VK Multimedia Information Systems

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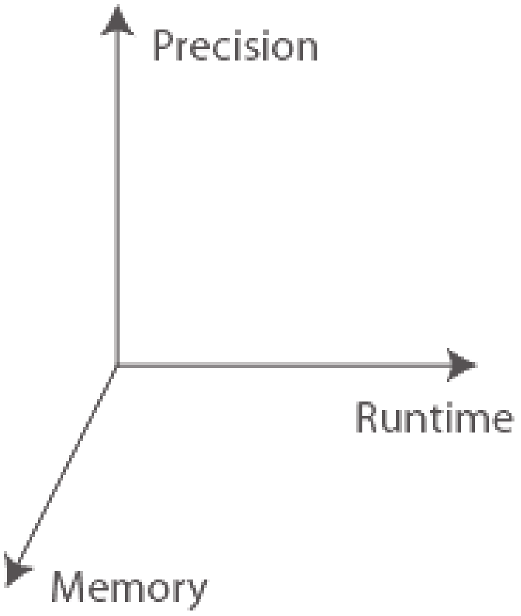
Retrieval Evaluation: Agenda

- **Retrieval Evaluation**
- The Lucene Search Engine
- Exercise 03

Retrieval Evaluation: Motivation

- Compare **objectively** different
  - Search engines
  - Models & weighting Schemes
  - Methods & techniques
- Scope
  - Academic
  - Commercial & industrial
- Different aspects
  - Runtime, retrieval performance



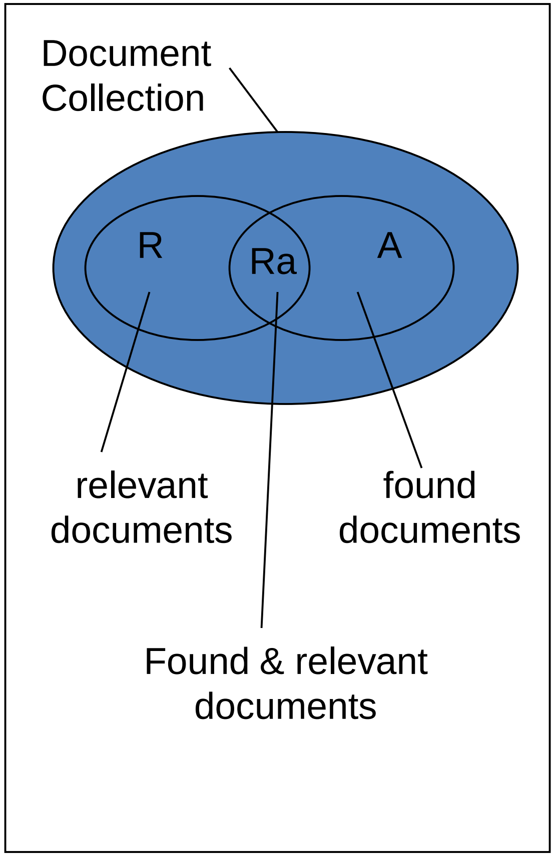
Retrieval Evaluation

- Comparability issues:
  - Test collections
  - Experts assessing retrieval performance
  - Metrics
    - What’s good? / What’s bad?
- Overall problem:
  - What is relevant?

Metrics: Precision & Recall

Within a document collection *D* with a given query *q*

- |R| .. num. of relevant docs
- |A| .. num. of found docs
- |Ra| .. num. found & relevant



Metrics: Precision

$$\text{Precision} = \frac{|Ra|}{|A|} = \frac{\text{found relevant docs}}{\text{found docs}}$$

- Gives % how many of the actual found documents have been relevant
- Between 0 and 1
  - – Optimum: 1 ... all found docs are relevant

Metrics: Recall

$$\text{Recall} = \frac{|Ra|}{|R|} = \frac{\text{found relevant docs}}{\text{relevant docs}}$$

- Gives % how many of the actual relevant documents have been found
- Between 0 and 1
  - – Optimum: 1 ... all relevant docs are found

Metrics: Precision & Recall

- With a query only 1 document has been found, but this one is relevant (100 would be relevant):
  - Precision & Recall
  - **Precision = 1**
  - **Recall = 0,01**

Metrics: Precision & Recall

- With a query all documents of D have been found (5% of D would be relevant)
  - Precision & Recall?
  - **Precision = 0,05**
  - **Recall = 1**

