LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Eagle Eye

Sommersemester 2017
Big Data Science Praktikum

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Agenda

- Brief Introduction
- Pre-processiong of dataset
- Front-end Design
- Back-end Design (BM25)
- Synonym implementation
- Naive Bayes Implementation
- Improvement

Techniques

Jersey

RESTful Web Services in Java.

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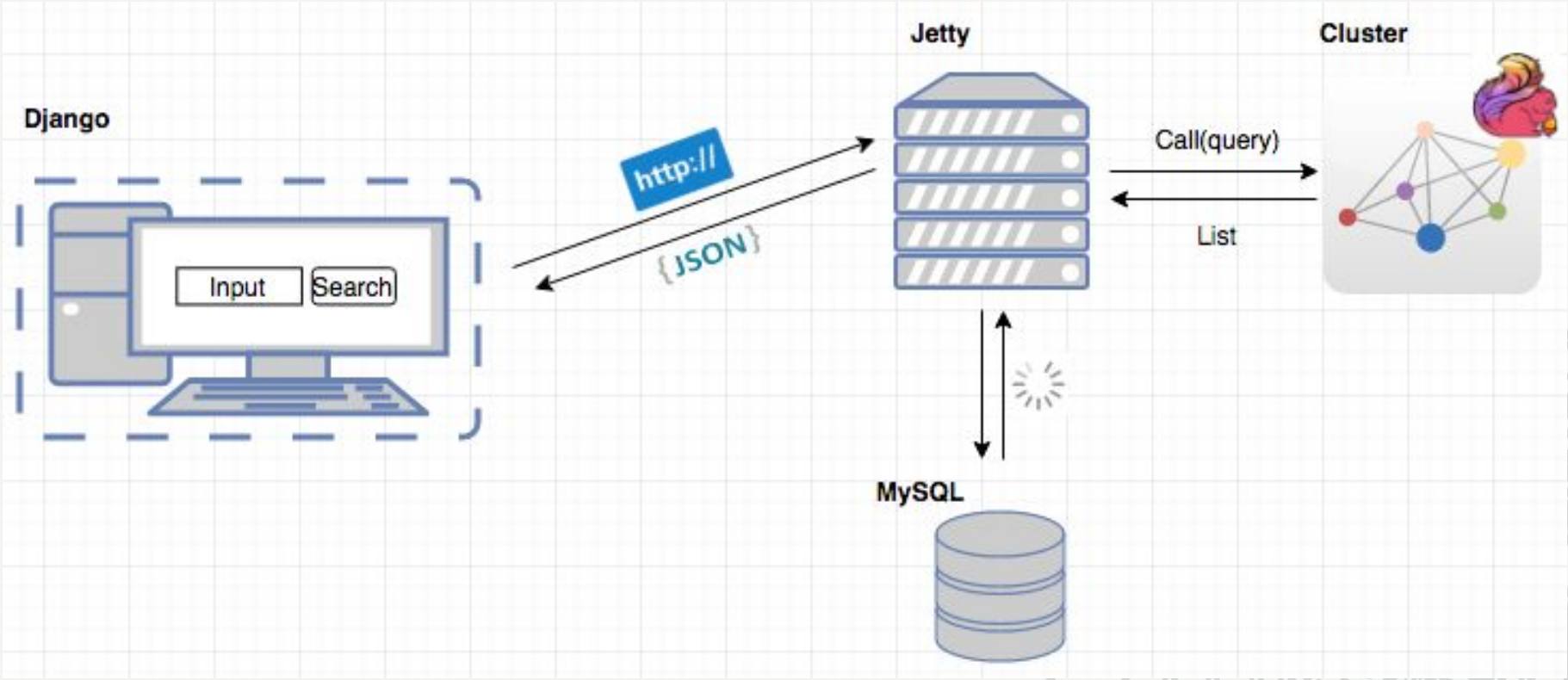
Architecture



