Document Clustering with Query Constraints

Bauhaus-Universität Weimar

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Chair of Big Data Analytics
Prof. Dr. Matthias Hagen

Defense of Master's Thesis
March 10th, 2015

Motivation

Bauhaus-Universität Weimar: University
www.**uni-weimar**.de/en/**university**/start/ ▾ Bauhaus University, Weimar ▾
The online magazine BAUHAUS.JOURNAL ONLINE provides up-to-date information about what's happening at **Bauhaus-Universität Weimar**.
Architecture and Urbanism - Studies - Faculty of Media - Academic Programmes

Bauhaus University, Weimar - Wikipedia, the free ...
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Academic tradition in Weimar - History of the university - Faculties - University library

Bauhaus University Weimar in Germany - MasterStudies.com
www.masterstudies.com/**universities**/.../**Bauhaus-University-Weimar**/ ▾
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Bauhaus University Weimar - MastersPortal.eu
www.**mastersportal.eu**/**universities**/.../**bauh**... ▾ Portal for EU Master Programs ▾
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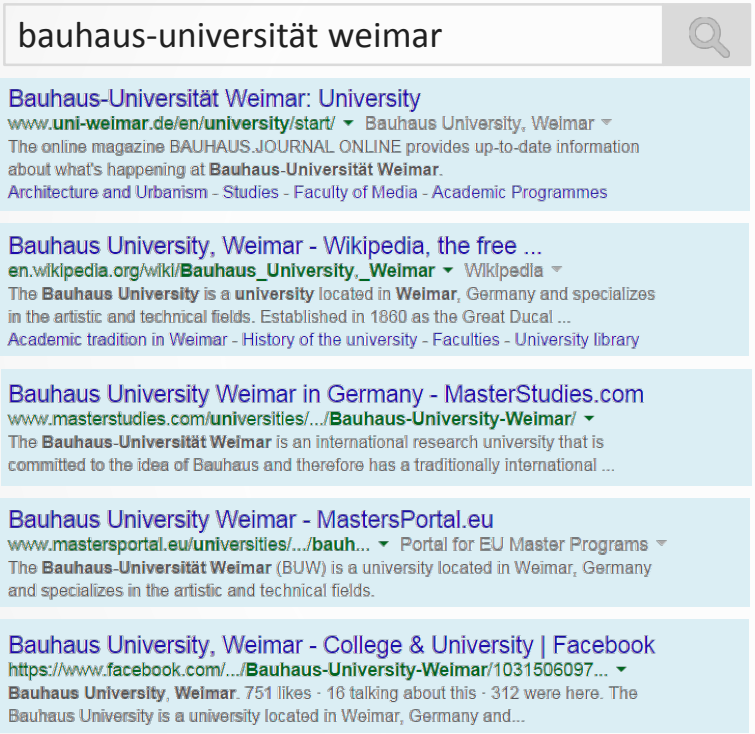
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Jaguar
www.**jaguar**.com/ ▾ Jaguar Cars ▾
Official worldwide web site of **Jaguar** Cars. Directs users to pages tailored to country-specific markets and model-specific websites.

Jaguar - Wikipedia, the free encyclopedia
en.wikipedia.org/wiki/**Jaguar** ▾ Wikipedia ▾
The **jaguar** (/ˈdʒægjuːər, ˈdʒægjʊər, ˈdʒægjuːɑr/ or /ˈdʒægwɑr/; Brazilian Portuguese: [ʒaˈgwaʁ], Spanish: [xaˈɣwar]), Panthera onca, is a big cat, ...

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The **jaguar** is the largest cat in the Americas. The **jaguar** has a compact body, a broad head and powerful jaws. Its coat is normally yellow and tan, but the color ...

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Jacksonville Jaguars, Official Site of the Jacksonville Jaguars
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Take a look back at some of the best images from the Jacksonville **Jaguars** ...
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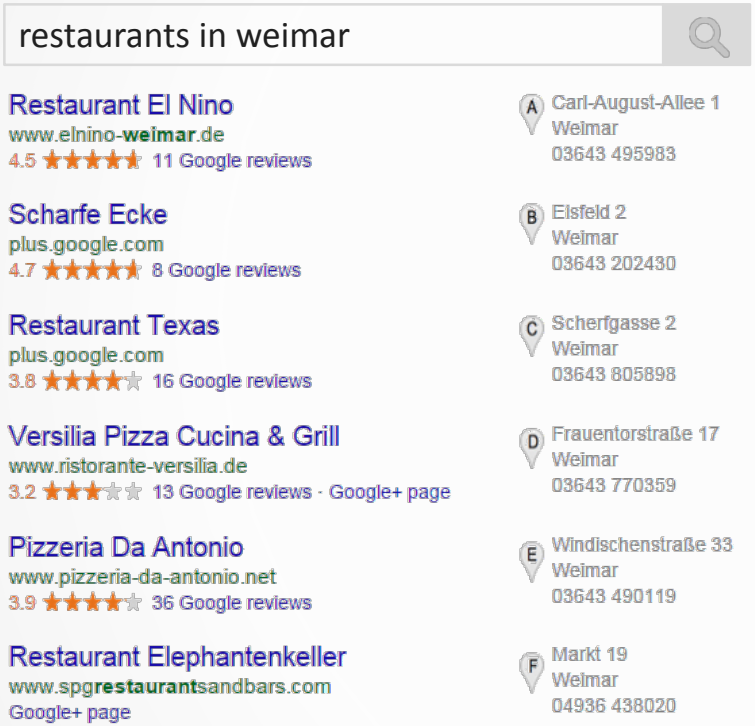
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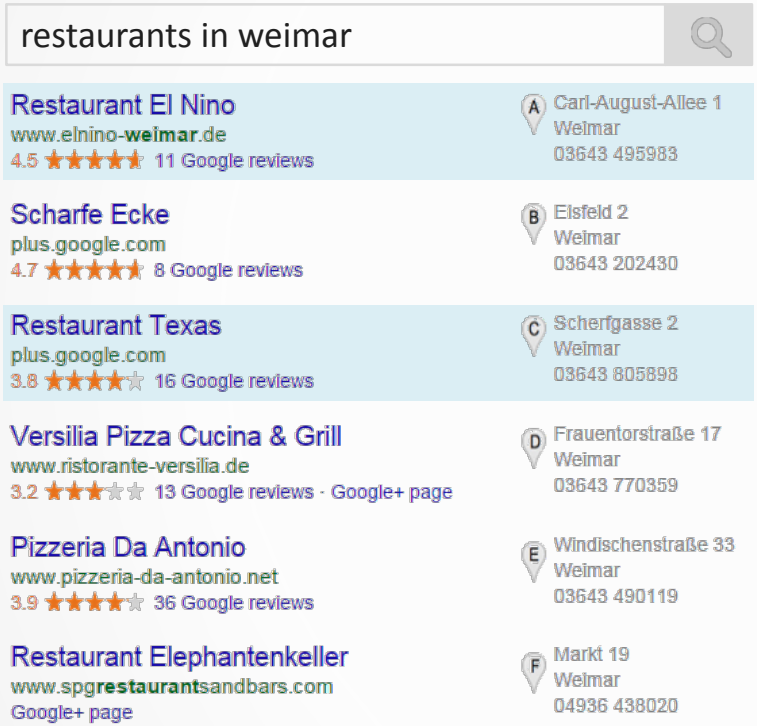
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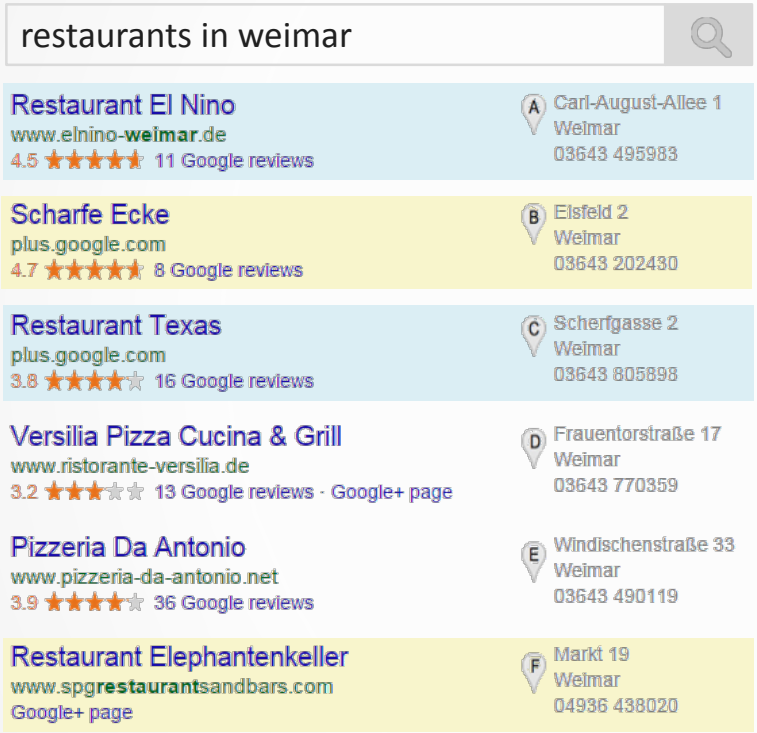
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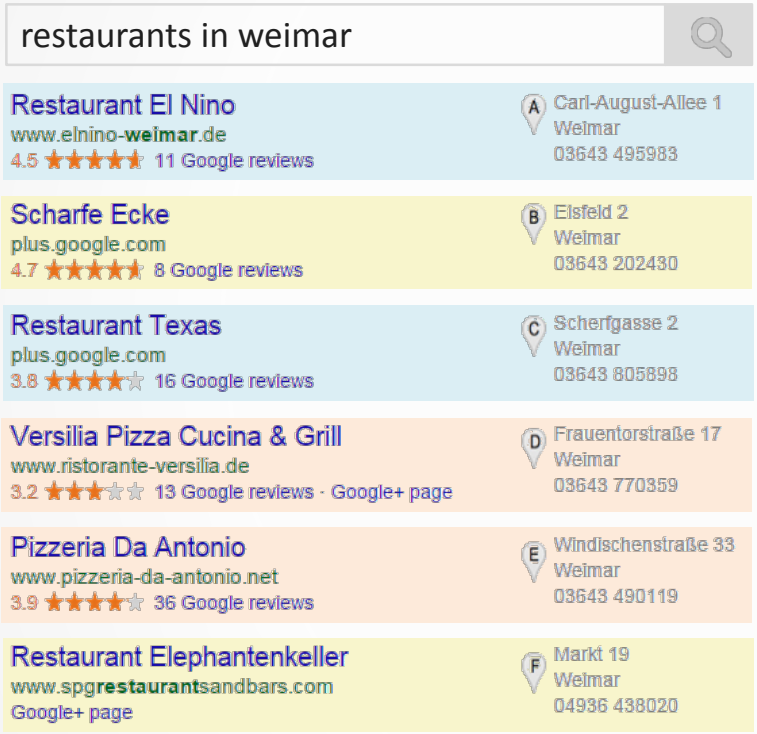
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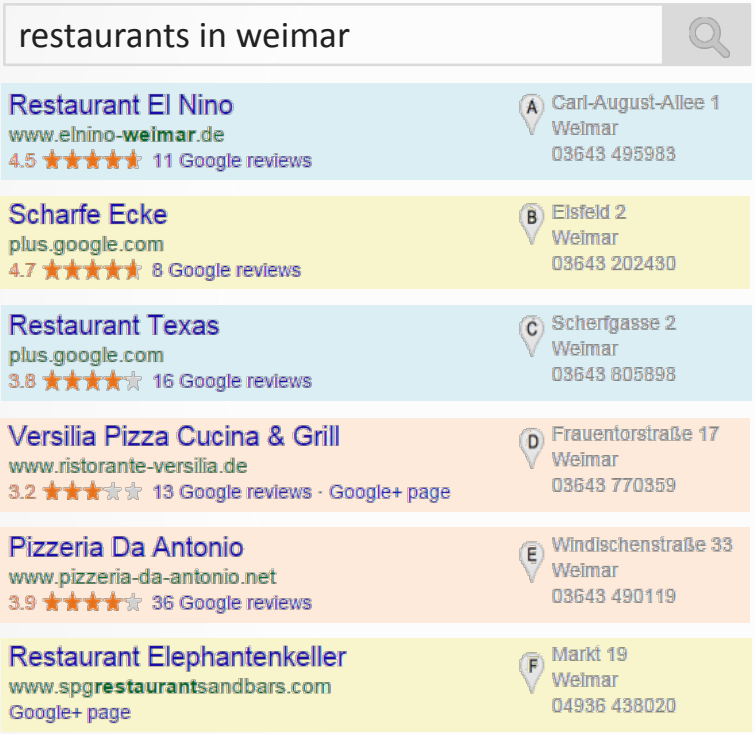
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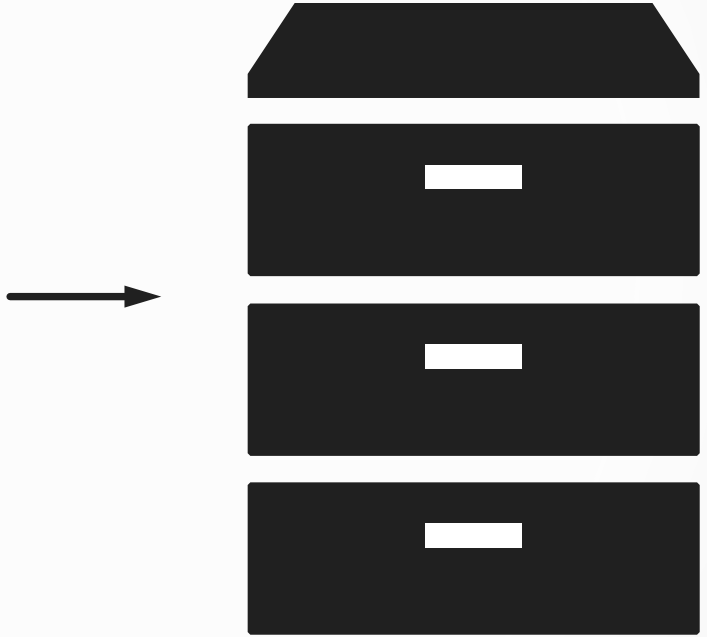