Example

- D = {D00, D01, … D99}
- Query 1:
  - Result Set 1: {**D2, D14, D25**, D76**, D84, D98**}
  - Relevant Docs {D1, D2, D14, D22, D23, D25, D84, D89, D90, D98}
- Query 2:
  - Result Set 1: {**D10, D14**, D60, D63, D77, D95}
  - Relevant Docs {D10, D14}

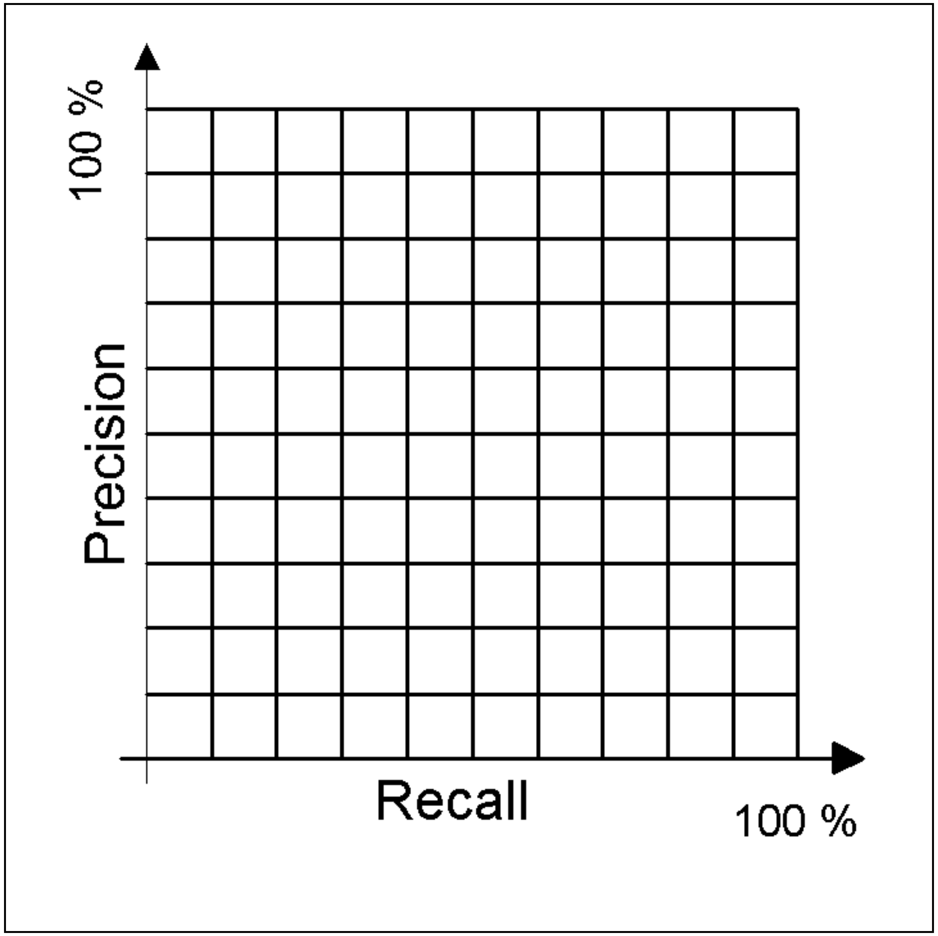
Recall vs. Precision Plot

- Assumption:
  - Result list is sorted by descending relevance
  - User investigates result list linearly
    - when recall changes …
- Approach:
  - Map different states to graph

Recall vs. Precision Plot

01. d123 *
02. d84
03. d56 *
04. d6
05. d8
06. D9 *
07. d511
08. d129
09. d187
10. d25 *
11. d38
12. d48
13. d250
14. d113
15. d3 *

