



Overview

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1 Motivation

Motivation

Where is the search box? Information systems need **Search** feature

2 Definition

Definition

Enterprise search

- is the practice of identifying and enabling specific content across the enterprise to be **indexed**, **searched**, and **displayed** to **authorized users**.
- is the organized retrieval of **structured** and **unstructured** data within your application.

3 Differences from normal web search

Enterprise vs. web search (Intranet vs. Internet)

- **Multiple data sources** websites, files, email, etc.
- **Collecting and indexing data** missed a key page?
- **Relevance and ranking algorithms** popular hits and page rank
- **Users**
 - Searchers are Knowledge workers
 - Context available: department, job, location...
- **Security** authenticated users
- **Single site, Single best document** federated search

4 Enterprise Search Components

Enterprise Search Components

- Content awareness and collecting data
- Content processing and analysis
- Indexing
- Query processing
- Matching

Collecting data

- Finding content and pulling it into the system
- **Crawlers** retrieve documents and other content
 - over protocols like HTTP
 - use adapters to connect to relational databases, document management systems, etc..

Content processing

- **Identification** sentences, determined by periods or other punctuation marks
The operator operates successfully!
- **Tokenization** breaking up text into tokens (words, phrases, symbols, etc..)
[The] [operator] [operates] [successfully]
- **Normalization** tokens to lower case to provide case-insensitive search *[the]*
[operator] [operates] [successfully]

Content processing II

- **Stop-words removing** meaningless tokens, (there, so, other, etc..) - *[operator]*
[operates] [successfully]
- **Stemming and lemmatization** to get the normal form of the word -
[operate] [operate] [success] .
.
.
- **Synonym expansion:** Controlled vocabulary, manually or automatically derived thesaurus, etc.. **Wordnet**
- **POS tagging** : the **book** on the table (noun), to **book** a flight (verb)

Indexing

- The resulting terms are stored in an index, instead of storing the full text of the document
- Contains the dictionary of all unique words in the corpus
- Groups information into logical categories that in turn can be searched and return results to users
- TF-IDF

Indexing - TF-IDF

- **TF: Term Frequency**, how frequently a term occurs in **one document**.
$$TF = (\text{Number of times term } t \text{ appears in a document} / \text{Total number of terms in the document})$$
- **IDF: Inverse Document Frequency**, how important a term is in the **corpus**
$$IDF = \log (\text{Total number of documents} / \text{Number of documents with term } t \text{ in it})$$

Indexing - TF-IDF

$$TF * IDF(w) = TF(w) \cdot \frac{1}{DF(w)}$$

The word is more popular when it appears several times in a document

The word is more important if it appears in less documents

- $TF(w) \rightarrow$ term frequency (number of times a term occurs in a single document)
- $DF(w) \rightarrow$ document frequency (number of documents a term occurs in within the corpus)
- $TF * IDF \rightarrow$ relative importance of the word in the document

Indexing - TF-IDF

the following example is the example about indexing

Query: *the example*

$$TF_{the} = 2$$

$$TF_{example} = 2$$

$$IDF_{the} = 0$$

$$IDF_{example} = \frac{1}{7}$$

The total score of this doc against the query is:

$$\begin{aligned} score &= TF_{the} \times IDF_{the} + TF_{example} \times IDF_{example} \\ &= 2 \times 0 + 2 \times \frac{1}{7} = \frac{2}{7} = 0.2857142857 \end{aligned}$$

Searching

Enterprise search applications may allow

- general free-form keyword searching
- specialized query syntax to allow more specific queries
- a standardized query language like SQL or SPARQL

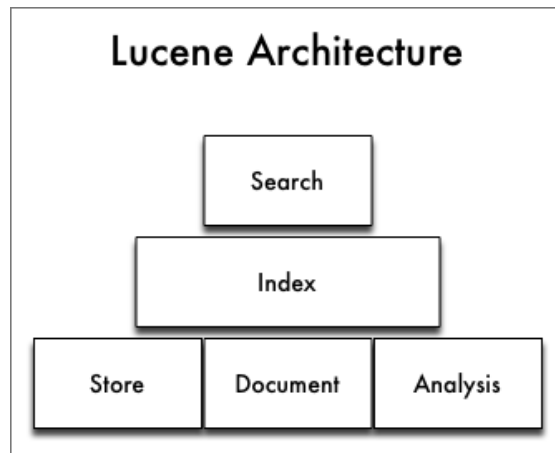
The query parser converts the query into a representation which can be used, along with the index, to determine matching results.

Query expansion for better performance (recall and precision)

5 Examples of enterprise search platforms and libraries

Lucene

- Java powerful open-source full-text search library
- Makes it easy to add full-text search capability to your application.
- **not** a complete application **but** a code library and API



Lucene - Simple Indexing example

- in-memory index from some strings.