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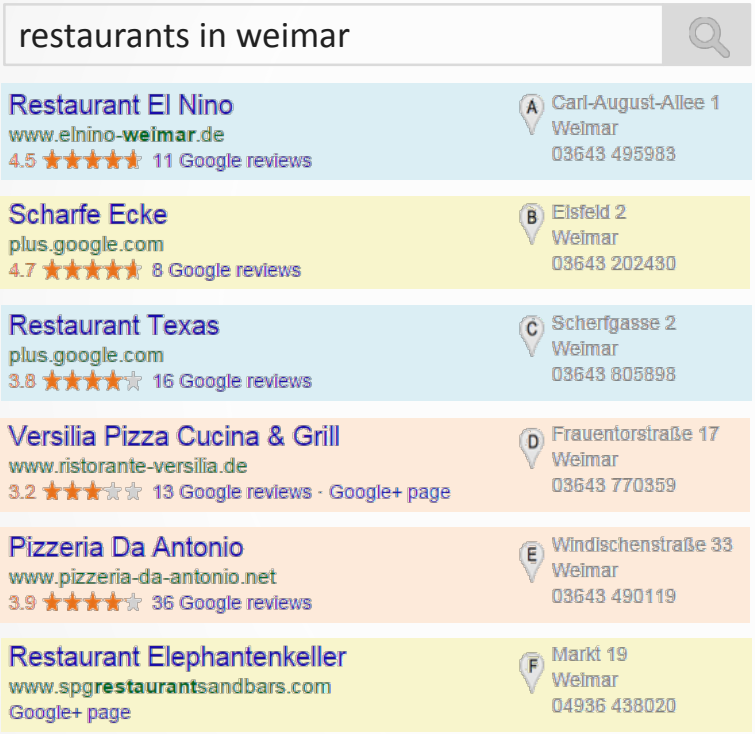
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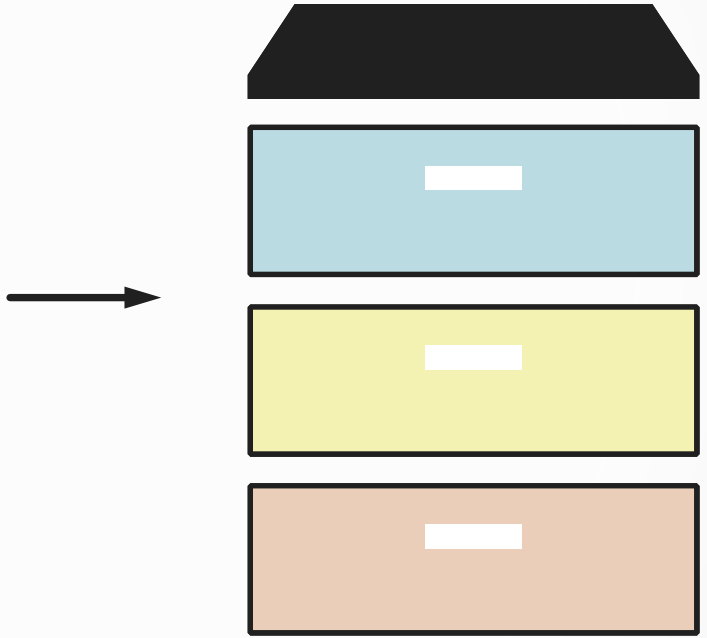
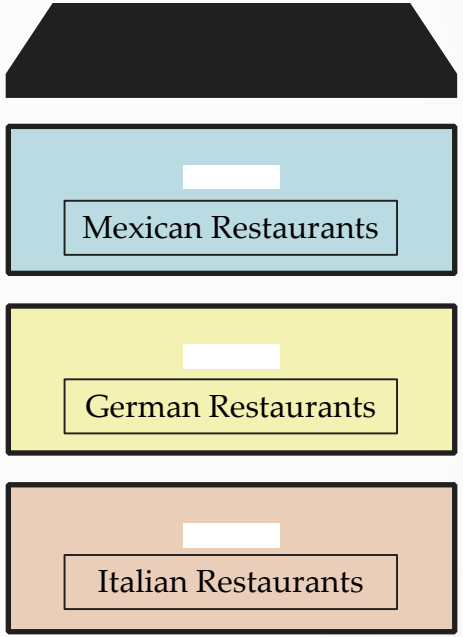
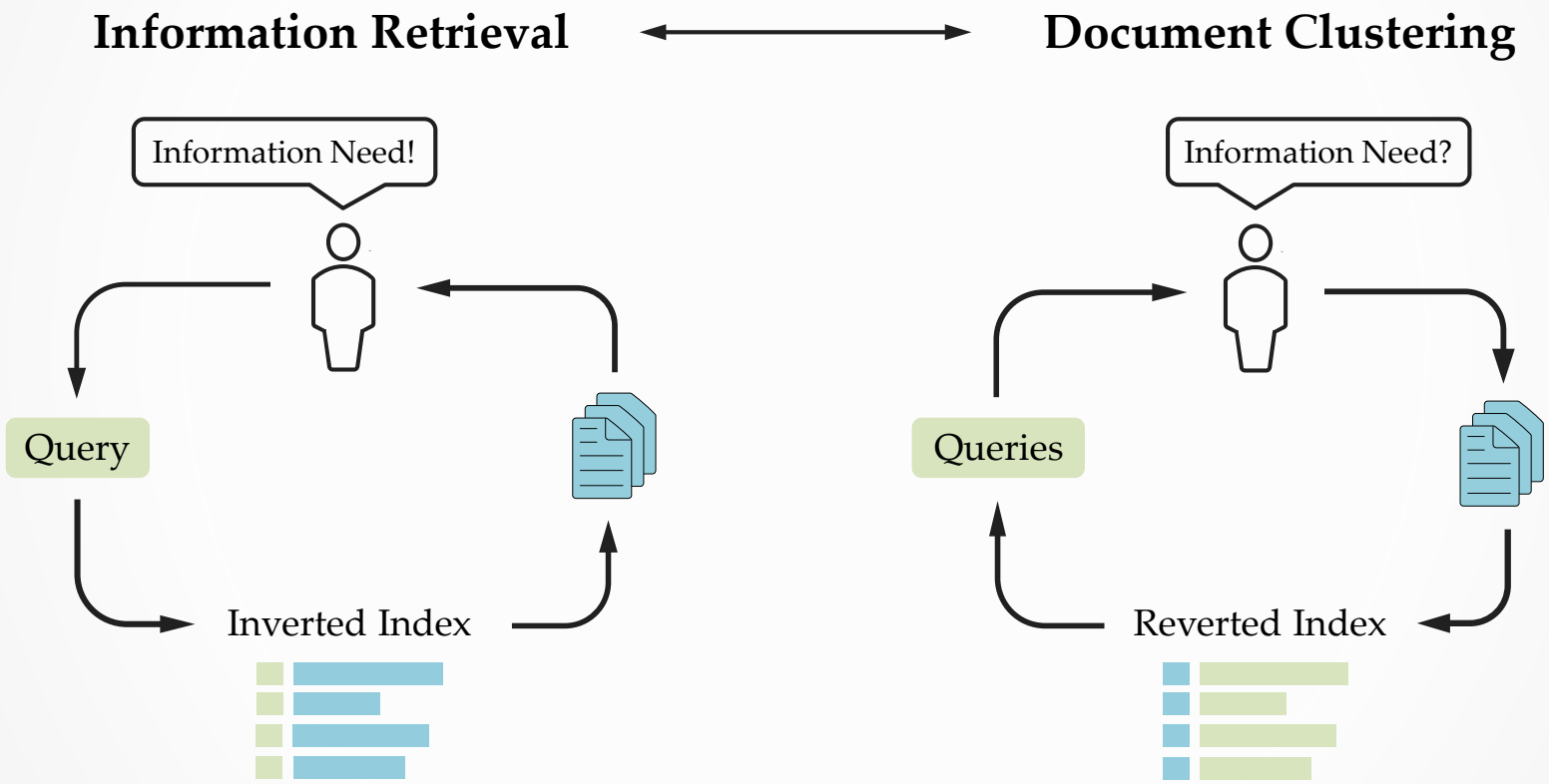