Rq={d3, d5, d9, d25, d39, d44, d56, d71, d89, d123} → 10



Recall vs. Precision Plot

01. d123 *

02. d84

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10. d25 *

11. d38

12. d48

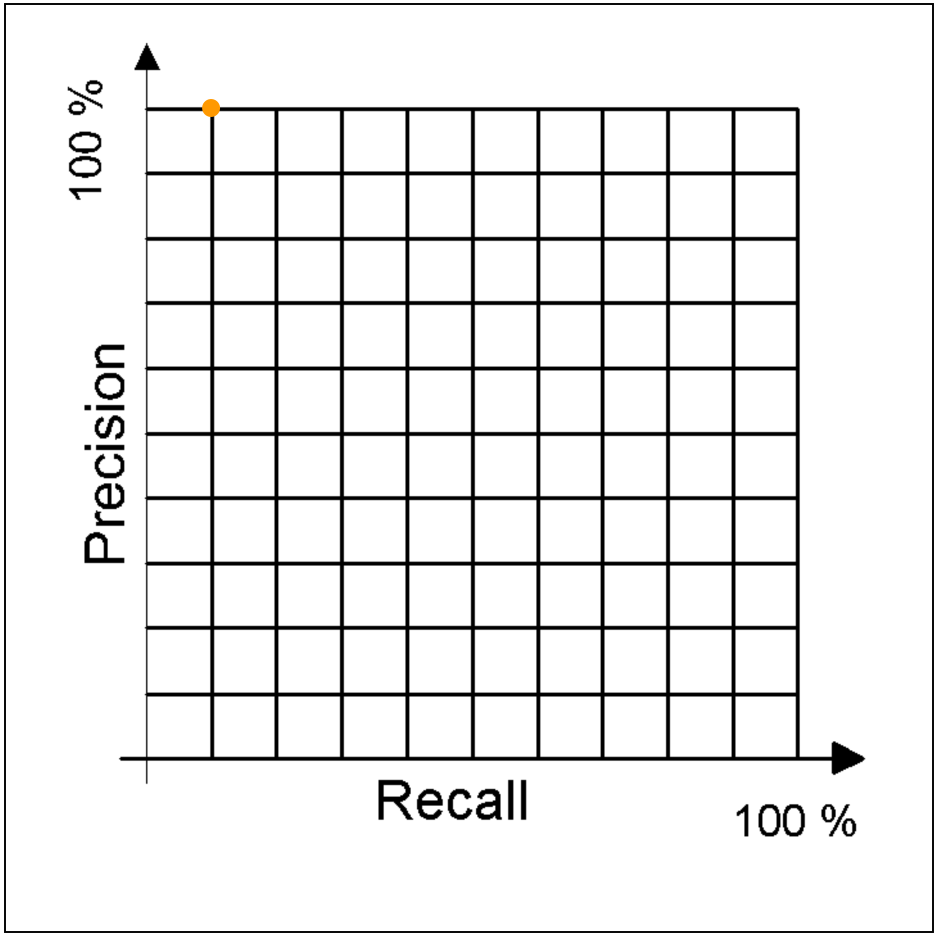
13. d250

14. d113

15. d3 *

$$\text{Recall} = \frac{|Ra|}{R} = \frac{1}{10}$$

$$\text{Precision} = \frac{|Ra|}{A} = \frac{1}{1}$$