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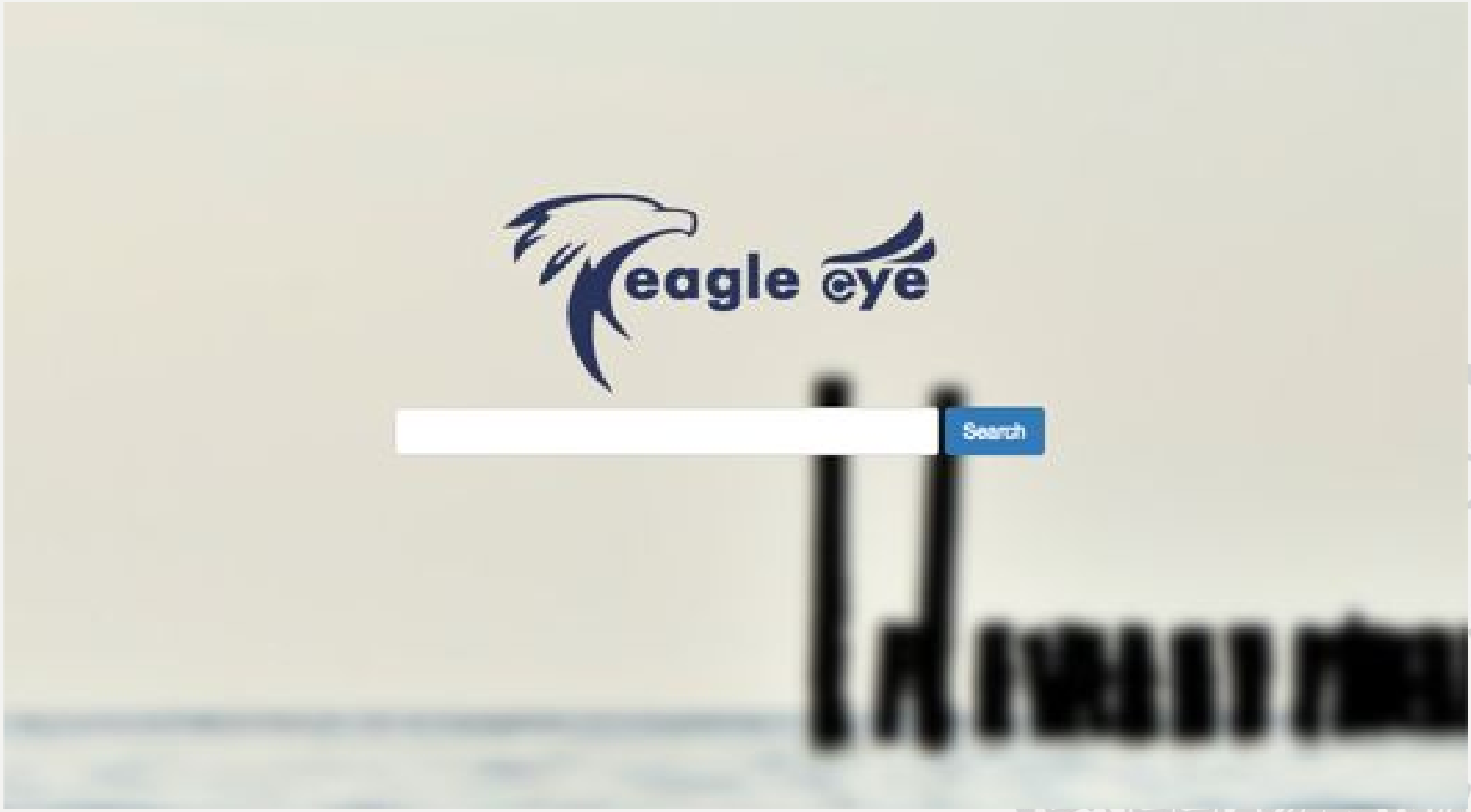
Data Preprocessing

