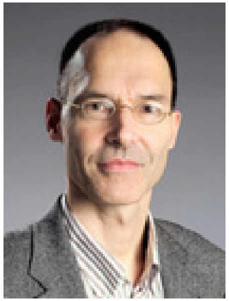
J. Heinrich
Reimer

Alexander
Bondarenko

Maik
Fröbe



Matthias
Hagen



Benno
Stein

Michael
Völske

Martin-Luther-Universität Halle-Wittenberg

Bauhaus-Universität Weimar

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A Brief Tour into Axiomatic IR

Successful retrieval scoring functions share similar properties:

- TF weighting
- IDF weighting
- Length normalization

Example:

$$BM25(q,d) = \sum_{i=1}^{n} IDF(t_i) \cdot \frac{TF(t_i,d) \cdot (k_1 + 1)}{TF(t_i,d) + k_1 \cdot \left(1 - b + b \cdot \frac{|d|}{avgdl}\right)}$$

“Axioms” formally capture such properties / constraints of relevance.

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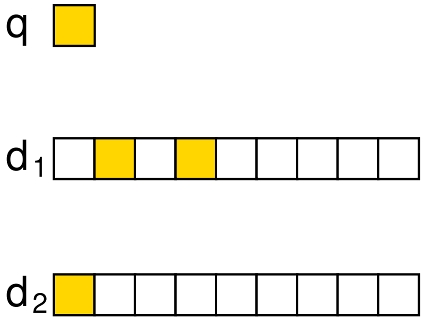
Axiom Example: TFC1

TFC1 Favor documents with more occurrences of query terms [Fang et al., SIGIR'04]

Given:

- Single-term query $q = \{t\}$
- Documents d_1, d_2 with $|d_1| = |d_2|$



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Given:

- Single-term query $q = \{t\}$
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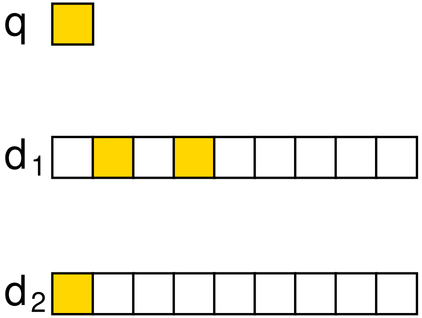
IF $TF(t, d_1) > TF(t, d_2)$ THEN $d_1 >_{\text{TFC1}} d_2$



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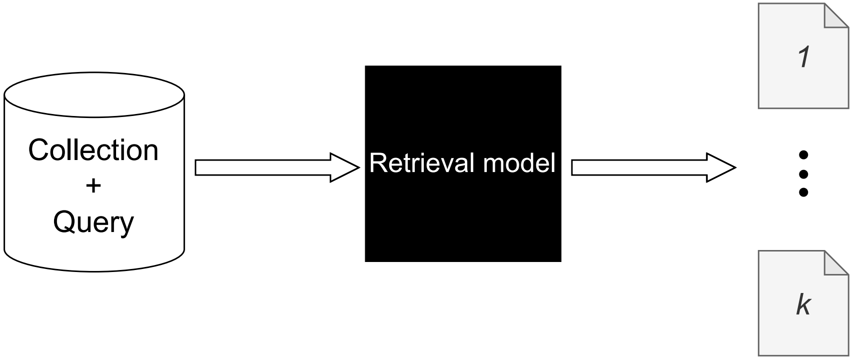
Axiom Applications

- ❑ Improving an initial retrieval result via re-ranking [Hagen et al., CIKM’16]
- ❑ Using axioms as regularization loss in neural models [Rosset et al., SIGIR’19]
- ❑ Learning how to combine different retrieval models [Arora and Yates, AMIR@ECIR’19]
- ❑ Analyzing and explaining neural rankers [Völske et al., ICTIR’21; Formal et al., ECIR’21]



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Motivation

- Many IR toolkits: Terrier, Anserini, Capreolus, PyTerrier, etc.
- They do not include components for IR axioms

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ir_axioms

- Python framework for experiments with IR axioms
- Implements 25 axioms (relax $|d_i| \approx_{10\%} |d_j|$, multi-term queries, etc.)
- Access to retrieval models and test collections in PyTerrier and ir_datasets
- Extensibility: simple to define new axioms

```python
class TFC1(Axiom):
  name = "TFC1"
  def preference(self, c, q, d_i, d_j) -> float:
    if not approximately_same_length(c, d_i, d_j, 0.1):
      return 0
    tf_i = sum(c.term_frequency(d_i, t) for t in c.terms(q))
    tf_j = sum(c.term_frequency(d_j, t) for t in c.terms(q))
    if approximately_equal(tf_i, tf_j, 0.1):
      return 0
    return 1 if tf_i > tf_j else -1
```

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Showcase

Jupyter Notebook:

`https://github.com/webis-de/ir_axioms/blob/main/examples/sigir2022_showcase.ipynb`

Google Colab:

`https://colab.research.google.com/github/webis-de/ir_axioms/blob/main/examples/sigir2022_showcase.ipynb`

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Summary

`ir_axioms`:

- 25 axioms
- Post-hoc analysis of rankings
- Axiomatic re-ranking pipeline
- Axiom preferences as features for LTR
- Caching and parallelization

Software and examples (contributions are welcome):

```
webis-de/ir_axioms
pip install ir_axioms
```

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thank you!

Thanks to SIGIR for a student travel grant.