Goals

1. Group similar documents in the same cluster.
2. Label each cluster with a meaningful name.



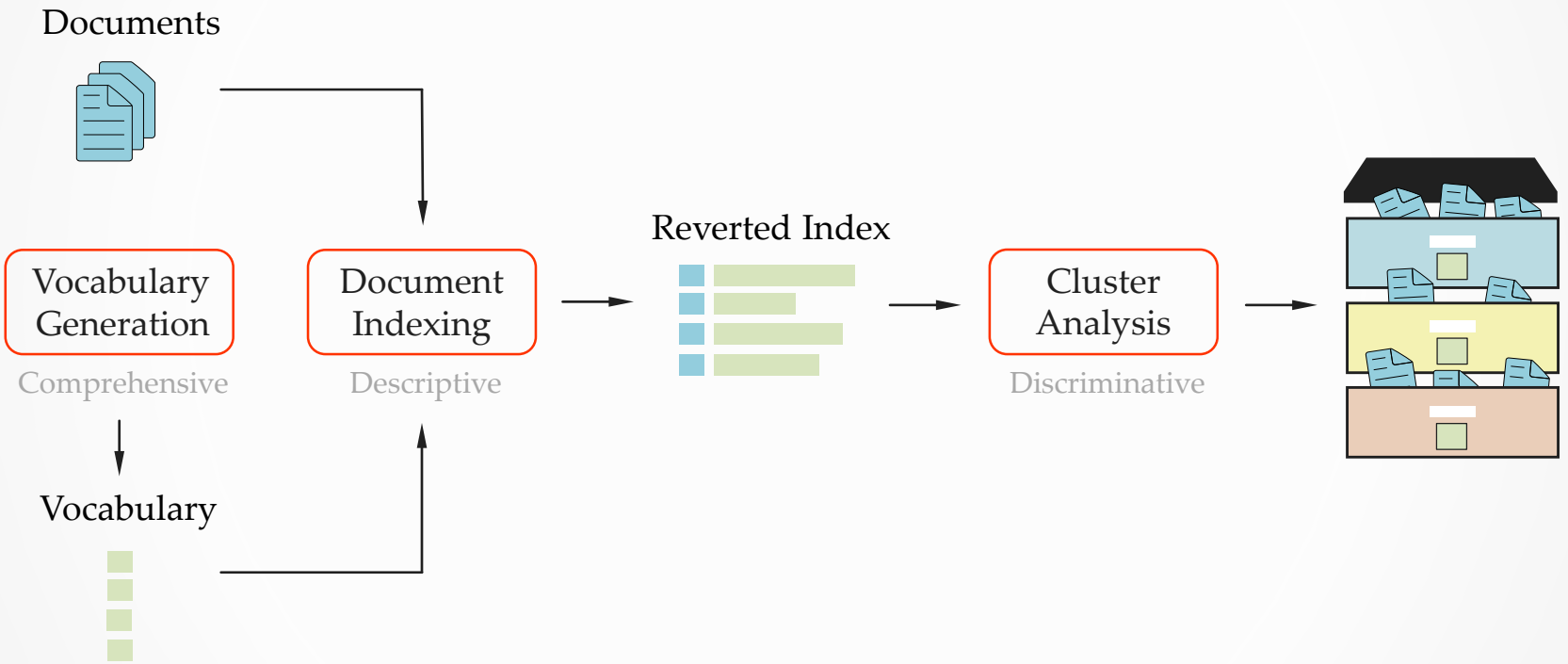
Basic Idea


Information Retrieval
Document Clustering
Information Need!
Query
Inverted Index
Information Need?
Queries
Reverted Index

Characteristics of Cluster Labels [Stein and Meyer zu Eißen, 2004]

Comprehensive	The syntax of the label should be appropriate.
Descriptive	The label should speak for each document in a cluster.
Discriminative	The semantic overlap between two cluster labels should be minimal.

Processing Pipeline



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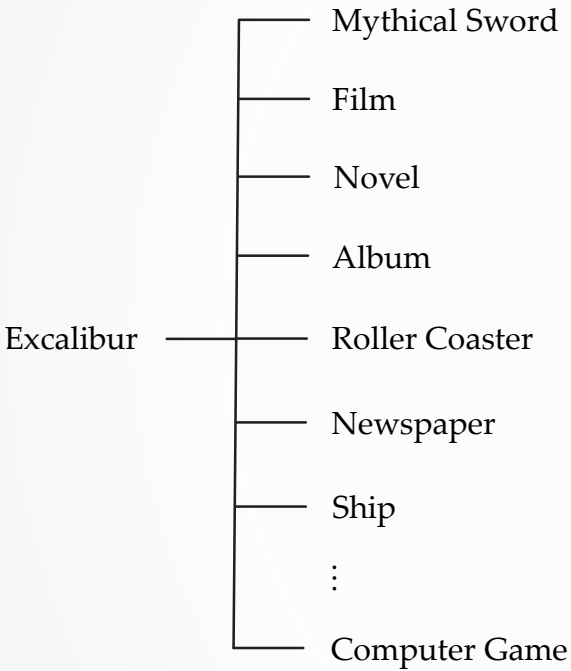

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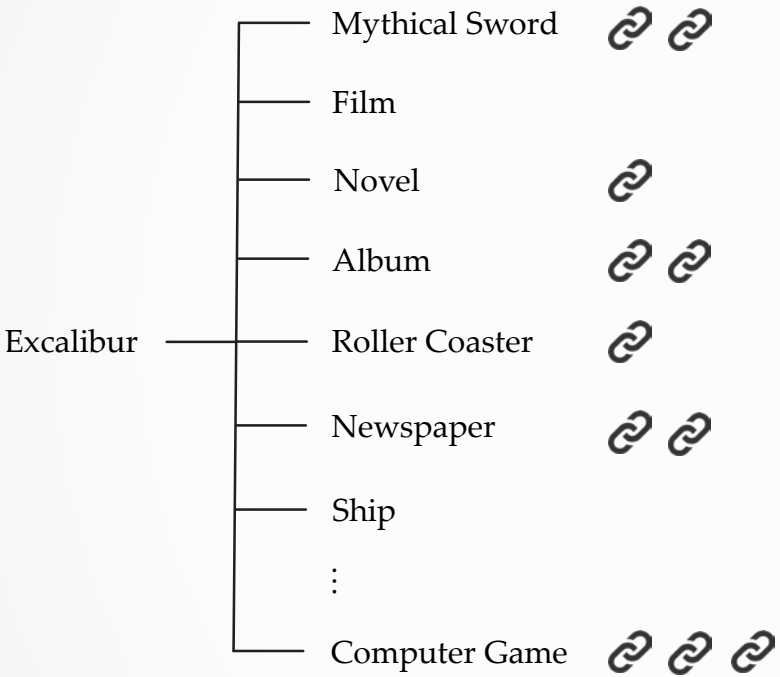

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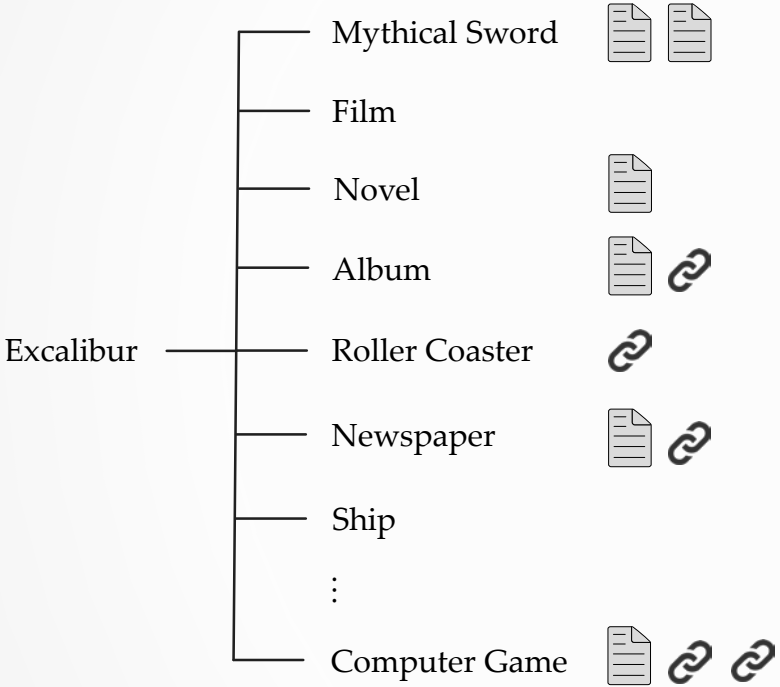

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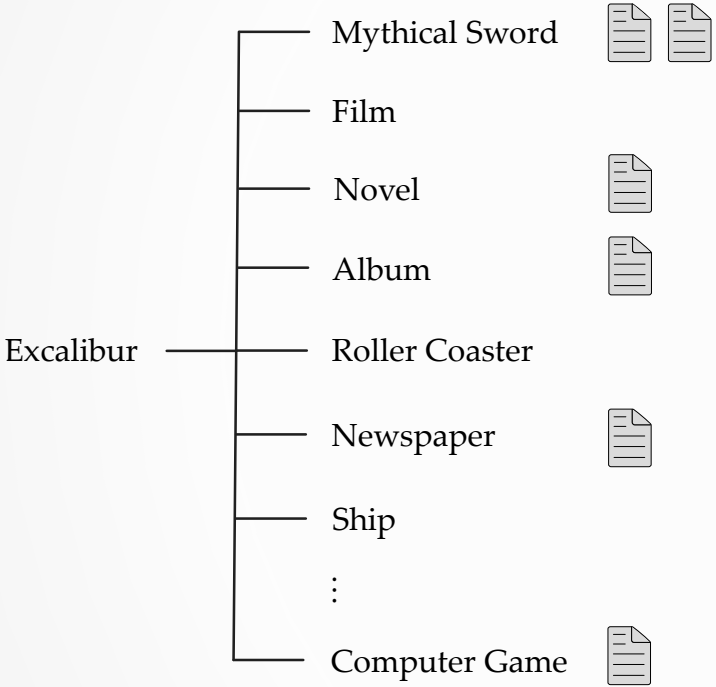

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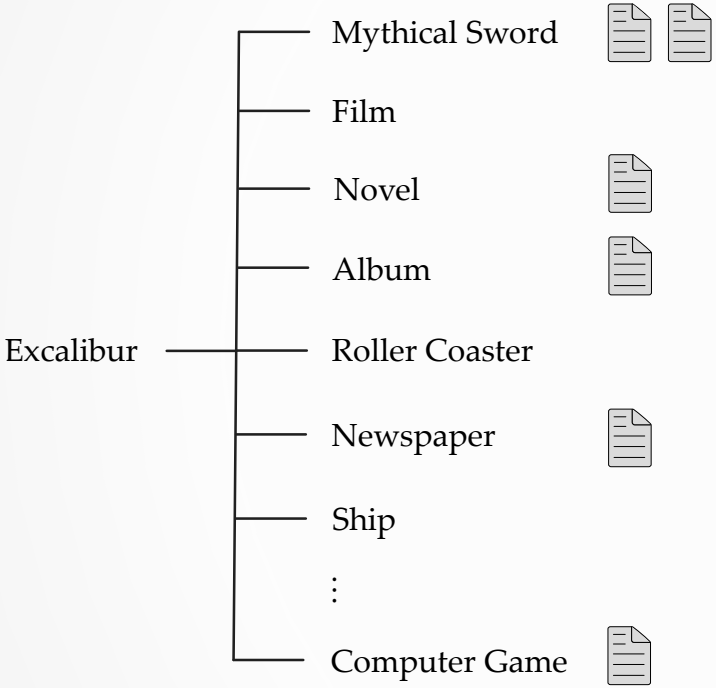