- "xml.etree.ElementTree" module
- divide and save them into separated CSV-extension file respectively by "PostTypeId"(1 means question, 2 means answer)
- Regular Expression filter
- CSV extension files(question, answer)

	Id	Title	Body	CreationDate
0	1	Comments are a code smell	A coworker of mine believes that any use of...	2010-09-01T19:34:48.000
1	4	Getting non-programmers to understand the deve...	When starting a project for a company that's ...	2010-09-01T19:37:39.957
2	9	Hor		
3	16	Do		
4	18	Wh		

	Id	ParentId	CreationDate	Body	OwnerUserId
0	3	1	2010-09-01T19:36:50.053	Ideally code should be so well coded that it...	11
1	7	1	2010-09-01T19:42:16.797	I think the answer is the usual "It depends" ...	21
2	12	4	2010-09-01T19:44:47.413	IMO I've found that the transparency offered...	21
3	13	1	2010-09-01T19:45:33.183	Only if the comment describes what the code i...	4
4	20	9	2010-09-01T19:48:20.170	Stress. I give in to temptation and surf Stac...	6

Frontend



Features

- real-time suggestion
- spelling correction

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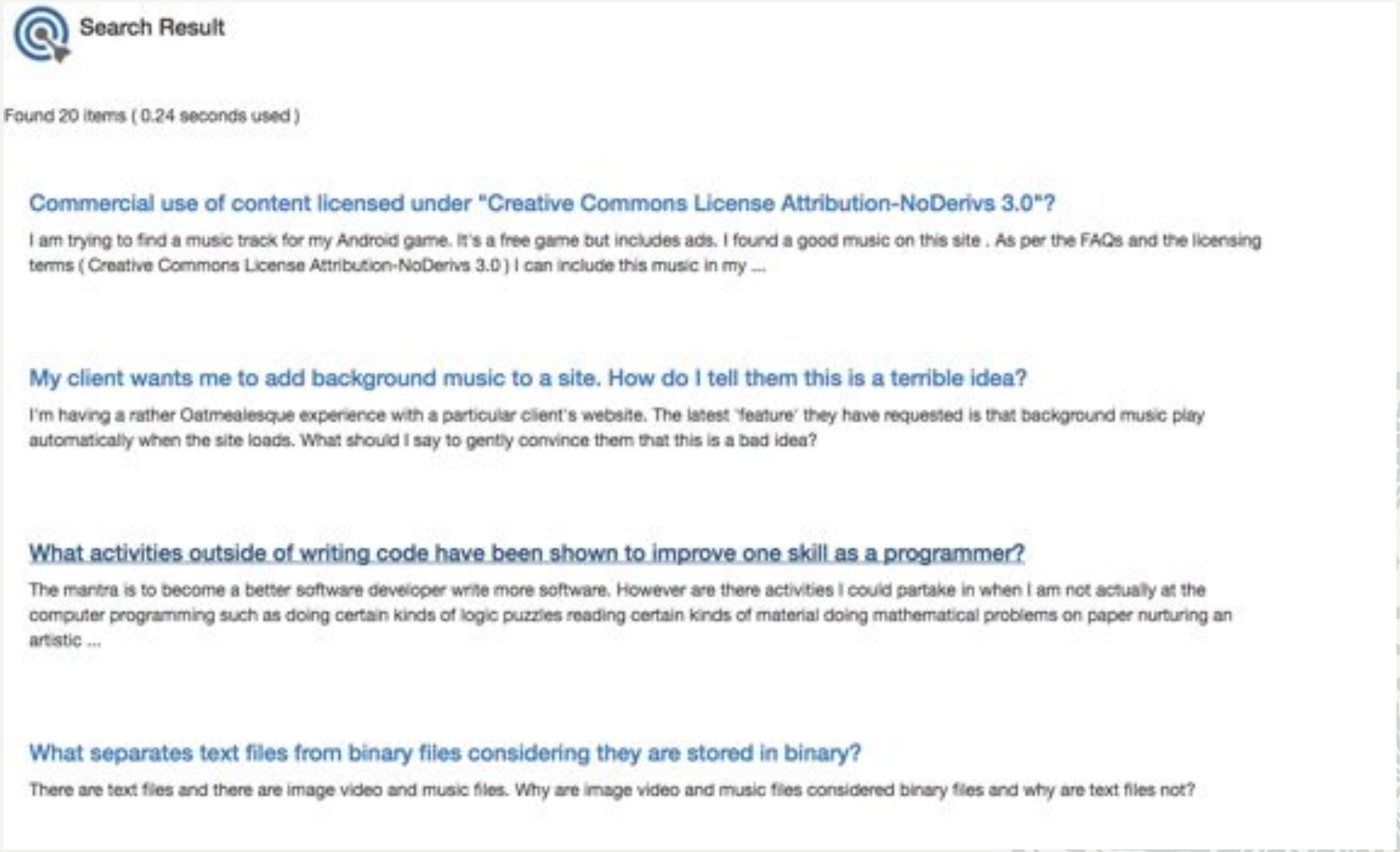
Search Result