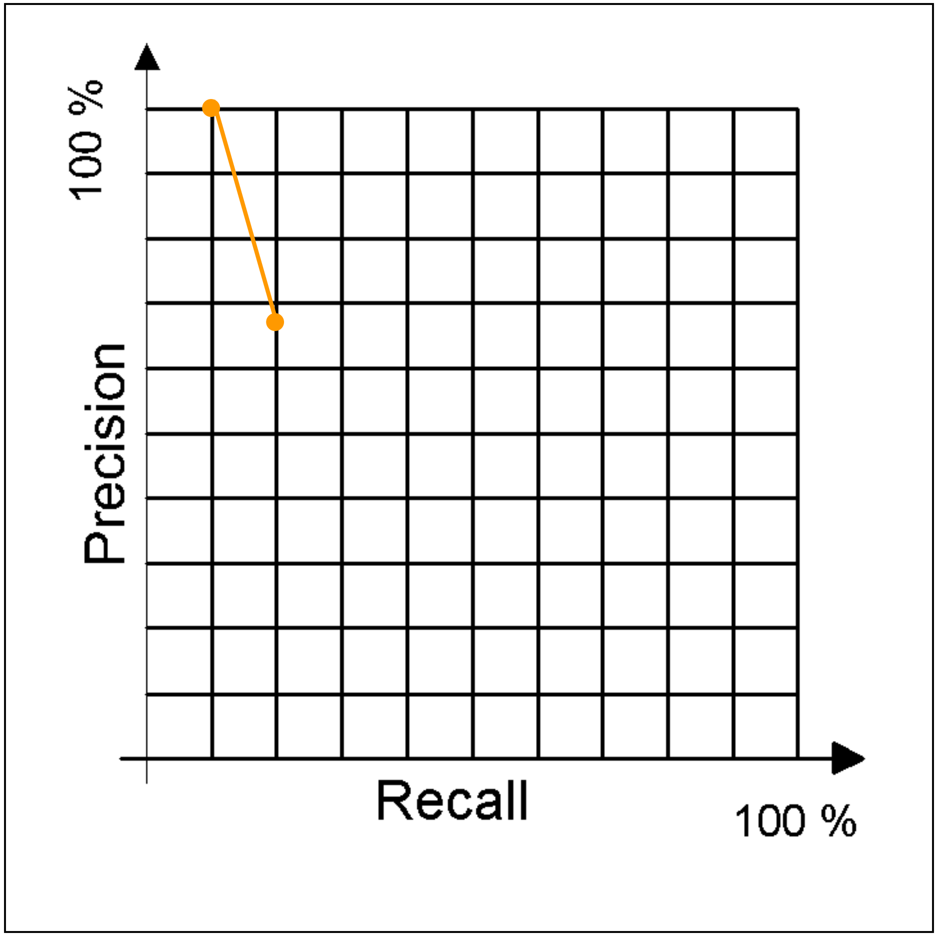


Recall and Precision

01. d123 *
02. d84
03. d56 *
04. d6
05. d8
06. D9 *
07. d511
08. d129
09. d187
10. d25 *
11. d38
12. d48
13. d250
14. d113
15. d3 *

$$\text{Recall} = \frac{|Ra|}{R} = \frac{2}{10}$$

$$\text{Precision} = \frac{|Ra|}{A} = \frac{2}{3}$$



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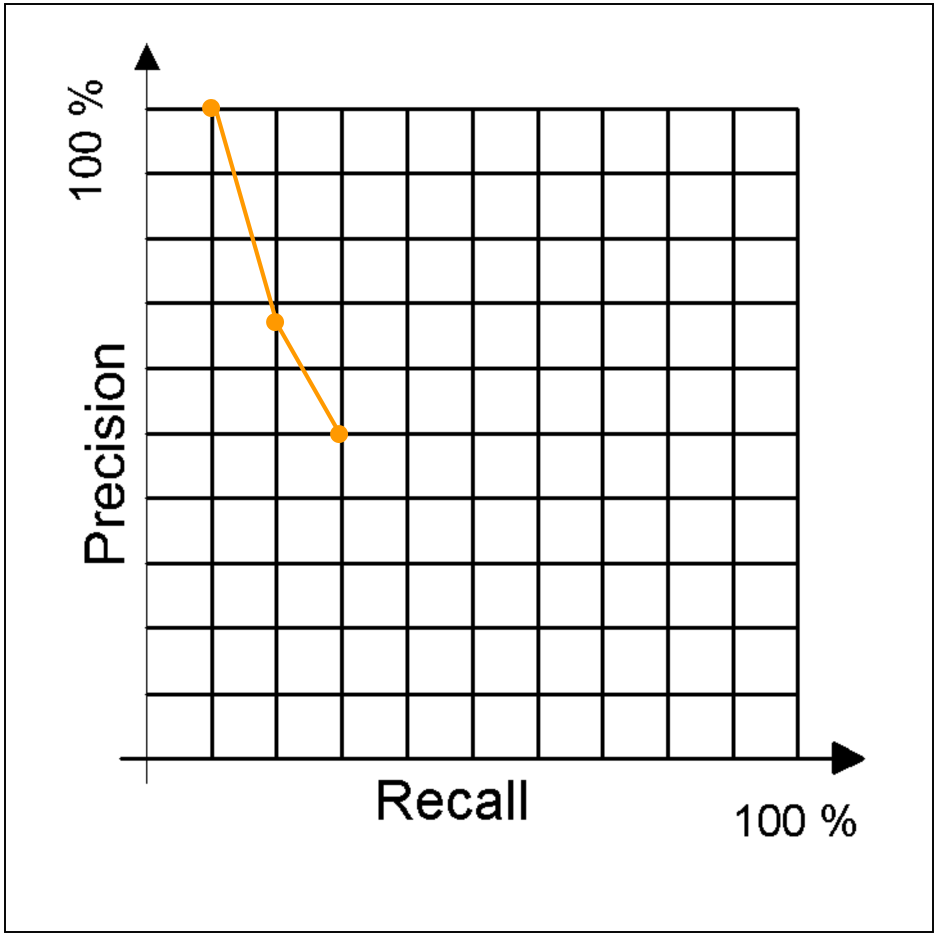