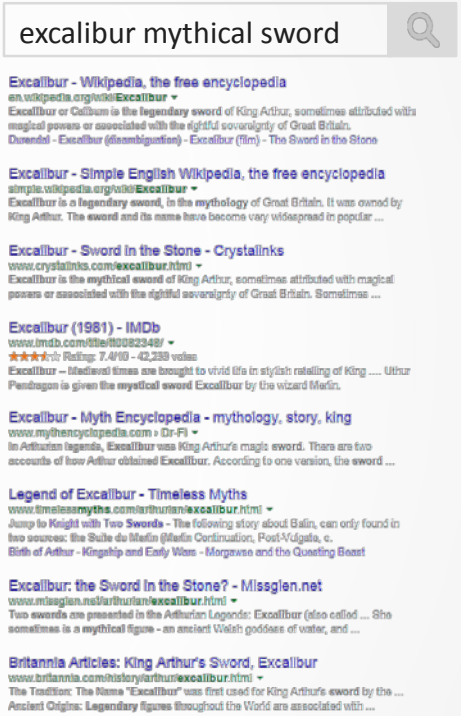

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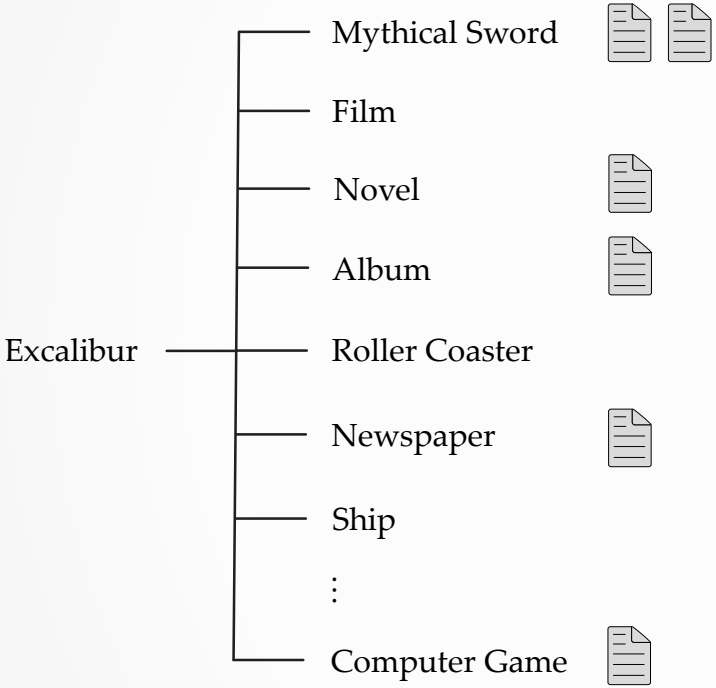

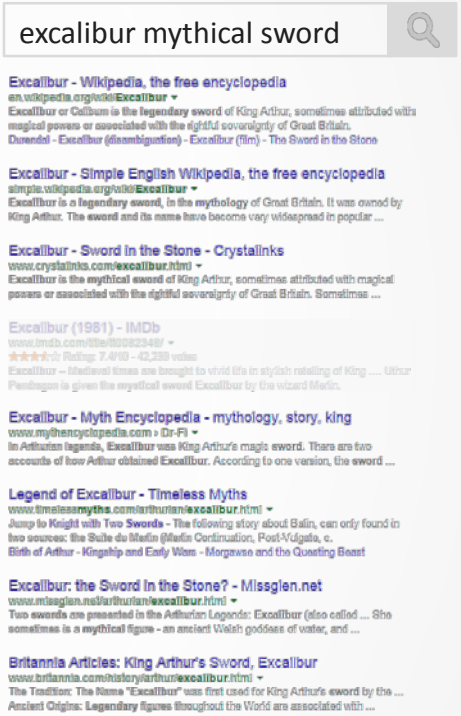

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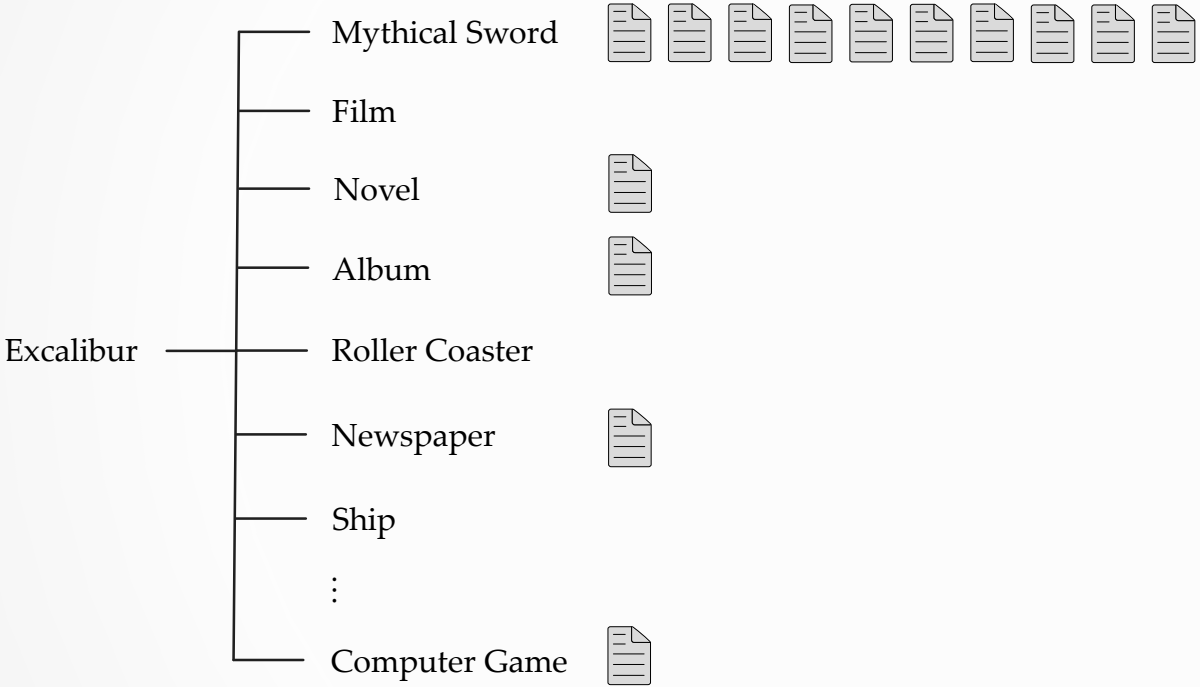

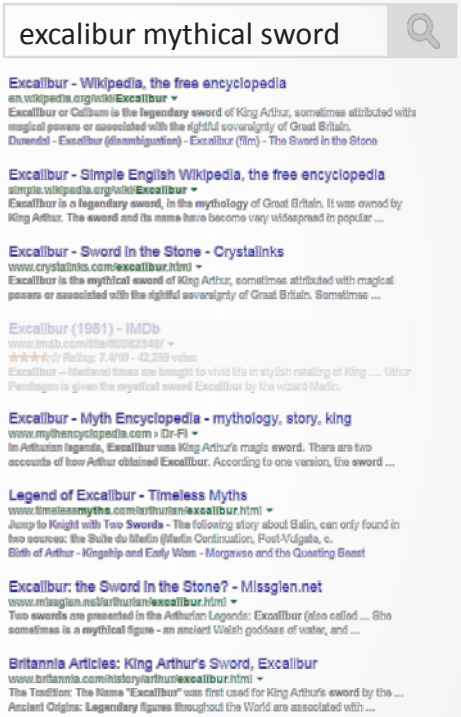

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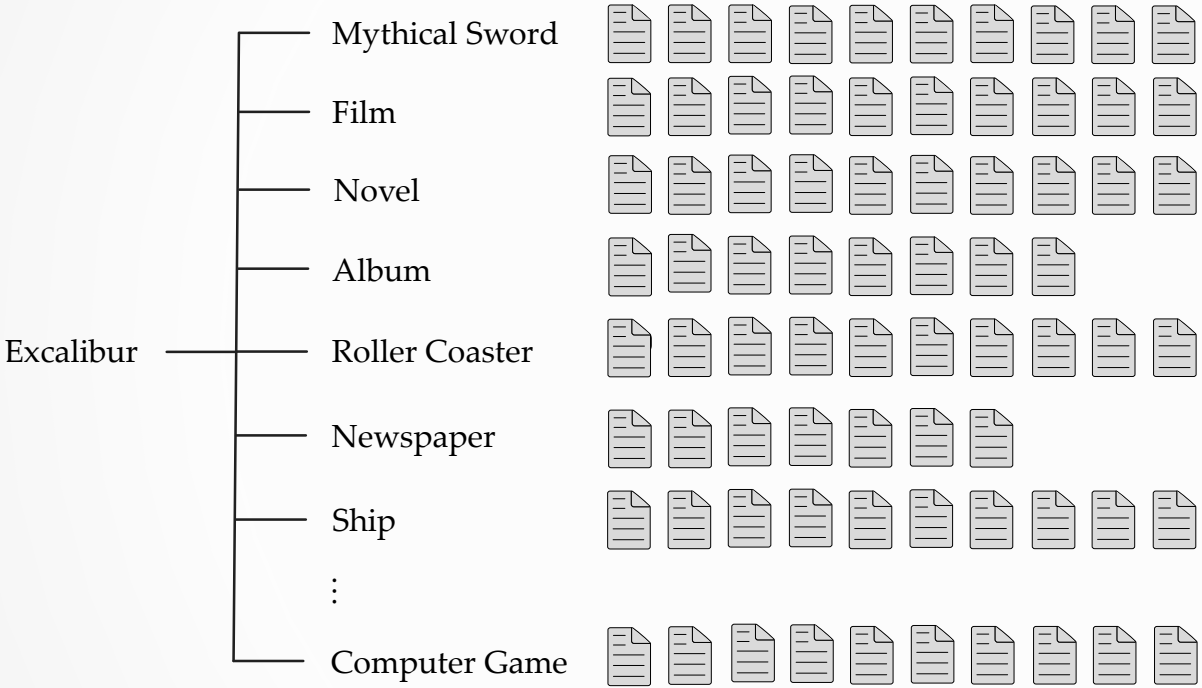

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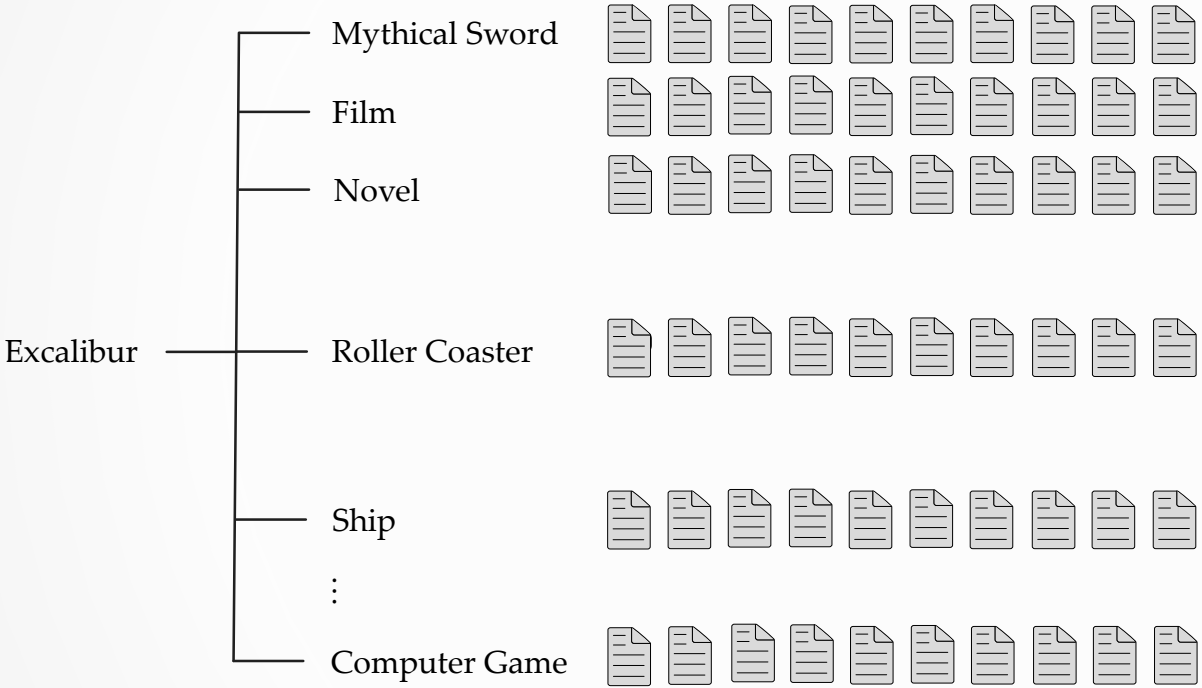