Indexing

```
StandardAnalyzer analyzer = new StandardAnalyzer();  
Directory index = new RAMDirectory();
```

```
IndexWriterConfig config = new IndexWriterConfig(analyzer);
```

```
IndexWriter w = new IndexWriter(index, config);  
addDoc(w, "Lucene in Action", "193398817");  
addDoc(w, "Lucene for Dummies", "55320055Z");  
addDoc(w, "Managing Gigabytes", "55063554A");  
addDoc(w, "The Art of Computer Science", "9900333X");  
w.close();
```

Lucene - Simple Indexing example II

- `addDoc()` is what actually adds documents to the index

- use of **TextField** for content we want tokenized, and **StringField** for id fields and the like, which we don't want tokenized.

indexing - addDoc()

```
private static void addDoc(IndexWriter w, String title, String isbn) throws IOException
{
    Document doc = new Document();
    doc.add(new TextField("title", title, Field.Store.YES));
    doc.add(new StringField("isbn", isbn, Field.Store.YES));
    w.addDocument(doc);}

```

Lucene - Simple query example

- We read the query from stdin, parse it and build a lucene Query out of it.

query

```
String querystr = "your query keywords";
Query q = new QueryParser("title", analyzer).parse(querystr);

```

Lucene - Simple search example

- Using the Query we create a Searcher to search the index. Then a TopScoreDocCollector is instantiated to collect the top 10 scoring hits

search

```
int hitsPerPage = 10;
IndexReader reader = DirectoryReader.open(index);
IndexSearcher searcher = new IndexSearcher(reader);
TopDocs docs = searcher.search(q, hitsPerPage);
ScoreDoc[] hits = docs.scoreDocs;

```

Elasticsearch

- Open source search server powered by Lucene under the hood
- Written in Java
- Cross platform
- Scalability and distributed architecture
- HTTP REST API

- Schema-less JSON documents
- Developed by *Elasticsearch BV*
- Near real-time search

Elasticsearch

- Wikimedia
- Quora
- SoundCloud
- Github
- Netflix
- Foursquare . . .

Elasticsearch - Introduction Example

- **Download** the latest distribution from <https://www.elastic.co/downloads/elasticsearch>
- **Unpack** it on your machine
- **Run** it, by launching **elasticsearch**
- **Lunch** it from the web browser <http://localhost:9200>

Introduction Example

Elasticsearch - Introduction Example

Result in the browser

```
{
  "status" : 200,
  "name" : "Big Man",
  "cluster_name" : "elasticsearch",
  "version" : {
    "number" : "1.7.2",
    "build_hash" : "e43676b1385b8125d647f593f7202acbd816e8ec",
    "build_timestamp" : "2015-09-14T09:49:53Z",
    "build_snapshot" : false,
    "lucene_version" : "4.10.4"
  },
  "tagline" : "You Know, for Search"
}
```

Building a basic search app

Elasticsearch - Building a basic search app

Create an Index

```
PUT /myapp?pretty
```

Index a Document

```
PUT /myapp/tweet/1?pretty
{
  "name": "John Doe",
  "tweet": "I think elasticsearch is AWESOME",
  "date" : "2013-06-03",
  "loc" : {
    "lat": 13.4,
    "lon": 52.5
  }
}
```

Create an Index - Response

```
{
  "_index" : "myapp",
  "_type" : "tweet",
  "_id" : "1",
  "_version" : 1,
  "result" : "created",
  "_seq_no" : 0,
  "_primary_term" : 1
}
```


Get the Document

```
GET /myapp/tweet/1?pretty
```

Get the Document - Response

```
{
  "_index" : "myapp",
  "_type" : "tweet",
  "_id" : "1",
  "_version" : 1,
  "found" : true,
  "_source" : { ...OUR TWEET... }
}
```

Update the Document

```
PUT /myapp/tweet/1?pretty
{
  "name": "Jahn Doe",
  "tweet": "I think elasticsearch is AWESOME",
  "date" : "2013-06-03",
  "loc" : {
    "lat": 13.4,
    "lon": 52.5
  }
}
```

Delete the Document - Response

```
Delete /myapp/tweet/1?pretty
```

PS: Response: "version" : 3

Indexing

Doc#1 → - [operate] [operate] [success]

'operate' : [1, 47, 72], 'success' : [1, 55, 92, 107],

Inverted Index

Doc#1 → - [operate] [operate] [success]

```
inverted_index = {
  'operate' : [1, 47, 72],
  'success' : [1, 55, 92, 107],
  'search' : [34, 92,, 119],
  ' zebra' : [15, 34, 55, 107],
}
```

Mapping

```
{
  "tweet": {
    "properties": {
      "name": { "type": "string" },
      "tweet": { "type": "string" },
      "date": { "type": "date" },
      "loc": { "type": "geo_point" },
    }
  }
}
```

PS: Do not change the mapping of existing field

Mapping

Full text : (default)

```
{ "type": "string", index: "analyzed" }
```

Exact string

```
{ "type": "string", index: "not_analyzed" }
```

Not searchable

```
{ "type": "string", index: "no" }
```

Search the index - Empty Search

```
GET /myapp/_search
{
  "query": { "match_all": {} }
}
```