Recall and Precision

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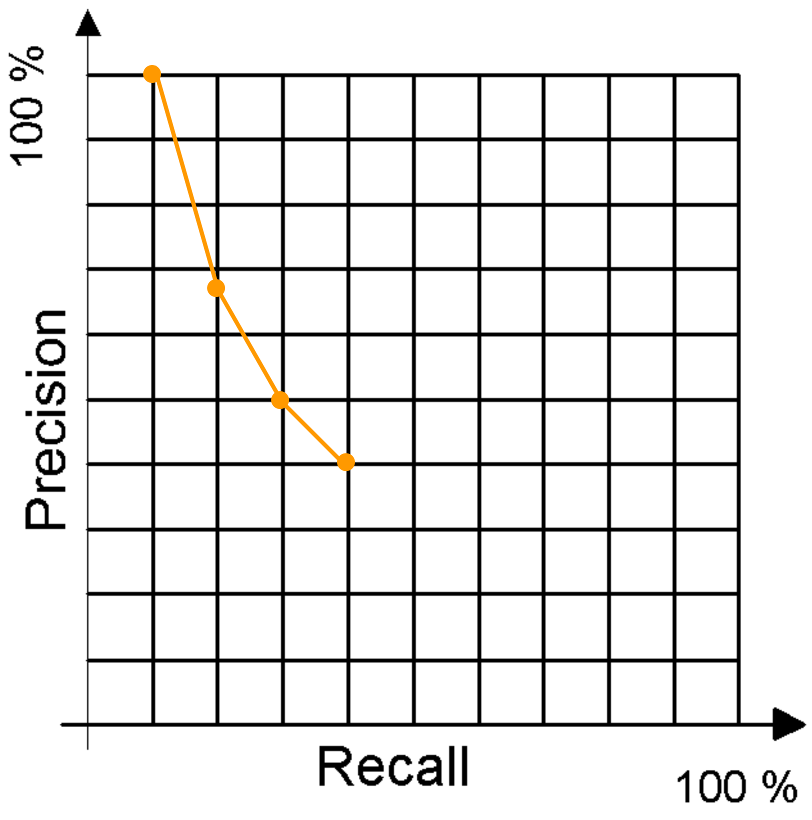

Recall and Precision

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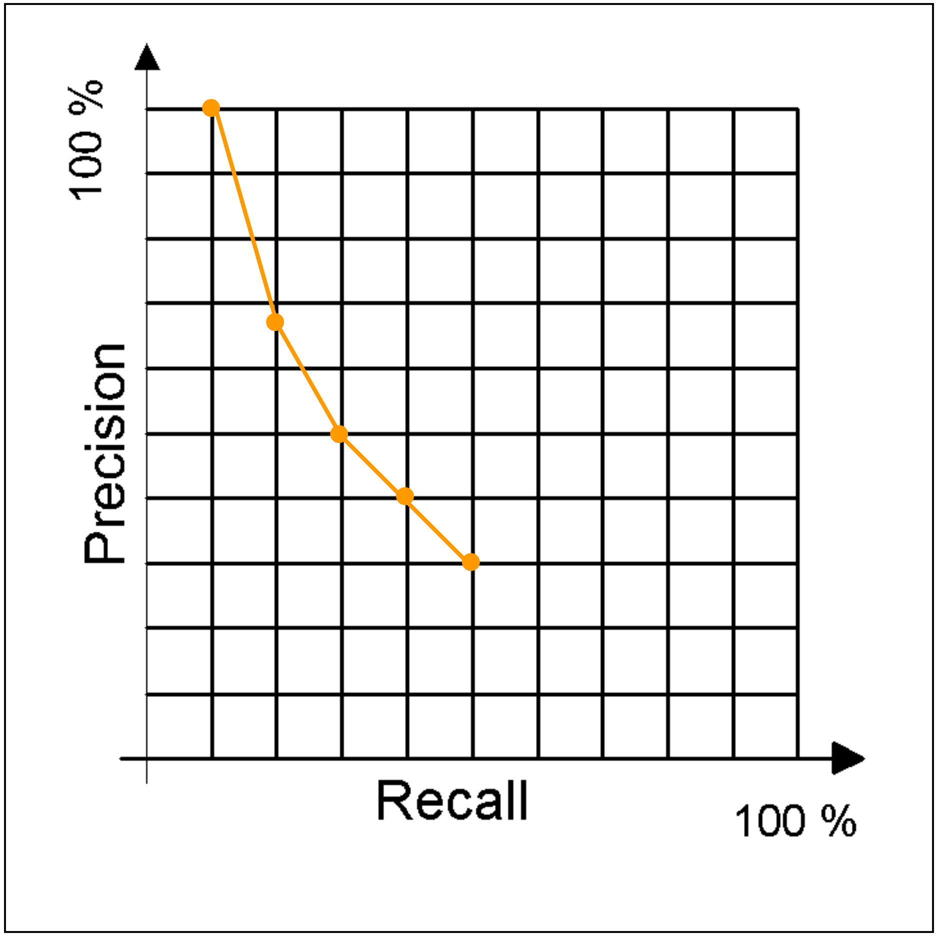


