CSCE 5300 Introduction to Big Data and Data Science

Lesson 5

Apache Lucene
Apache Solr

Overview

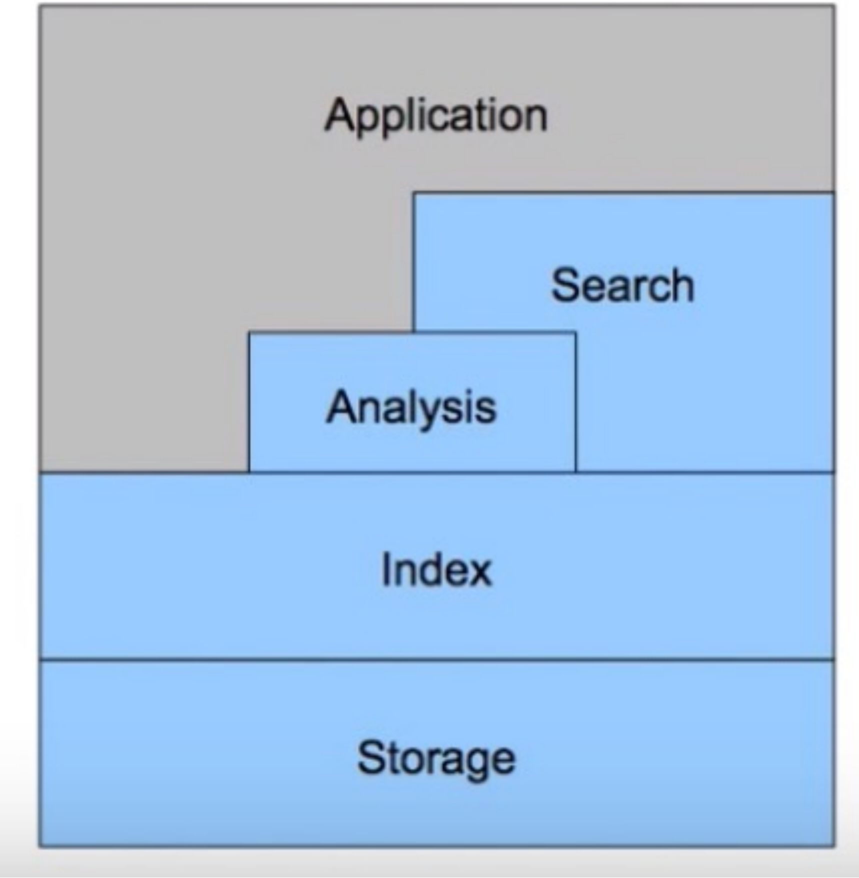
- Apache Lucene
- Apache Solr

Apache Lucene

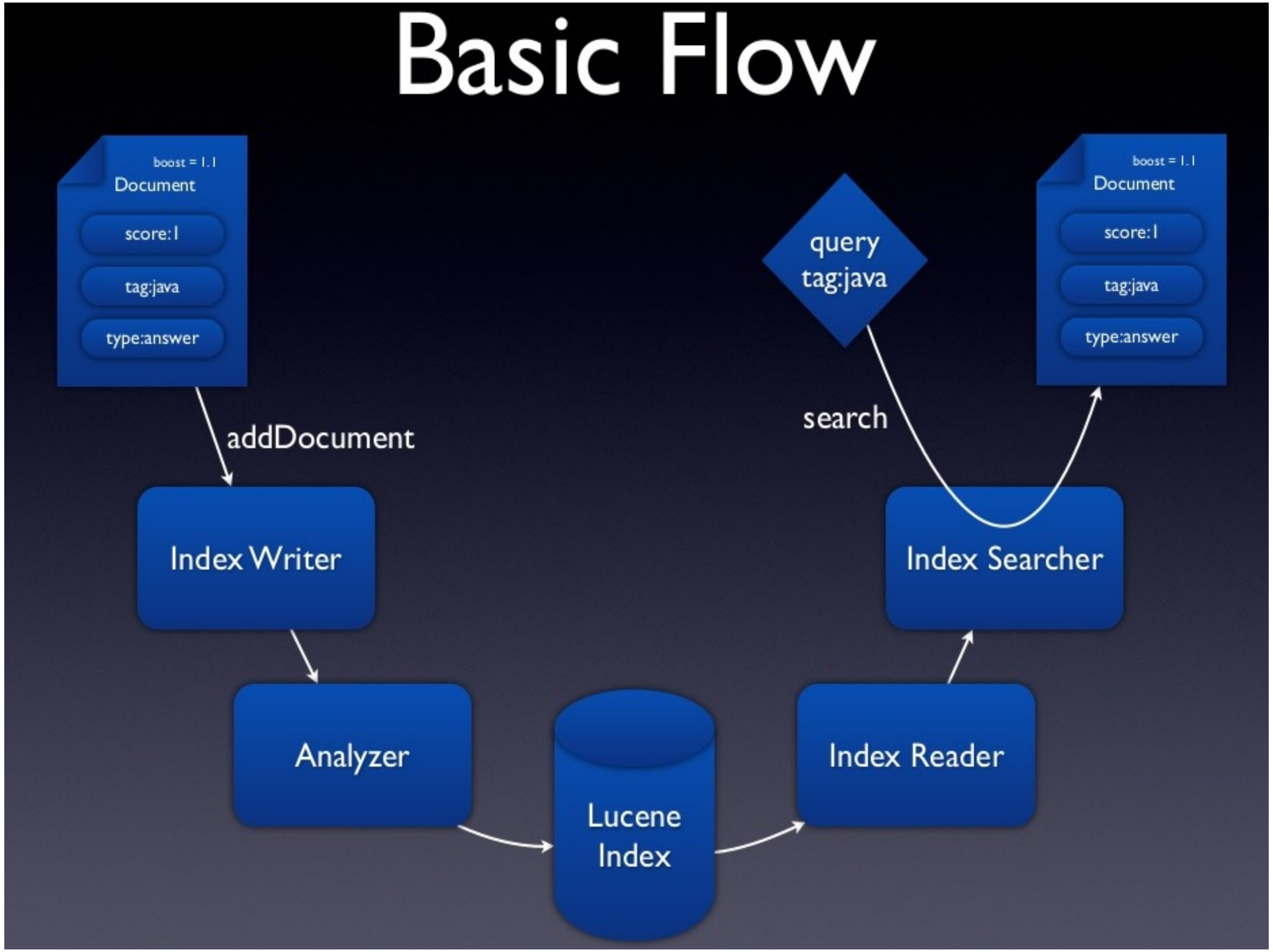
Apache Lucene Highlights

- Fast, high performance, scalable search/IR library
- Open source
- Initially developed by Doug Cutting (Also author of Hadoop)