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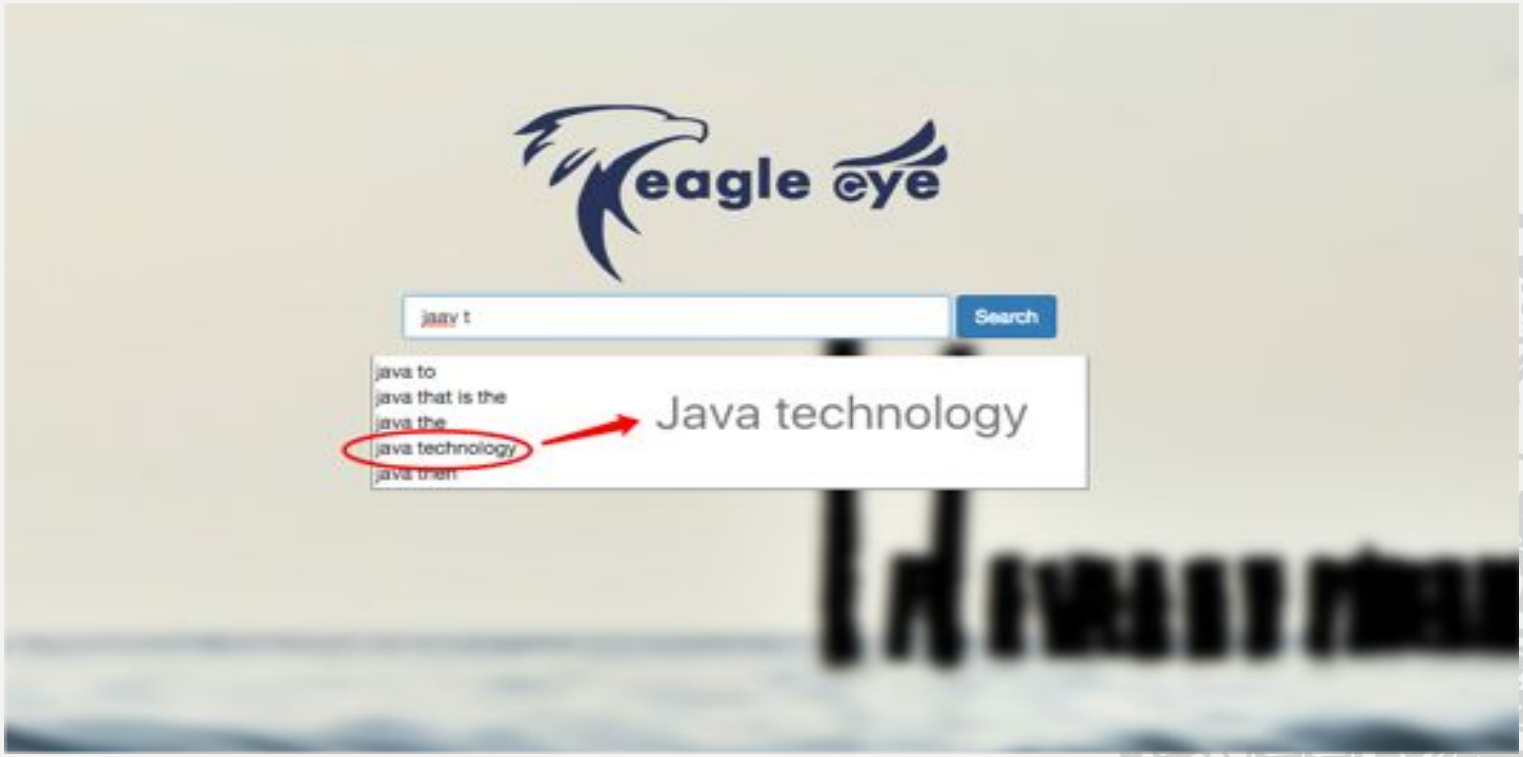
Real-time Suggestion