F-Measure

$$E(j) = 1 - \frac{1 + b^2}{\frac{b^2}{recall(j)} + \frac{1}{precision(j)}}$$

F(j) = 1 – E(j) … van Rijsbergen

- Lower values -> lower performance
- If b=1, F(j) is average
- If b=0, F(j) is precision
- If b=inf, F(j) is recall
- b=2 is a common choice

Mean Average Precision (MAP)

- Find average precision for each query
- Compute mean AP over all queries
  - Macroaverage: all queries are considered equal
- For average recall-precision curves
  - Average at standard recall points

Mean Average Precision (MAP)

Example: Query Q1:

1. D12 (relevant) -> Precision: 1
2. D61
3. D39 (relevant) -> Precision: 2/3
4. D75 (relevant) -> Precision: 3/4
5. D66
6. D14 (relevant) -> Precision: 4/6
7. D52
8. D33 (relevant) -> Precision: 5/8

- Average Precision: (1+2/3+…)/5=0.742

Mean Average Precision (MAP)

- Compute MAP:
  - Q1: 0,742
  - Q2: 0,633
  - Q3: 0,874
  - Q4: 0,722
- MAP = (0,742 + 0,633 + ..) / 4 = 0,743

MAP

$$AP(q) = \frac{1}{N_R} \sum_{n=1}^{N_R} P_q(R_n), \qquad MAP = \frac{1}{|Q|} \sum_{q \in Q} AP(q),$$

src. Deselaers, T., Keysers D., and Ney H., "Features for Image Retrieval: An Experimental Comparison", Information Retrieval, vol. 11, issue 2, Springer 2008.

Precision @ 10

- Precision for the first 10 results
- Measures the quality of the first page
- Motivated by
  - Subjective impression that they all should be relevant
  - Fact that many people examine only first page

Error classification rate

- Instance based learning
  - First result gives the class
- Inverse Precision @ 1

$$ER = \frac{1}{|Q|} \sum_{q \in Q} \begin{cases} 0 & \text{if the most similar image is relevant} \\ 1 & \text{otherwise} \end{cases}$$

src. Deselaers, T., Keysers D., and Ney H., "Features for Image Retrieval: An Experimental Comparison", Information Retrieval, vol. 11, issue 2, Springer 2008.

Test Collections & Initiatives

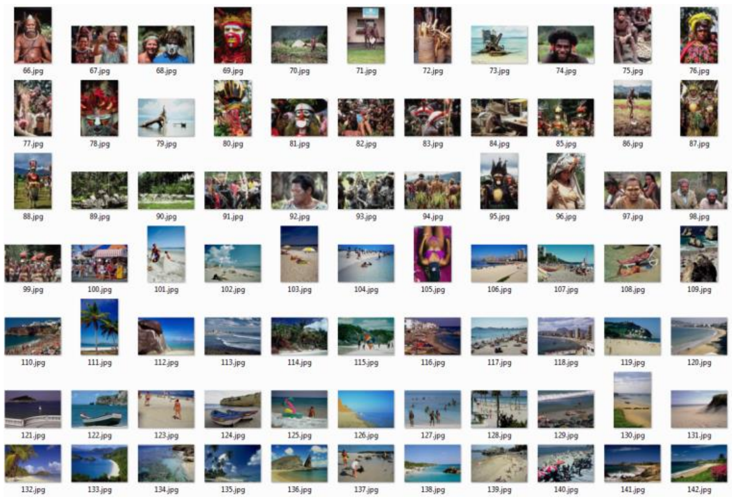
- Aim:
  - Provide data, topic & results
- Prominent Initiatives
  - Text Retrieval Conference (TREC)
  - INitiative for the Evaluation of XML Retrieval (INEX)
  - Cross Language Evaluation Forume (CLEF)

The TREC Collection

- Aim: Support IR Research on big data collections with
  - Test collection
  - Uniform measures and methods
  - Platform for comparison & challenges
- TREC collection size increases steadily
- Several different tracks:
  - Ad hoc, Web, Blog, Confusion, Genomics Track, Question Answering, Spam, Terabyte
- Examples:
  - Spam: ~ 91.000 messages (300 MB zipped)
  - Ad hoc has 5 sets:
    - e.g. Disk 5: 260.000 documents (1 GB zipped)

Prominent VIR data sets

- The SIMPLIcity data set
  - 1,000 images from the Corel stock photos.
  - 10 categories with 100 images each.