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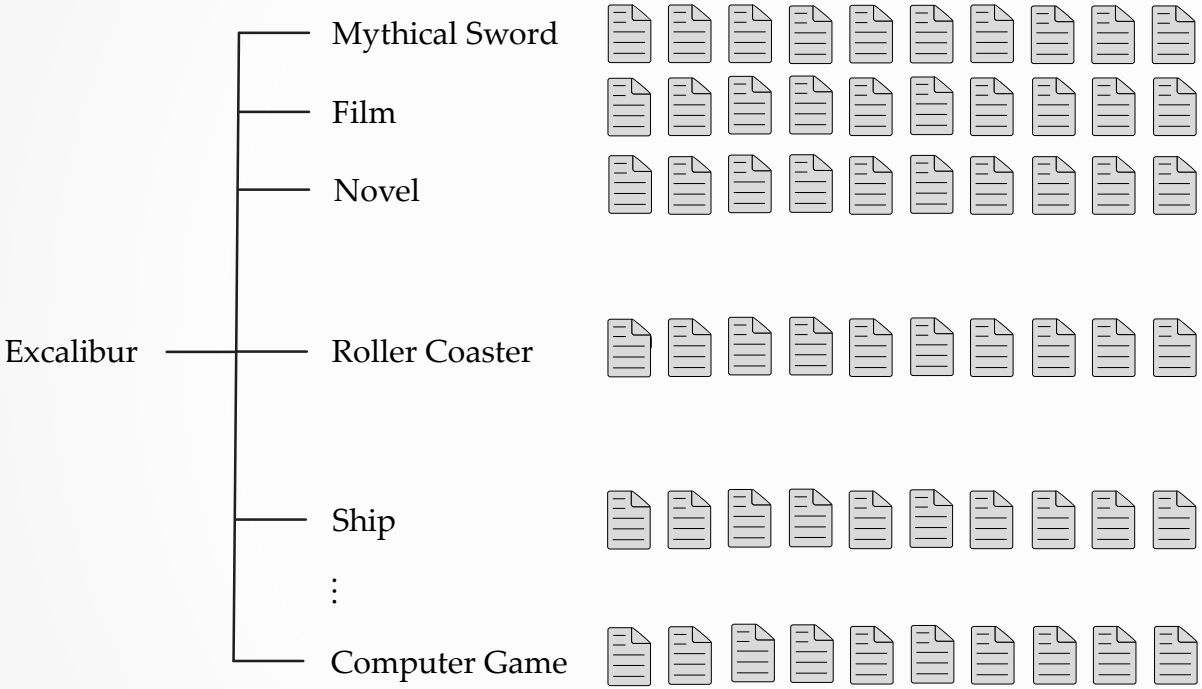


44 Topics

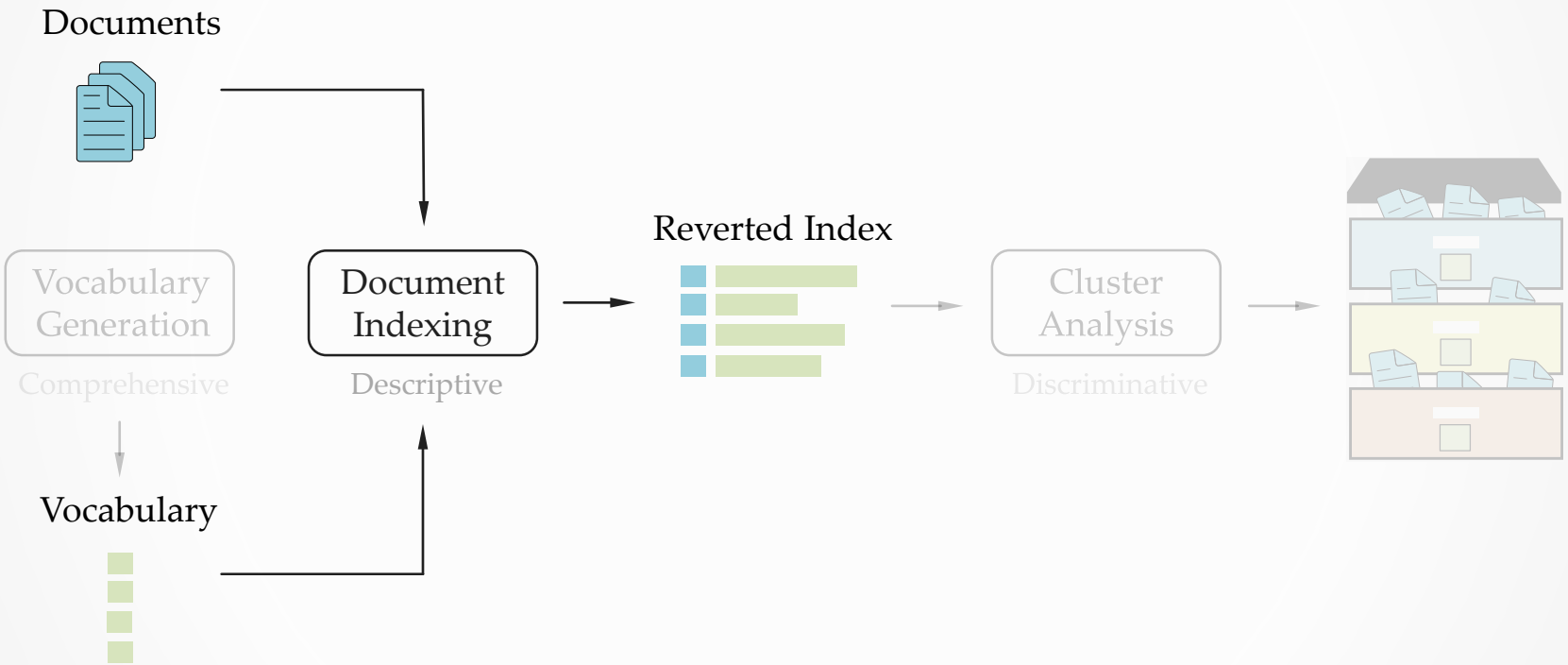
468 Subtopics

4 680 Documents

Vocabulary Generation

Vocabulary Generation

Document Indexing



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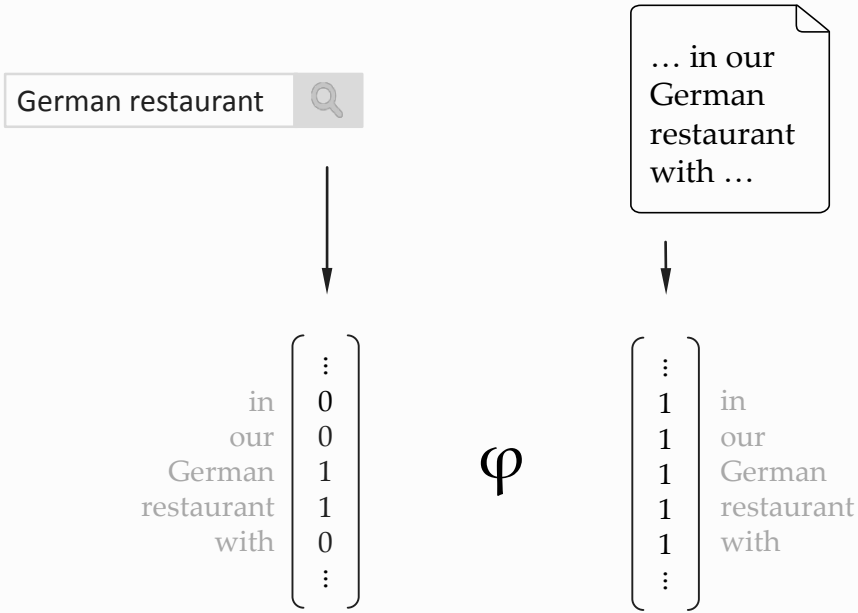

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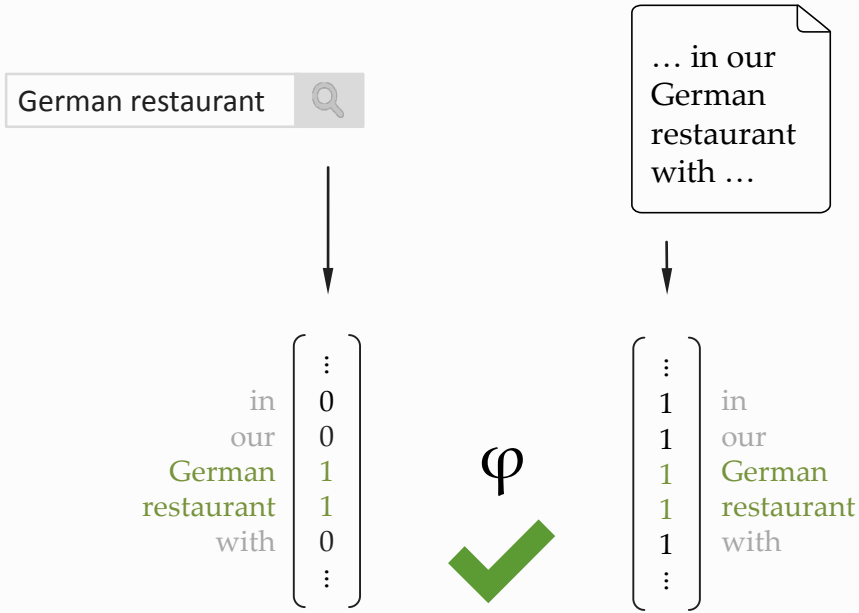
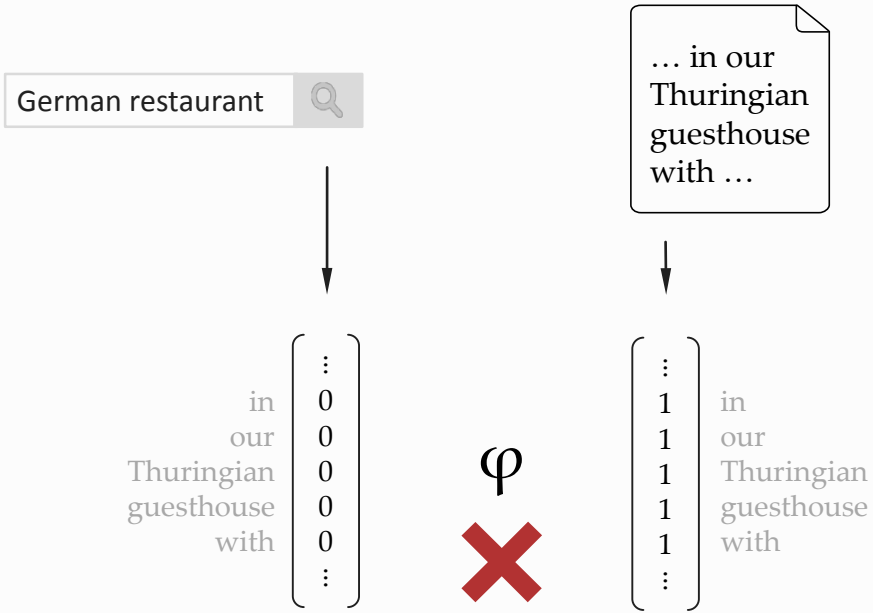
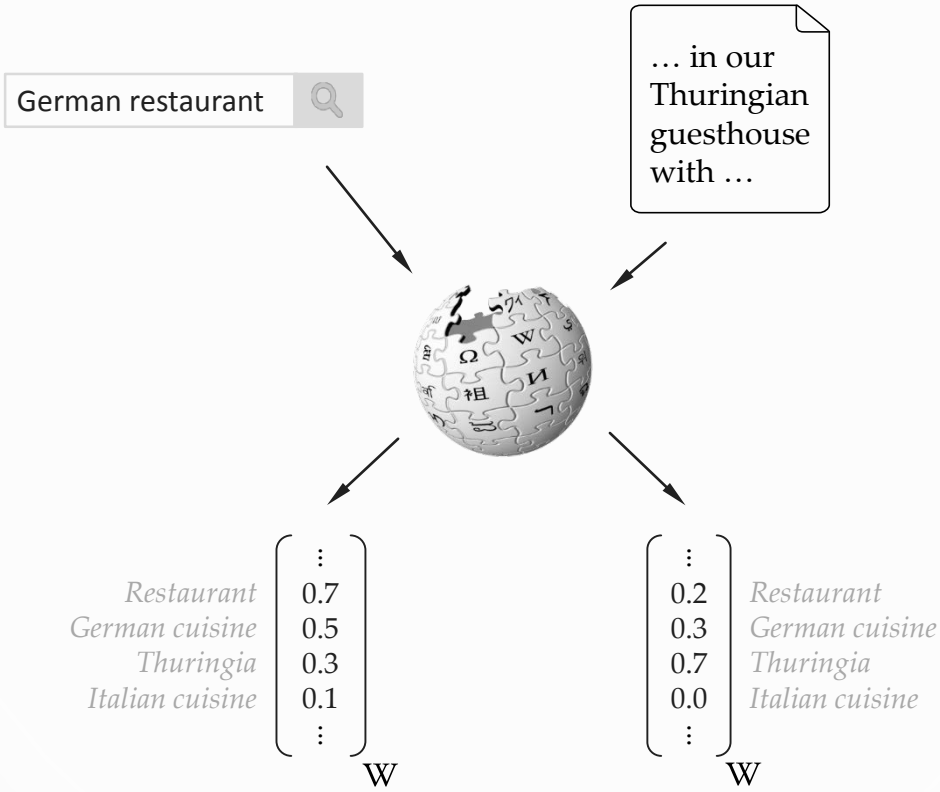