When user input search query in the webpage, system will give the suggestion below the input box. This is a kind of prediction, System will predict the whole query according to the prefix.



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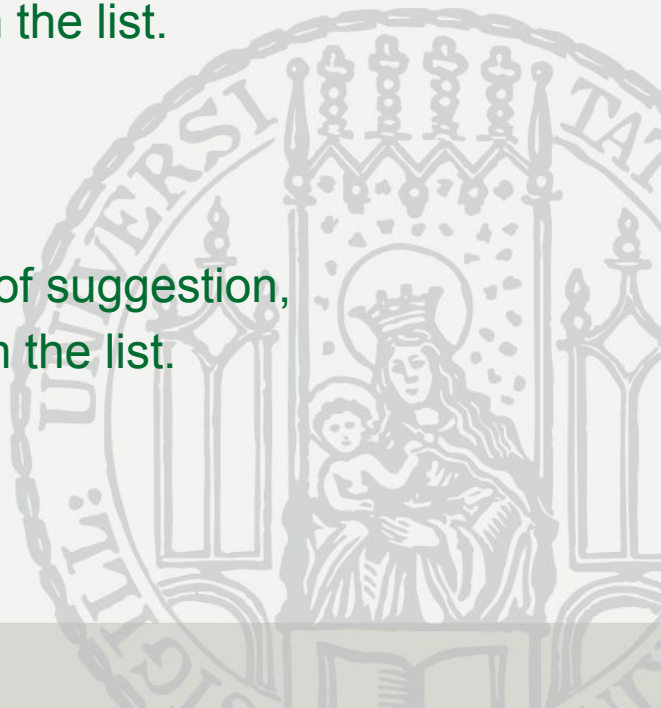
Realtime Suggestion

- **Unigram (N-gram n=1)**
  input: ja, use prefix to find suggestion

- **Bigram (N-gram n=2)**
  input: jaav to
  first spelling correct, use **java** to find a list of suggestion,
  then use **to** as prefix to find suggestion from the list.

- **Trigram (N-gram n=3)**
  input: java and sc
  first spelling correct, use **java and** find a list of suggestion,
  then use **sc** as prefix to find suggestion from the list.