SIMPLIcity Example

- LireDemo

Benchmarking

- Show LIRE approach

Summary: Evaluation

- Lots of measures exist besides Precision & Recall
- Selection based on Use Case & Scenario
- Initiatives & Collections allow comparison
- Also user centered evaluation methods exist
- collections & initiatives are criticized:
  - Handling of outliers, significance of differences, ...

Retrieval Evaluation: Agenda

- Retrieval Evaluation
- **The Lucene Search Engine**
- Exercise 03

Lucene

- A **Java** text search engine
  - .NET Implementation exists
  - Also used in PHP, etc.
- Initiated by Doug Cutting
  - Later developed Hadoop
  - Yahoo! then Cloudera
  - On the board of the Apache Software Foundation

Lucene

- Implements an **inverted list**
  - Stores term -> document
    - Per field (e.g. title, content, …)
    - And additional information (count, position, length, etc.)
  - File format & storage.
- Preprocesses input
  - Stemming, etc.
- Provides search & index update
  - Query, Ranking

Inverted list example …

1. hello world
2. hello bob
3. hello! say hello to bob.
4. around the world
5. bob’s world

- hello -> 1, 2, 3
- world -> 1, 4, 5
- bob -> 2, 3, 5
- say -> 3
- to -> 3
- around ->4
- the –> 4

even better:
hello (3 docs, 4 occ.) ->
    1 (pos. 0), 2 (pos 0), 3 (pos. 0, pos. 12)

Inverted list example …

- hello -> 1, 2, 3
- world -> 1, 4, 5
- bob -> 2, 3, 5
- say -> 3
- to -> 3
- around ->4
- the –> 4

- IDF
  - # of documents known
  - Size of corpus known
- TF
  - # of occurrences known
- Other stats
  - Length of document
  - Avg. length of docs
  - etc.

Lucene: Basic Usage

Let lucene-{version}.jar and lucene-demos-{version}.jar be in your classpath

- To index files type:
  - java org.apache.lucene.demo.IndexFiles [dir]
- To search in the index type:
  - java org.apache.lucene.demo.SearchFiles

Lucene: Queries

- Lucene has an extensive query parser
  - Parses text to internal representation
- Lucene supports several types of queries
  - Field based: title:"multimedia information"
  - Boolean clauses: multimedia AND image
  - Wildcards: te?t OR te*t
  - Fuzzy search: roam~ (e.g. *foam* and *roams*)
  - Proximity search: "java apache"~10
  - Term boosting: java^4 apache

Lucene File Format

- Definitions:
  - An index contains a sequence of documents.
  - A document is a sequence of fields.
  - A field is a named sequence of terms.
  - A term is a string.
- Lucene uses
  - different types of fields:
    - stored, indexed, tokenized
  - Sub-indexes (segments, upon insertion)

Lucene: Usage

- IndexWriter
  - Writes documents to the index
  - Uses Analyzer
- IndexSearcher
  - Searching documents in an index
  - Same Analyzer as for indexing needed
  - A Hits object is returned
- Document
  - Groups fields to logical unit

Lucene: Features

- It’s really fast & stable
  - Even compared to commercial products
- Handles multiple indexes
  - MultiReader, distributed search
- Has strong development support
  - Yahoo! & Apache (top level project)
- Lots of Stemmers, Tokenizers, etc.
  - English, German, Korean, Chinese, ...

