CS520 Web Programming
Full Text Search with Lucene

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Search Text

- Web search
- Desktop search
- Applications
  - Search posts in a bulletin board
  - Search product descriptions at an online retailer
  - …

Database Query

- Find the posts regarding “SSHD login errors”.

```
select * from posts
        where content like '%SSHD login errors%';
```

Here are the steps to take to fix the SSHD login errors: …

Please help! I got SSHD login errors!

Problems with Database Queries

Please help! I got an error when I tried to login through SSHD!

There a problem recently discovered regarding SSHD and login. The error message is usually …

The solution for sshd/login errors: …

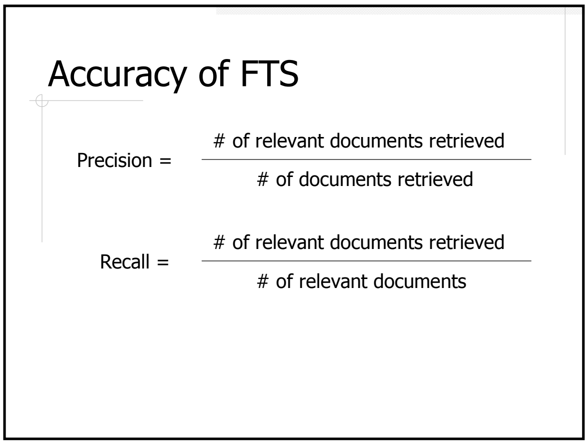
- And how about performance??

Full Text Search (FTS)

- More formally known as Information Retrieval (IR)
- Deals with the *representation*, *storage*, *organization*, and *access* of LARGE quantity of textual data.

Characteristics of FTS

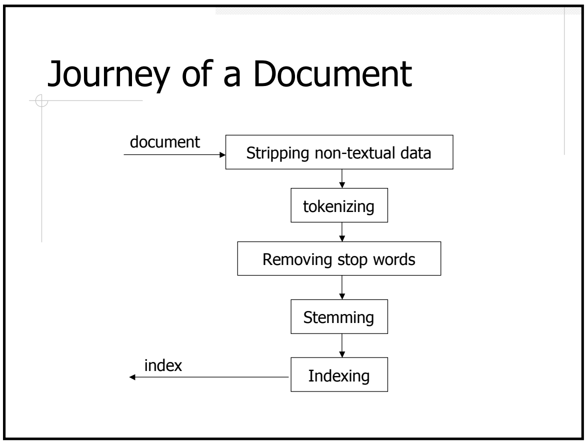
- Vs. database
  - “Fuzzy” query processing
  - Relevancy ranking



Accuracy of FTS

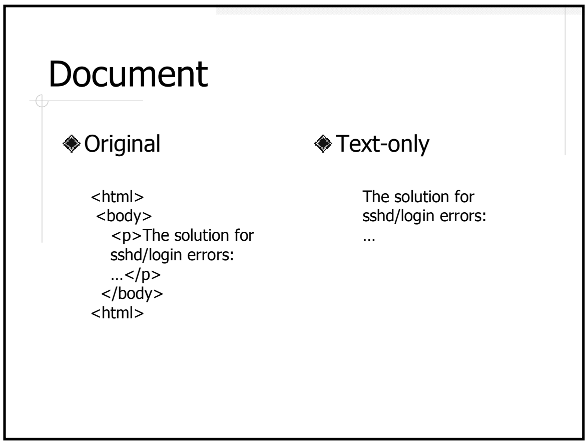
$$\text{Precision} = \frac{\text{\# of relevant documents retrieved}}{\text{\# of documents retrieved}}$$

$$\text{Recall} = \frac{\text{\# of relevant documents retrieved}}{\text{\# of relevant documents}}$$



Journey of a Document

document → Stripping non-textual data → tokenizing → Removing stop words → Stemming → Indexing → index



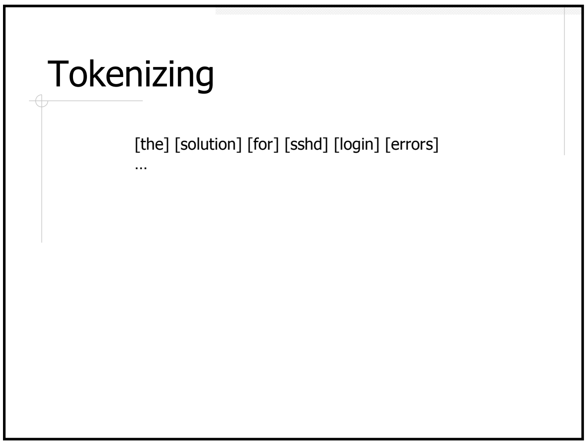
Document

- Original

```
<html>
 <body>
   <p>The solution for
   sshd/login errors:
   …</p>
  </body>
<html>
```