- Indexing and Searching
- Inverted Index of documents
- Provides advanced Search options like synonyms, stopwords, based on similarity, proximity.
- **http://lucene.apache.org/**

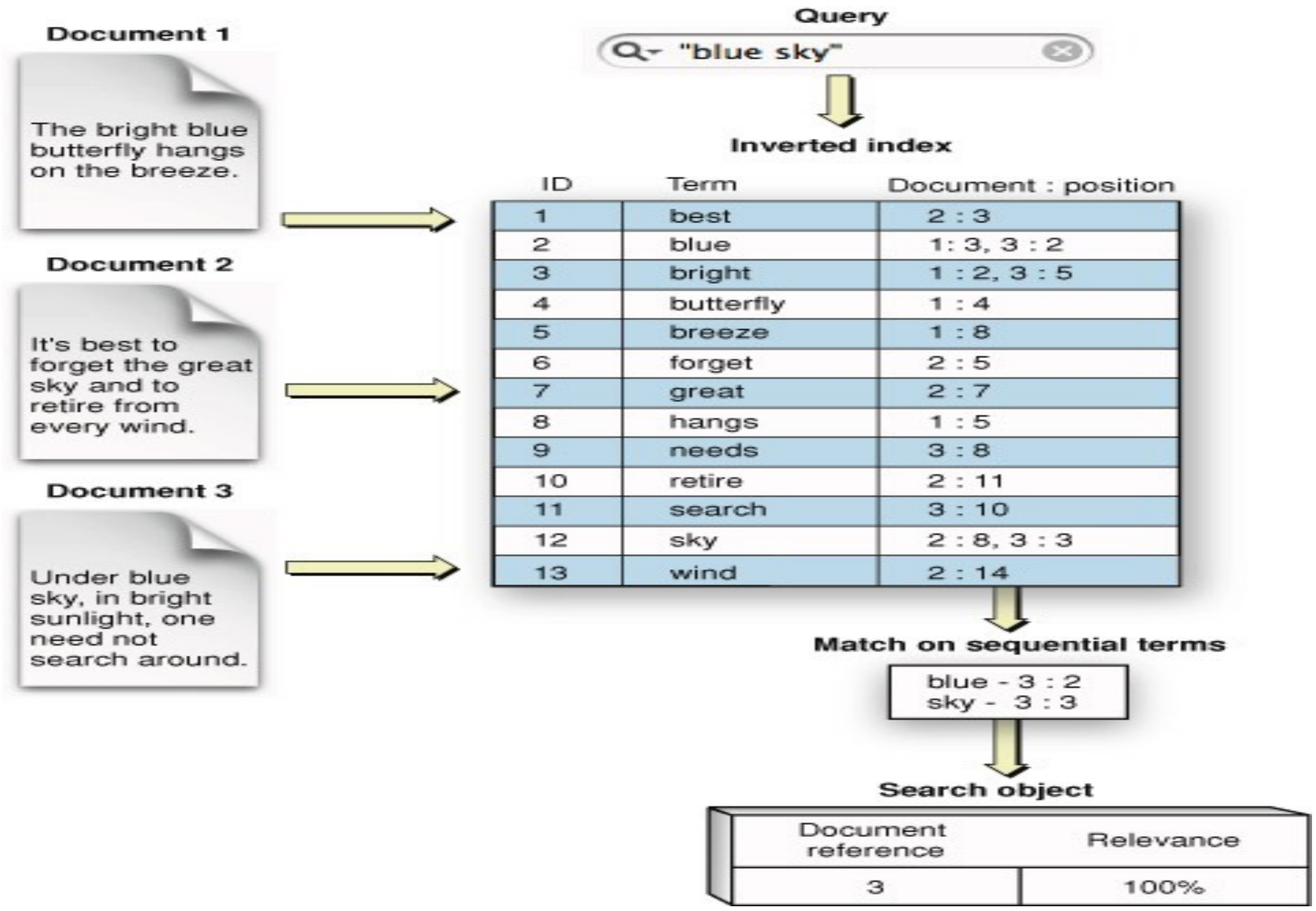
Lucene - Architecture



Lucene – Work Flow



Lucene Internals - Inverted Index



Document 1

The bright blue butterfly hangs on the breeze.