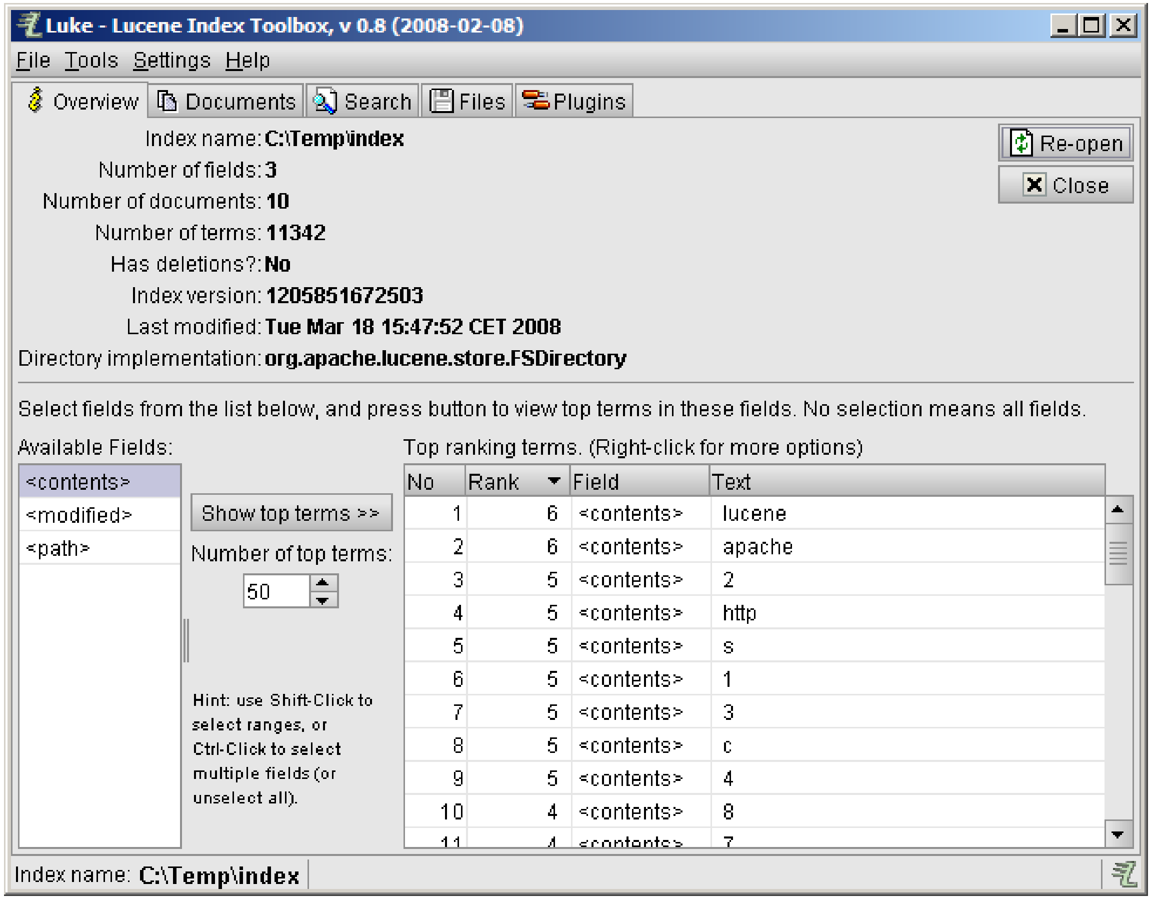
Lucene: Projects & Tools

- Nutch
  - Open source internet search engine
- Lucene .NET
  - Source code port to .NET
- Solr
  - Search server supporting web services, REST, ..
- Luke
  - GUI index management tool

Lucene Demo in Source

- ... see Java Code

Luke Demo …



Index name: **C:\Temp\index**
Number of fields: **3**
Number of documents: **10**
Number of terms: **11342**
Has deletions?: **No**
Index version: **1205851672503**
Last modified: **Tue Mar 18 15:47:52 CET 2008**
Directory implementation: **org.apache.lucene.store.FSDirectory**

Select fields from the list below, and press button to view top terms in these fields. No selection means all fields.

Available Fields:

- <contents>
- <modified>
- <path>

Number of top terms: 50

Hint: use Shift-Click to select ranges, or Ctrl-Click to select multiple fields (or unselect all).

Top ranking terms. (Right-click for more options)

No	Rank	Field	Text
1	6	<contents>	lucene
2	6	<contents>	apache
3	5	<contents>	2
4	5	<contents>	http
5	5	<contents>	s
6	5	<contents>	1
7	5	<contents>	3
8	5	<contents>	c
9	5	<contents>	4
10	4	<contents>	8
11	4	<contents>	7

Index name: C:\Temp\index

Retrieval Evaluation: Agenda

- Retrieval Evaluation
- The Lucene Search Engine
- **Exercise 03**

Exercise 03

- Retrieval Evaluation
  - Collection of 35 documents
  - Query and unsorted list of relevant documents - R
  - Ranked lists of 2 different search engines (A1 & A2)
- Your task
  - Compute precision and recall
  - Draw precision vs. recall plot
  - Compare A1 and A2 based on your findings

Don’t forget!

- Send me your results!