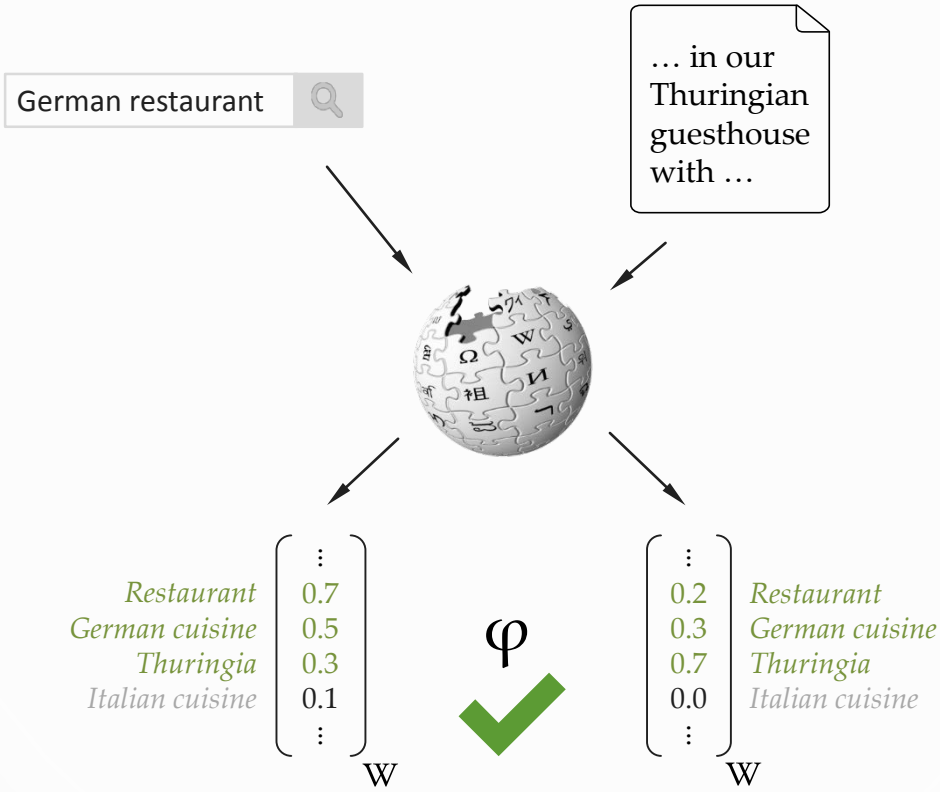
Document Indexing



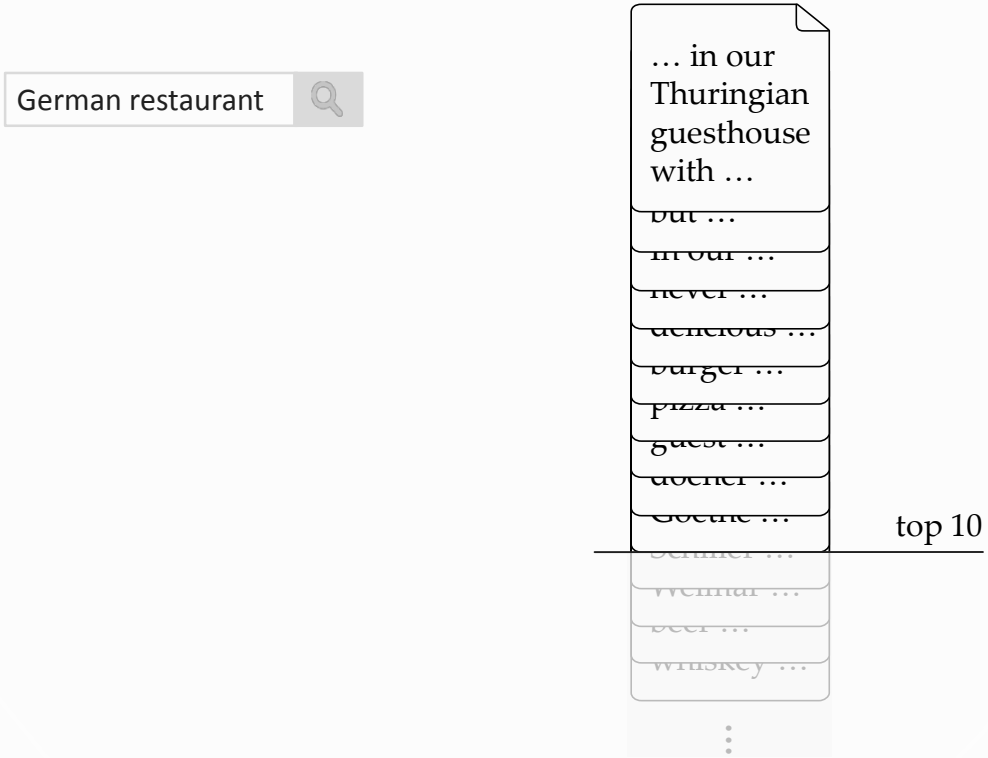
Document Indexing – Explicit Semantic Analysis (ESA)



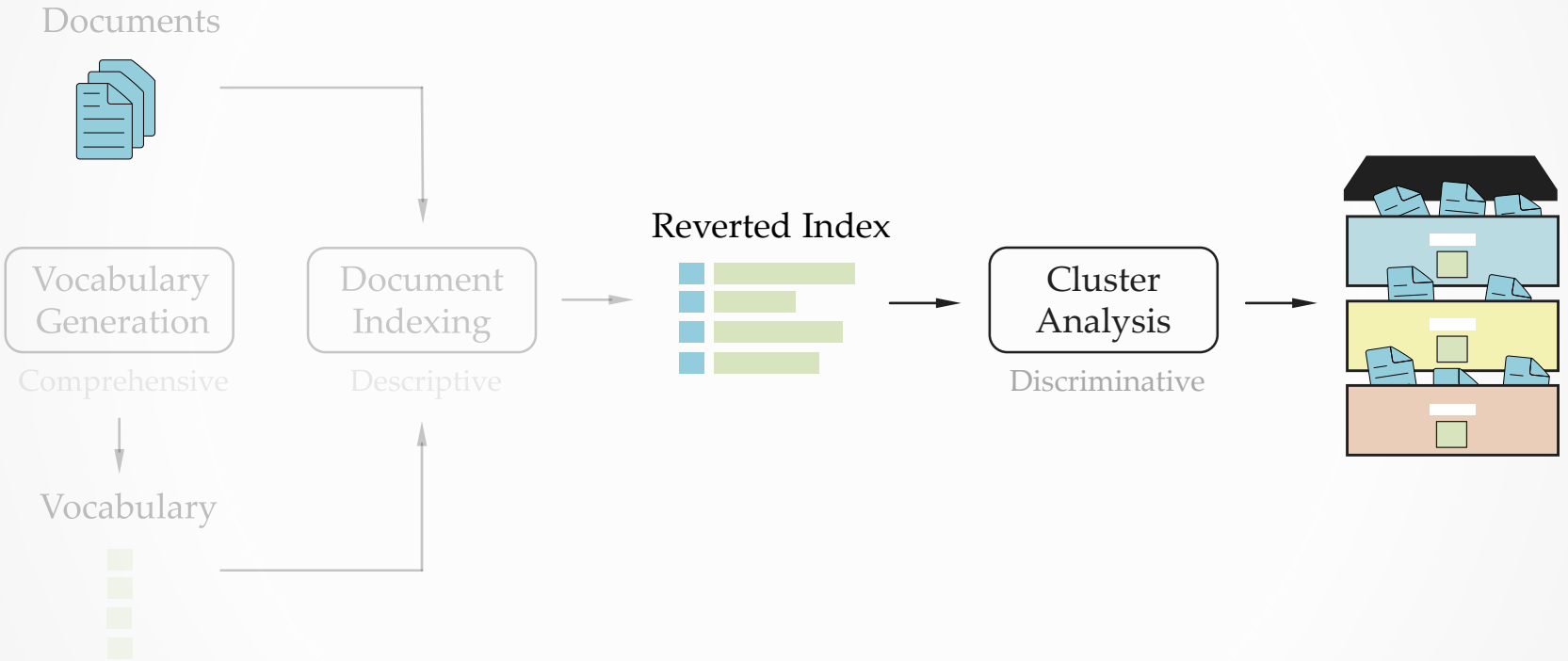
Document Indexing – Explicit Semantic Analysis (ESA)