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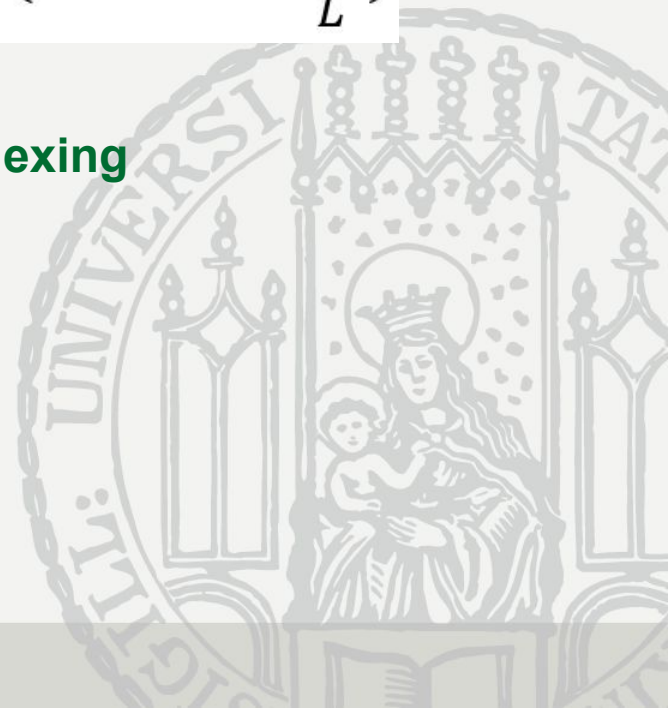
BM25 Scoring Model

- **Implementation of BM25 with Java Flink**

$$\text{score}(\text{D}, \text{Q}) = \sum_{i=1}^{n} IDF(q_i) \frac{TF(q_i, D) \cdot (k_1 + 1)}{TF(q_i, D) + k_1 \cdot (1 - b + b \cdot \frac{|D|}{\bar{L}})}$$

- **IDF and TF are available with the help of Indexing**
- **Free parameters remain fixed**
- **Document length added to the index**



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Eagle Eye vs. Google&Bing

Google

Document ID	Google rank	Eagle Eye rank
304445	1	3302
90203	2	3842
254279	3	82
267846	4	-
287800	5	181
301114	6	1097
212593	7	527
305956	8	2190
131995	9	3064
254984	10	3701

Bing

Document ID	Bing rank	Eagle Eye rank
304445	1	3302
90203	2	3842
137172	3	1233
304579	4	-
267846	5	-
279216	6	1445
125275	7	1171
58998	8	377
348984	9	-
206860	10	2425

Problems

Bottleneck

- The performance of BM25 scoring model is unsatisfactory
- The time to perform a query is too long
- Unexpected I/O exceptions

Solution

- Use a new model to calculate the score of ranking
- Distribution using Apache Flink on server

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The New Scoring Model

- Add new features to the previous model

$$score = \sum_{i=1}^{N} q_i f_i$$

- Each value of features is multiplied by a weight
- Features are:
  - BM25 score
  - Quality of questions
  - Quality of answers
  - Other factors
- Use machine learning method to train the model

Training The New Model

Construction of training data

- Query 45 questions in Google and get ID of top 10 results
- Identify noises and delete them manually
- Get the training matrix of 342*10

Train the model

- A task of solving linear regression

$$\vec{y} = X\vec{\beta}$$

- Use Ordinary Least Square to solve the equation

$$\hat{\beta} = (X^T X)^{-1} X^T \vec{y}$$

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Performance Of The New Model

Document ID	Google rank	Eagle Eye rank (before opt.)	Eagle Eye rank (after opt.)	Comparison
307805	0	7	3	4↑
219320	1	1465	1448	17↑
332017	2	4098	4093	5↑
260207	3	2393	2387	6↑
270891	4	2669	2666	3↑
230060	5	24	22	2↑
238896	6	-1	-1	-
131397	7	51	51	-
275631	8	841	833	8↑
264598	9	338	339	1↓

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Ontology extraction

Idea:
The query the user generated might not deliver exactly what he wanted

Goal:
Finding exactly what the user is looking for

Achieved by:
Extraction of synonyms out of an automatically constructed ontology

“Cut my text into pieces”

Check for synonyms in ontology

“Split my string into tokens”

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Definition

What is an ontology:

An ontology is a set of concepts and categories *in a subject area or domain* that shows their properties and the relations between them