Response

```
{
  "took" : 2,
  "timed_out" : false,
  "_shards" : {
    "total" : 5,
    "successful" : 5,
    "failed" : 0
  },
  "hits" : {
    "total" : 14,
    "max_score" : 1.0,
    "hits" : [ {...} ]
  }
}
```

Filters vs. Queries

Filters

- Exact matching
- binary yes/no
- fast
- cacheable

Queries

- full text search
- relevance scoring
- heavier
- not casheable

Query:

```
{ "match": { "tweet": "search" }}
```

Filter:

```
{ "term": { "date": "2018-1-3" }}
```

Filtered queries & Boolean queries

```
GET /bank/_search
{
  "query": {
    "bool": {
      "must": { "term": { "category" : "tech" } },
      "filter": {
        "range": {
          "salary": {
            "from": 20000,
            "to": 30000
          }
        }
      }
    }
  }
}
```

Boolean → must, should, must_not

Aggregations

http://www.forrester.com - Forrester Research - Microsoft Internet Explorer

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Laura Ramos, Vice President, Principal Analyst

Laura serves Technology Product Management & Marketing professionals and primarily conducts research for Forrester's clients who are business-to-business (B2B) marketers. Her key research areas include tracking overall B2B marketing trends and issues, ...

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Clear Objectives And Profiles Lead To Success With Web 2.0 Tactics

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by Laura Ramos, September 24, 2008

Business marketers hole up to produce boatloads of content that customers and sales seldom see and value little. Determined to do better, HP social media managers engaged experts who work daily with customers to develop relevant marketing content grounded ...

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 - Br. J. Appl. Phys. (7)

Global warming and clean electricity

★★★★★ Bodansky, D.

Plasma Phys. Control. Fusion 1991-11-01

In particular, major reductions can be achieved if fossil fuels are replaced in **electricity** generation and if **electricity** assumes a larger role in the overall energy economy.

IOP Publishing

700922 : Production of Static Electricity By Splashing of Water - in Waterfalls, Bathrooms, and Supertankers During Cleaning

★★★★★ E., T., Pierce, E., T., Pierce

1970-02-01

SAE International

A Semiclosed-Cycle Gas Turbine With Carbon Dioxide-Argon as Working Fluid

★★★★★ Pildis, I. U.

Journal of Engineering for Gas Turbines and Power, J. Eng. Gas Turbines Power, GTP Volume 119 Issue 3 1997-07-01

This paper describes the performance analysis of a semiclosed-cycle gas turbine. The working fluid is carbon dioxide and the fuel is low heating ... The objective of the machine is to produce **clean electricity** with the smallest efficiency penalty.

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Aggregations

Aggregations

```
GET /bank/_search
{
  "size": 0,
  "aggs": {
    "group_by_state": {
      "terms": {
        "field": "state"
      }
    }
  }
}
```

Aggregations

```
GET /bank/_search
{
  "size": 0,
  "aggs": {
    "group_by_age": {
      "range": {
        "field": "age",
        "ranges": [
```

```

    {
      "from": 20,
      "to": 30
    },
    {
      "from": 30,
      "to": 40
    },
    {
      "from": 40,
      "to": 50
    }
  ] },

```

```

"aggs": {
  "group_by_gender": {
    "terms": {
      "field": "gender.keyword"
    },
    "aggs": {
      "average_balance": {
        "avg": {
          "field": "balance"
        }
      }
    }
  }
}
}
}
}
}

```

Solr

- Also built on Lucene
 - So similar feature set
 - Also exposes Lucene functionality, like Elastic Search, so easy to extend.
- A part of Apache Lucene project
- Perfect for Single Server search
- Clustering is there. But it's definitely not as simple as ElasticSearch
- Solr is for text search while Elasticsearch is for filtering and grouping, the analytical query workload, and not just text search.

Evaluation of search system

Evaluation of search system

$$\text{precision} = \frac{|\{\text{relevant documents}\} \cap \{\text{retrieved documents}\}|}{|\{\text{retrieved documents}\}|}$$

$$\text{recall} = \frac{|\{\text{relevant documents}\} \cap \{\text{retrieved documents}\}|}{|\{\text{relevant documents}\}|}$$

$$\text{Precision} = \frac{tp}{tp + fp}$$

$$\text{Recall} = \frac{tp}{tp + fn}$$

	Documents Retrieved (search results)		
Actual Documents (Should be retrieved)		Class = Yes	Class = No
	Class = Yes	True Positive	False Negative
	Class = No	False Positive	True Negative

What is bad search?

- No search box
- Too many hits: Return 10,000 hits when the average user looks at the top-20 only
- Bad scoring: The most relevant item is not at the top of the list

- Poor duplicate detection: Too many similar documents
- Inability to judge user intent: spell checking, recommendation system, auto complete.

The End

Thank You