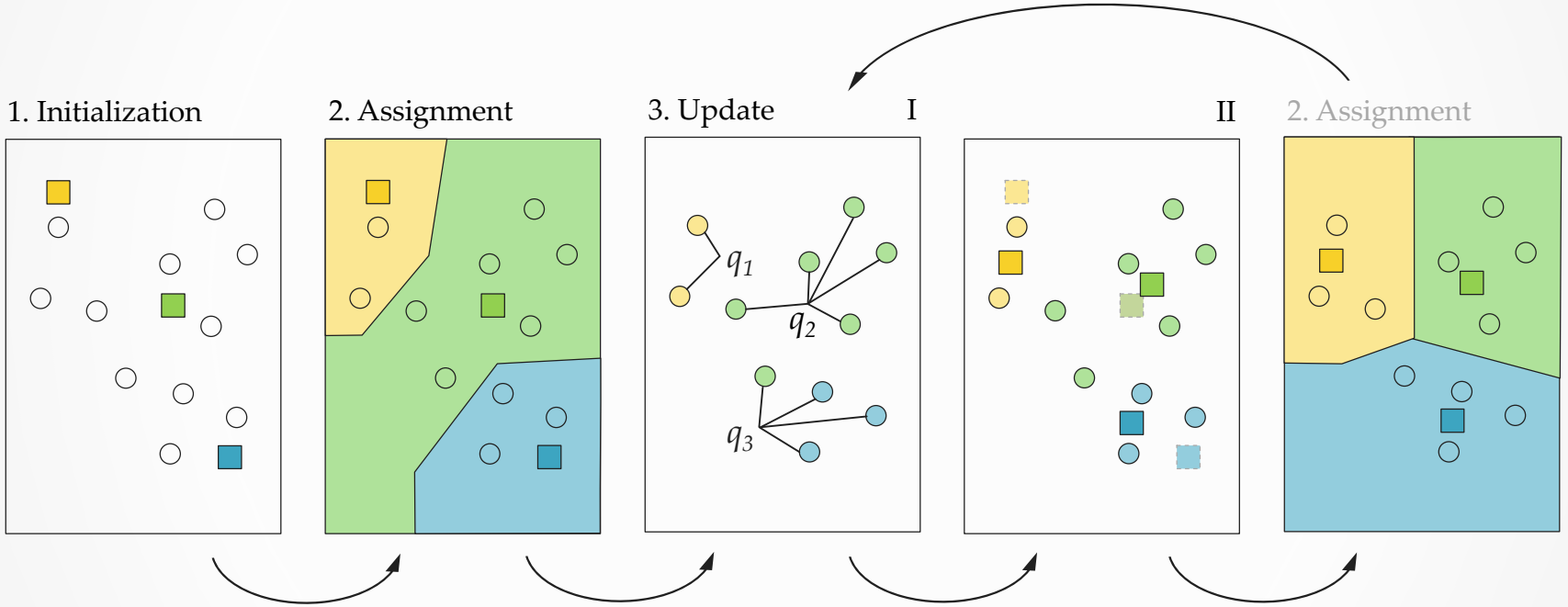
Document Indexing – Relevance Constraint



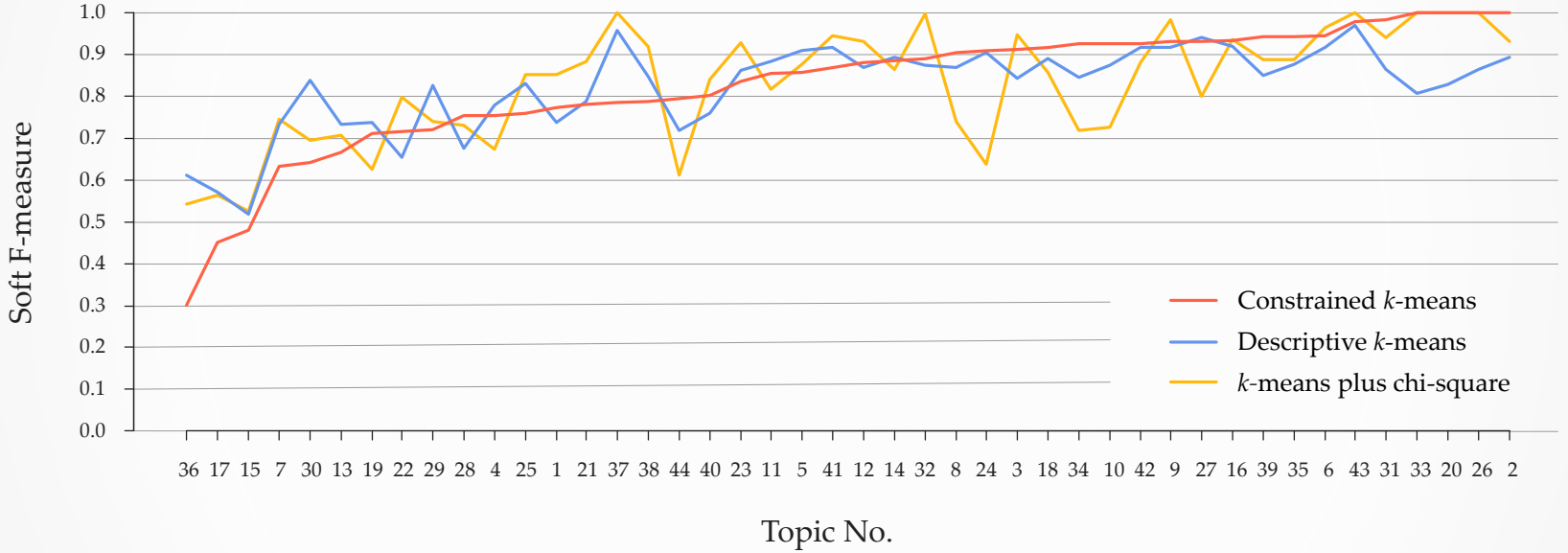
Cluster Analysis



Cluster Analysis – Constrained *k*-means



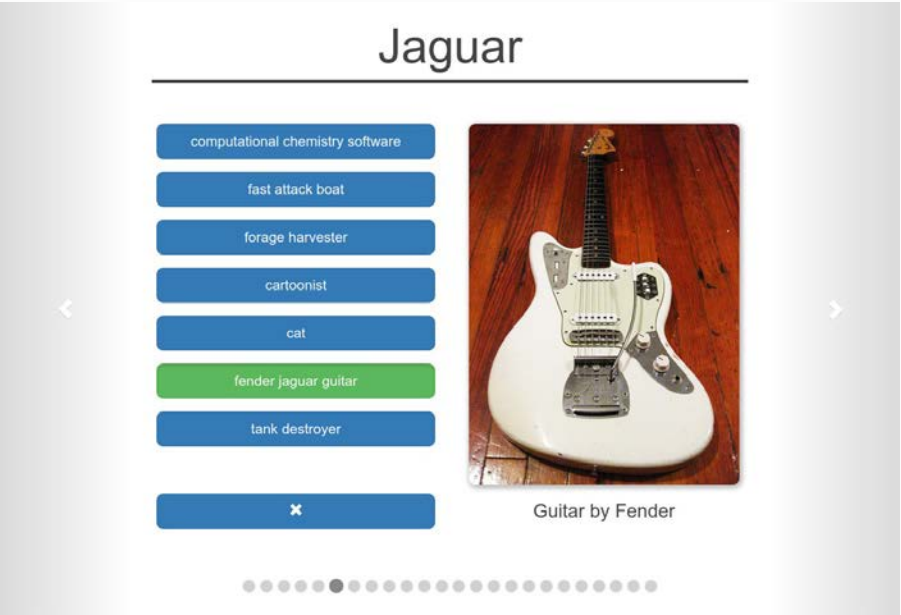
Evaluation of Cluster Documents



Evaluation of Cluster Labels – Discriminative Power

Topic

Cluster Labels

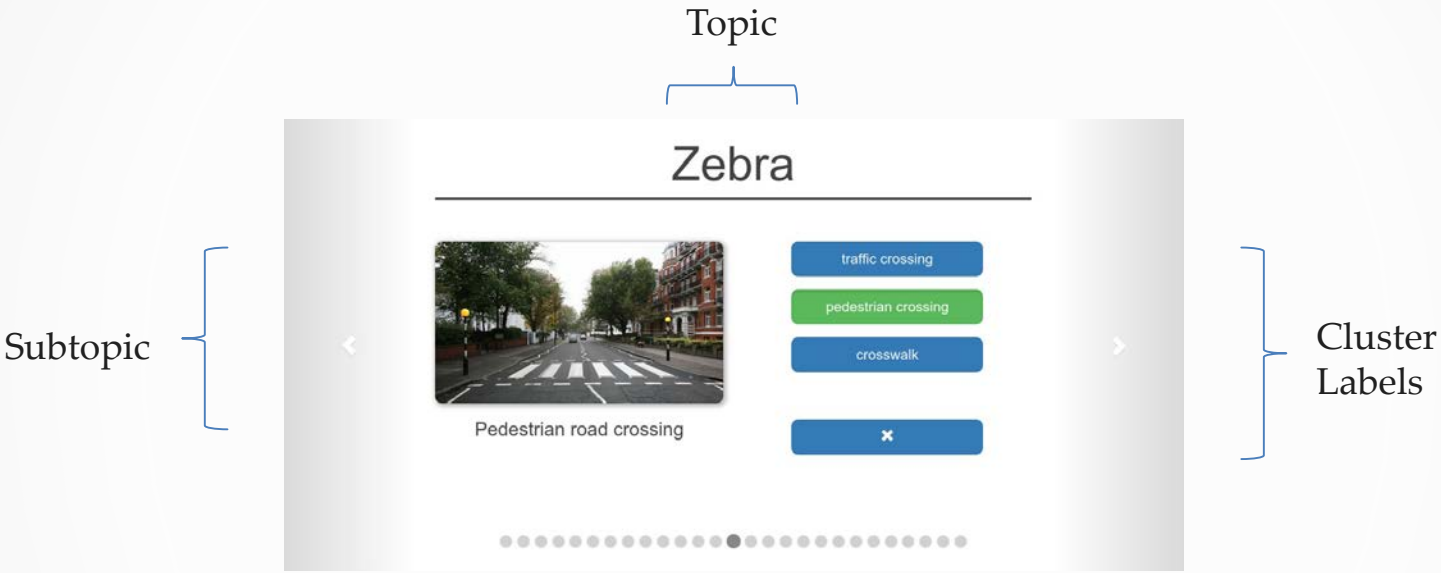


Subtopic

Evaluation of Cluster Labels – Discriminative Power

Judgment	Constrained *k*-means	Descriptive *k*-means	*k*-means + chi-square
✔	**213**	180	152
✘	**15**	25	39
–	**21**	44	58
∑	249	249	249
F-measure	**0.9221**	0.8392	0.7581
p-value	–	0.0049	0.0000

Evaluation of Cluster Labels – Descriptive Power



Voting	Constrained *k*-means	Descriptive *k*-means	*k*-means + chi-square
✔	**299**	274	184
p-value	–	0.3525	0.0000

Summary

- Novel perspective on document clustering
- Flexible processing pipeline
- Query-based evaluation measures
- User Study
- Ambient++ data set

Future work

- Predefined taxonomy as vocabulary
- Hierarchical clustering
- Other evaluation data sets

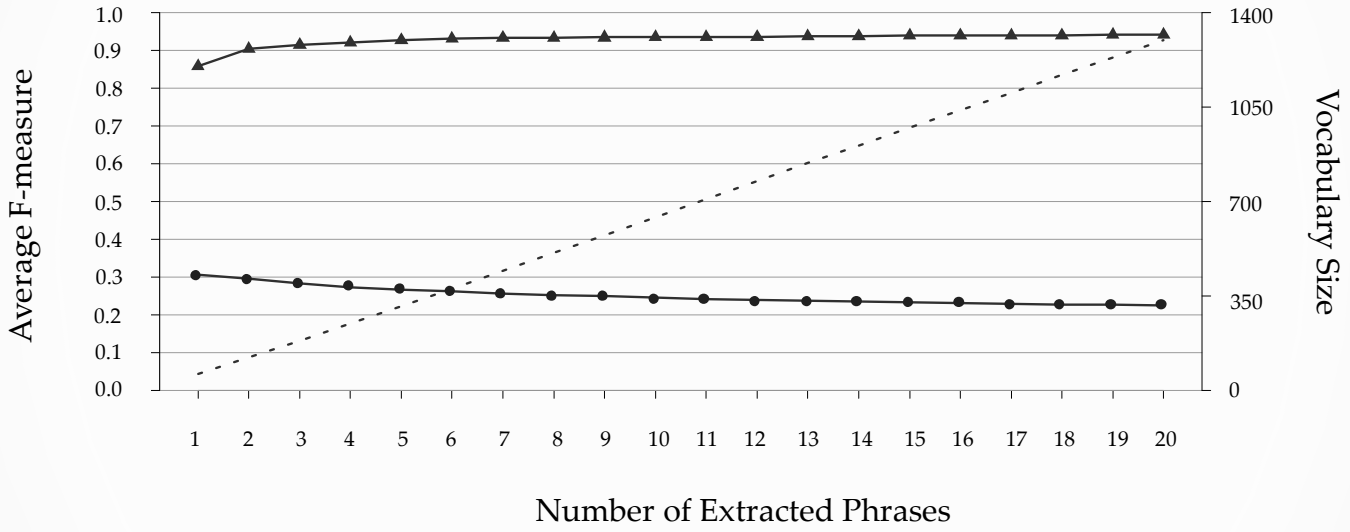
Thank you.