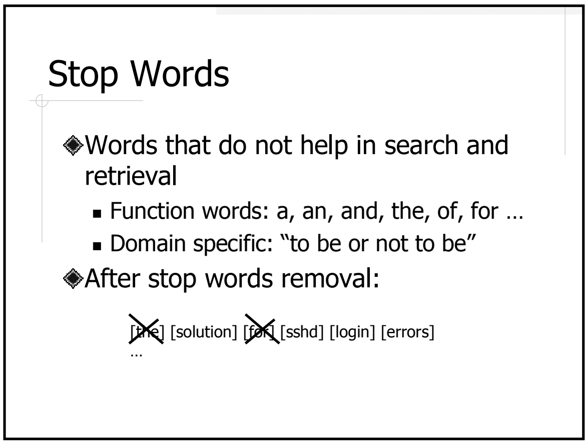
- Text-only

The solution for
sshd/login errors:
…



Tokenizing

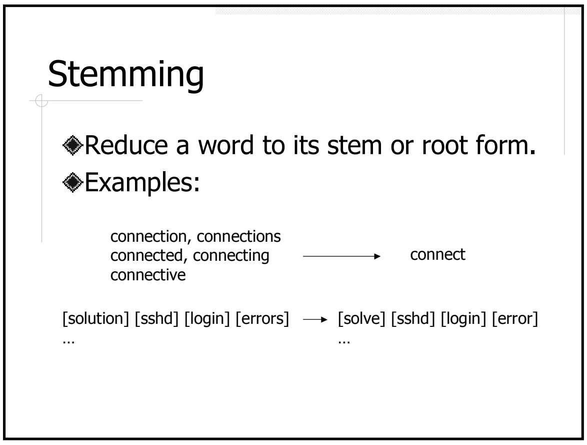
[the] [solution] [for] [sshd] [login] [errors]
…



Stop Words

- Words that do not help in search and retrieval
  - Function words: a, an, and, the, of, for …
  - Domain specific: “to be or not to be”
- After stop words removal:

[~~the~~] [solution] [~~for~~] [sshd] [login] [errors]
…



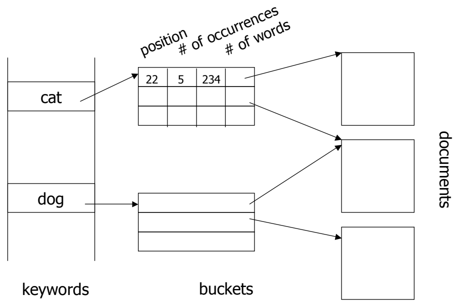
Stemming

- Reduce a word to its stem or root form.
- Examples:

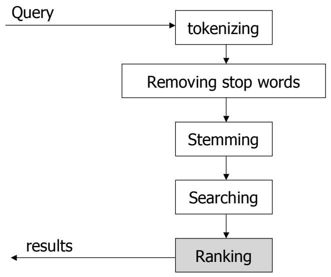
connection, connections
connected, connecting
connective
→ connect

[solution] [sshd] [login] [errors] → [solve] [sshd] [login] [error]
… …

Inverted Index



Query Processing



FTS Implementations

- Databases
  - MySQL: MyISAM tables only
  - PostgreSQL: tsearch2 module; OpenFTS
  - Oracle, DB2, MS SQL Server
- Standard-alone IR libraries
  - Lucene
  - Egothor, Xapian, MG4J, …

Lucene Overview

- http://lucene.apache.org/
- Originally developed by Doug Cutting
- THE full text search solution for Java applications
- Handles text only – needs external converters to convert other document types to text

Example 1: Index Text Files

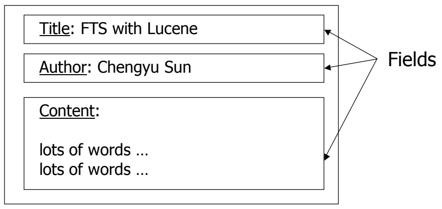
- `Directory`
- `Document` and `Field`
- `Analyzer`
- `IndexWriter`

Directory

- A place where the index files will be stored
- `FSDirectory` – file system directory
- `RAMDirectory` – virtual directory in memory

Document

- A document consists of a number of user-defined fields



Field

Field	Analyzed	Indexed	Stored

Field.Keyword(String,String)
Field.Keyword(String,Date)
		Y
		Y
			Y
			Y

Field.Unindexed(String,String)			Y
Field.Unstored(String,String)	Y	Y	

Field.Text(String,String)
Field.Text(String,Reader)
	Y
	Y
		Y
		Y
			Y

Analyzer

- Pre-processing the document or query text – tokenization, stop words removal, stemming …
- Lucene built-in analyzers
  - WhitespaceAnalyzer, SimpleAnalyzer, StopAnalyzer
  - StandardAnalyzer
    - Grammer-based
    - Recognize special tokens such as email addresses
    - Handle CJK text