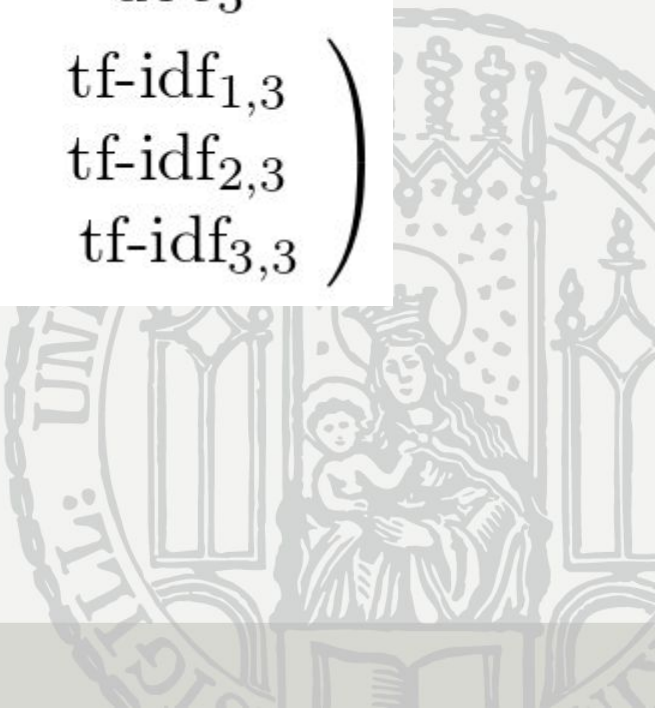
What we achieved:

Automatically constructed set of concepts in a domain containing terms and their individual degree of affection to this concept

Preparation Of Data

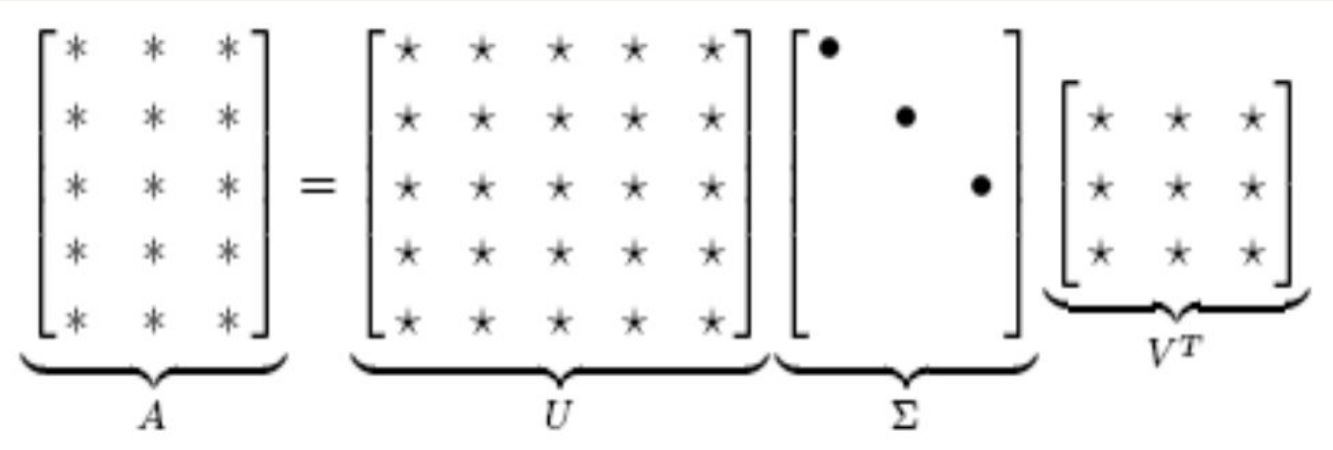
Create document-term-matrix with corresponding tf-idf as entries

$$\mathbf{M} = \begin{array}{c} \\ \text{term}_1 \\ \text{term}_2 \\ \text{term}_3 \end{array} \begin{array}{c} \begin{array}{ccc} \text{doc}_1 & \text{doc}_2 & \text{doc}_3 \end{array} \\ \begin{pmatrix} \text{tf-idf}_{1,1} & \text{tf-idf}_{1,2} & \text{tf-idf}_{1,3} \\ \text{tf-idf}_{2,1} & \text{tf-idf}_{2,2} & \text{tf-idf}_{2,3} \\ \text{tf-idf}_{3,1} & \text{tf-idf}_{3,2} & \text{tf-idf}_{3,3} \end{pmatrix} \end{array}$$