Literature

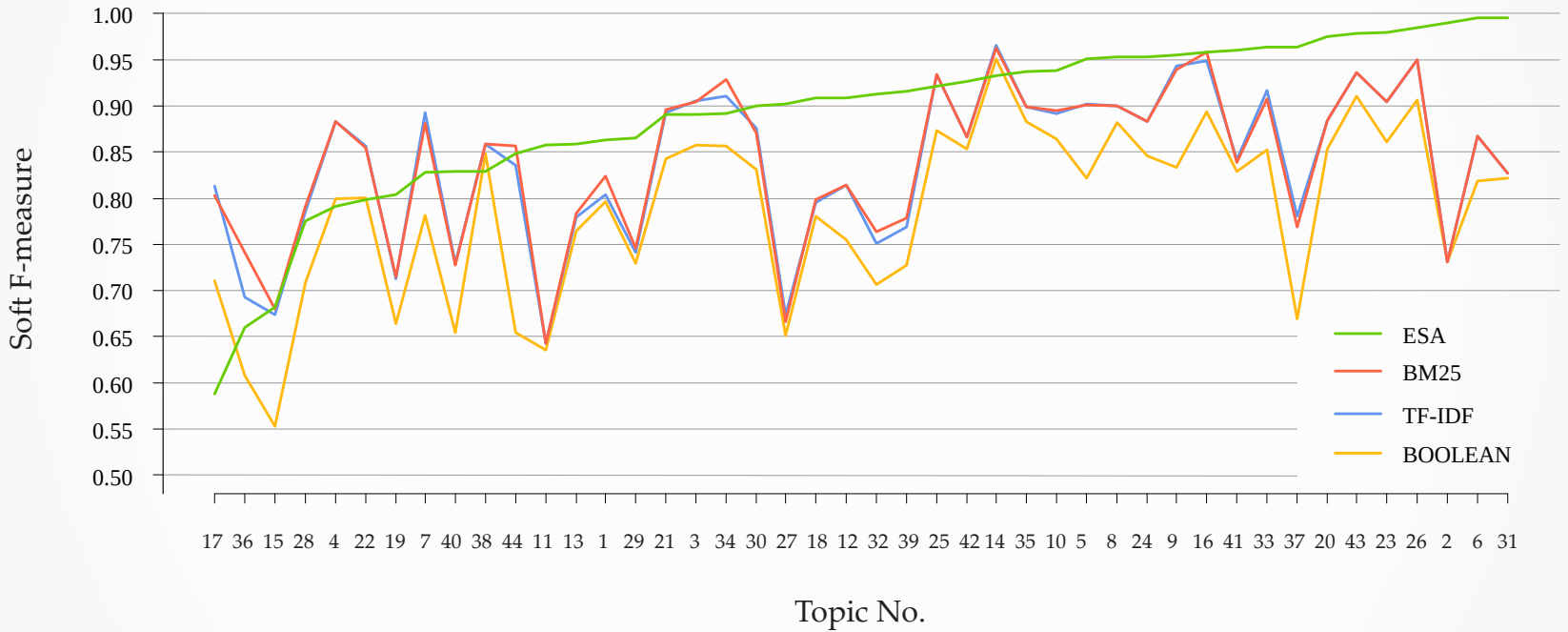
[Stein and Meyer zu Eißen, 2004] Benno Stein and Sven Meyer zu Eißen. Topic identification: Framework and application. In *Proceedings of the International Conference on Knowledge Management*, volume 400 of I-KNOW '14, pages 522–531, 2004.

[Barker and Cornacchia, 2000] Ken Barker and Nadia Cornacchia. Using noun phrase heads to extract document keyphrases. In *Proceedings of the 13th Biennial Conference of the Canadian Society on Computational Studies of Intelligence: Advances in Artificial Intelligence* , AI '00, pages 40–52, London, UK, 2000. Springer.

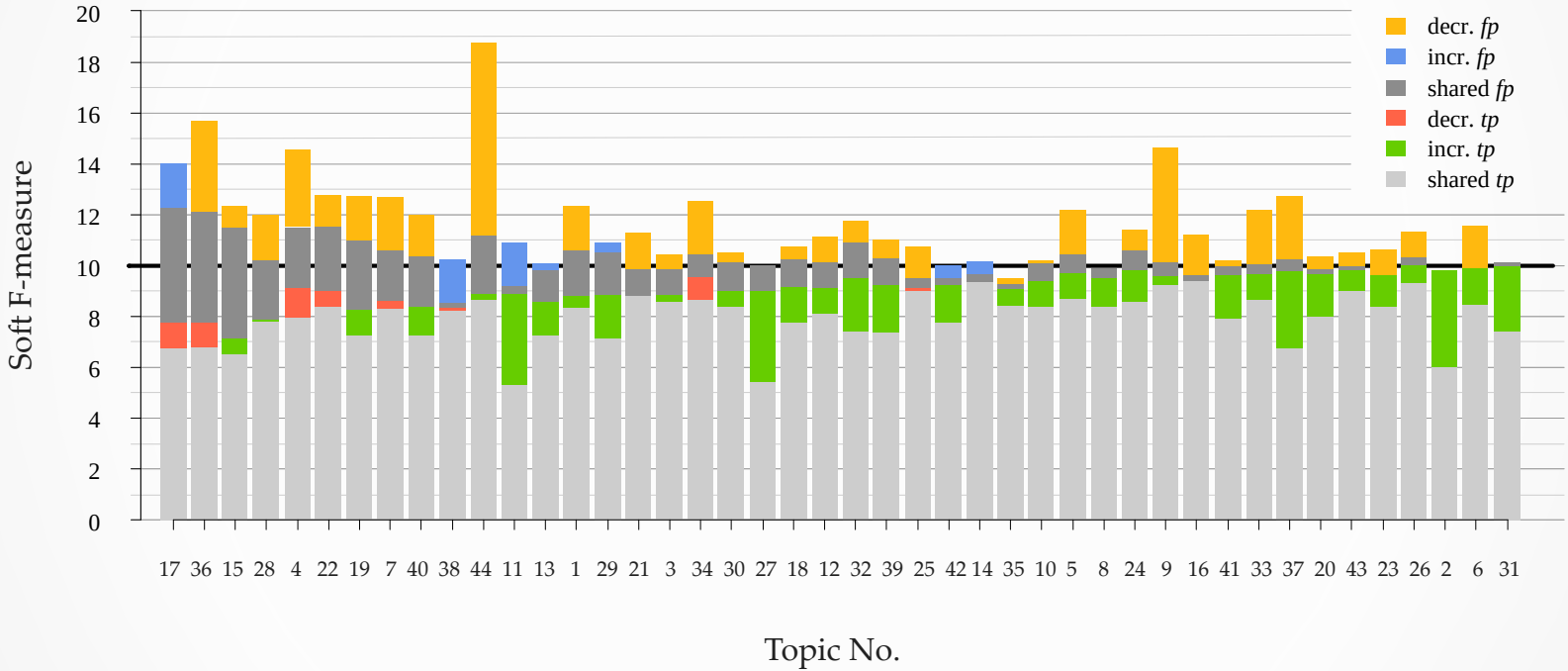
Vocabulary Generation – Number of Extracted Noun Phrases



Document Indexing – Evaluation of Retrieval Models



Document Indexing – Result lists from Boolean to ESA model



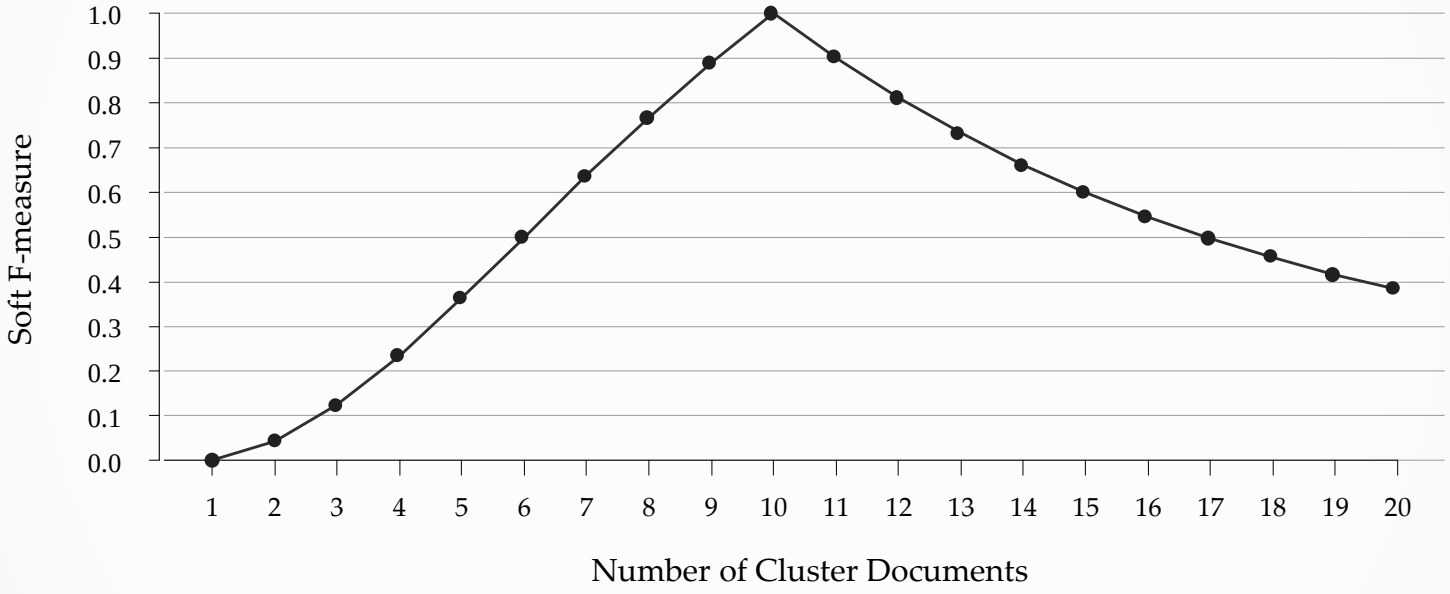
Soft F-measure

Cluster	Documents			
	a_1	a_2	b_1	b_2
A	1	1	0	0
B	0	1	1	1

		Truth	
		True	False
Clustering	True	$tp = \frac{1}{2} + 1 = 1.5$	$fp = 0 + 0 + \frac{1}{2} + \frac{1}{2} = 1$
	False	$tp = \frac{1}{2} + 0 = 0.5$	$tn = 1 + 1 + \frac{1}{2} + \frac{1}{2} = 3$
		$a_1a_2 + b_1b_2$	$a_1b_1 + a_1b_2 + a_2b_1 + a_2b_2$

$$\longrightarrow \quad F_1 = 2 \cdot \frac{0.6 \cdot 0.75}{(1 \cdot 0.6) + 0.75} = 0.\bar{6}$$

Justification of Soft F-measure



Cluster Analysis – Evaluation of Clustering Algorithms