Analyze Chinese Text

- Unigram
  - Lucene StandardAanalyzer
  - MySQL, PostgreSQL
- Bigram
  - Lucene CJKAnalyzer
- Grammar-based
  - Usually in commercial products

Chinese Text Example

Text: 今天天气不错。

Unigram:

[今] [天] [天] [气] [不] [错]

Bigram:

[今天] [天天] [天气] [气不] [不错]

Grammar-baed:

[今天] [天气] [不错]

IndexWriter

- addDocument(Document)
- close()
- optimize()

Example 2: Search

- ◈Query and QueryParser
- ◈IndexSearcher
- ◈Hits
- ◈Document (again)

Query and QueryParser

```
Query ::= ( Clause )*

Clause ::= ["+", "-"] [<TERM> ":"] ( <TERM> | "(" Query ")" )
```

Sample Queries

full text search

+full +text search

+full +text –search

+title:"text search”

+(title:full title:text) -author:"bob dole"

IndexSearcher

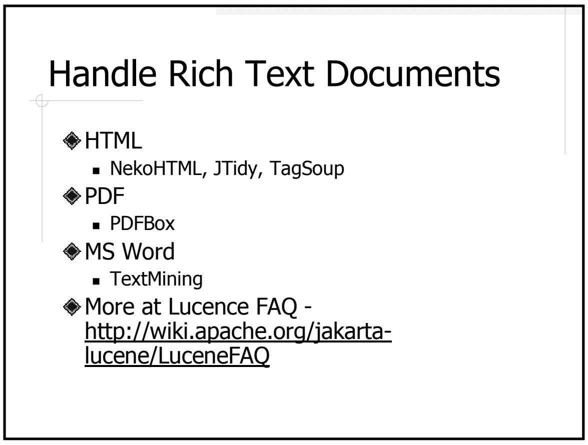
- ◈search(Query)
- ◈close()

Hits

- ◈A ranked list of documents used to hold search results
- ◈Methods
  - Document doc(int n)
  - int id(int n)
  - int length()
  - float score(int n)

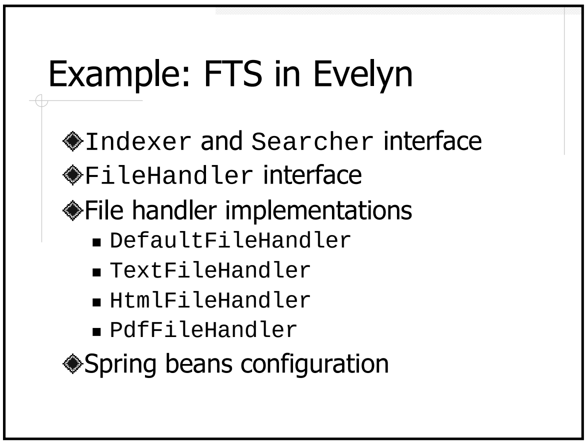
Document (again)

- ◈Methods to retrieve data stored in the document
  - String get(String name)
  - Field getField(String name)



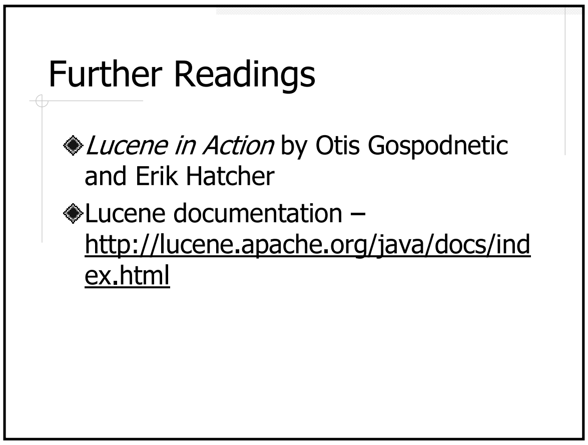
Handle Rich Text Documents

- HTML
  - NekoHTML, JTidy, TagSoup
- PDF
  - PDFBox
- MS Word
  - TextMining
- More at Lucence FAQ - http://wiki.apache.org/jakarta-lucene/LuceneFAQ



Example: FTS in Evelyn

- `Indexer` and `Searcher` interface
- `FileHandler` interface
- File handler implementations
  - `DefaultFileHandler`
  - `TextFileHandler`
  - `HtmlFileHandler`
  - `PdfFileHandler`
- Spring beans configuration



Further Readings

- *Lucene in Action* by Otis Gospodnetic and Erik Hatcher
- Lucene documentation – http://lucene.apache.org/java/docs/index.html