Singular Value Decomposition

Create the Singular Value Decomposition of this matrix



Further Processing

For further computation we only need the matrix *U*

$$\mathbf{U} = \begin{array}{c} \\ \text{term}_1 \\ \text{term}_2 \\ \text{term}_3 \end{array} \begin{array}{c} \begin{array}{ccc} \text{concept}_1 & \text{concept}_2 & \text{concept}_3 \end{array} \\ \begin{pmatrix} \text{affection}_{1,1} & \text{affection}_{1,2} & \text{affection}_{1,3} \\ \text{affection}_{2,1} & \text{affection}_{2,2} & \text{affection}_{2,3} \\ \text{affection}_{3,1} & \text{affection}_{3,2} & \text{affection}_{3,3} \end{pmatrix} \end{array}$$

Result

Name the concepts by concatenating the three most affected terms and write them to a .csv file

server-data-web	2	view	439	0.065098348890849 53
server-data-web	2	client	65	0.091679783213342 01
server-data-web	2	api	16	0.078033518556892 35
server-data-web	2	web	442	0.104308347392825 64
server-data-web	2	server	350	0.116936975743107 03
server-data-web	2	database	97	0.081733407487163 6
server-data-web	2	application	18	0.060723476772032 9
server-data-web	2	table	393	0.067348646949379 36
server-data-web	2	model	258	0.095219656646997 37
server-data-web	2	data	96	0.109238335949646 71
server-data-web	2	service	351	0.087962006245238 03
server-data-web	2	user	431	0.085894680419986 67

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Problems

- **Implementation of SVD in flink:**
  - Proper indexing of terms and documents
  - Representing/creating “0” entries in the matrix
  - Understanding the algorithms and concepts used
  - Results were crooked matrices and strange values
- **Switching to external library**
  - Uses double [ ][ ] to represent a matrix
  - Very high memory consumption
  - Very time consuming
- **No real synonyms were found**
  - Writing style in forums differs from scientific papers
  - Papers have more textbody

Naïve Bayes For Stack Overflow Questions

- Classes: android, ios, java, jquery, javascript, html, c#, php, python, c++, c

- Observations: Stack Overflow programming language questions

Naïve Bayes For Stack Overflow Questions

Goals:

- Enlarge the search engine by predicting programming language tags of the new Dataset
- Reduce time response

Main Steps

- **Dataset Preprocessing**
- **Training of the program :**

$$\Pr oglang^{*} = \arg\max_{\Pr oglang} [\sum_{i} (\log P(W_i \mid \Pr oglang)) + \log P(\Pr oglang)]$$

- **Test on another dataset and calculate the accuracy**

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Results

	No Merge	Merge in Training Phase	Merge in Test Phase	Merge in both Phases
Use 1st Part of the Dataset for training and 3rd part for Testing	37,71%	37,07%	41,44%	40,73%
Use 3rd part of the Dataset for training and 1stpart for Testing	42,53%	42,07%	46,61%	46,40%
Use 10 first parts for training and 11th and 13th for testing	34,76%	33,51%	38.90%	37,73%
Use 11th and 13th parts for training and 10 first parts for testing	47,46%	47,2%	55,65%	55,59%

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Improvement

- Improve user experience, response time should be less
- Work on the whole data dump of StackExchange
- Integrate the Naive, Synonyms algorithm into Eagle Eye project

DEMO

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Thank you for your attention