Document 2

It's best to forget the great sky and to retire from every wind.

Document 3

Under blue sky, in bright sunlight, one need not search around.

Query

"blue sky"

Inverted index

ID	Term	Document : position
1	best	2 : 3
2	blue	1: 3, 3 : 2
3	bright	1 : 2, 3 : 5
4	butterfly	1 : 4
5	breeze	1 : 8
6	forget	2 : 5
7	great	2 : 7
8	hangs	1 : 5
9	needs	3 : 8
10	retire	2 : 11
11	search	3 : 10
12	sky	2 : 8, 3 : 3
13	wind	2 : 14

Match on sequential terms

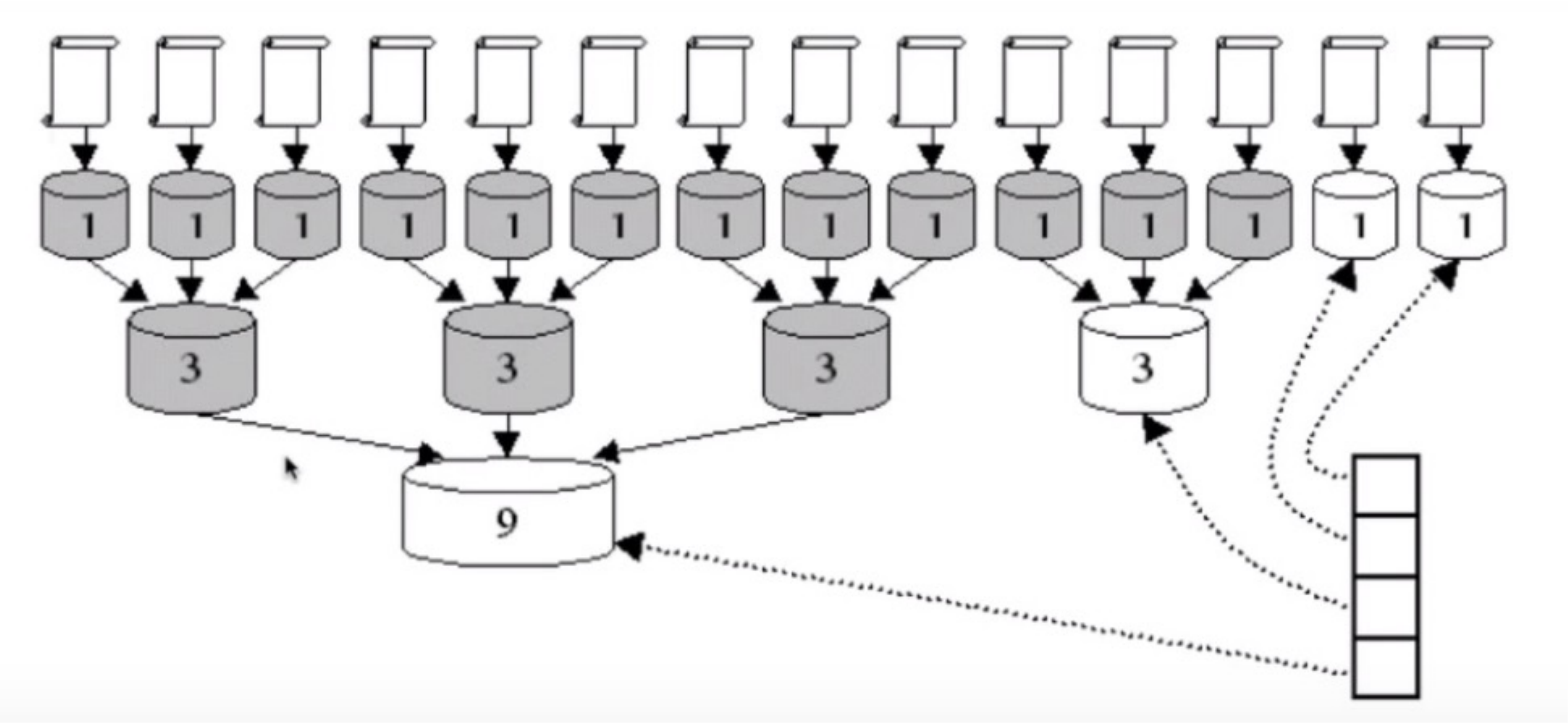
blue - 3 : 2
sky - 3 : 3

Search object

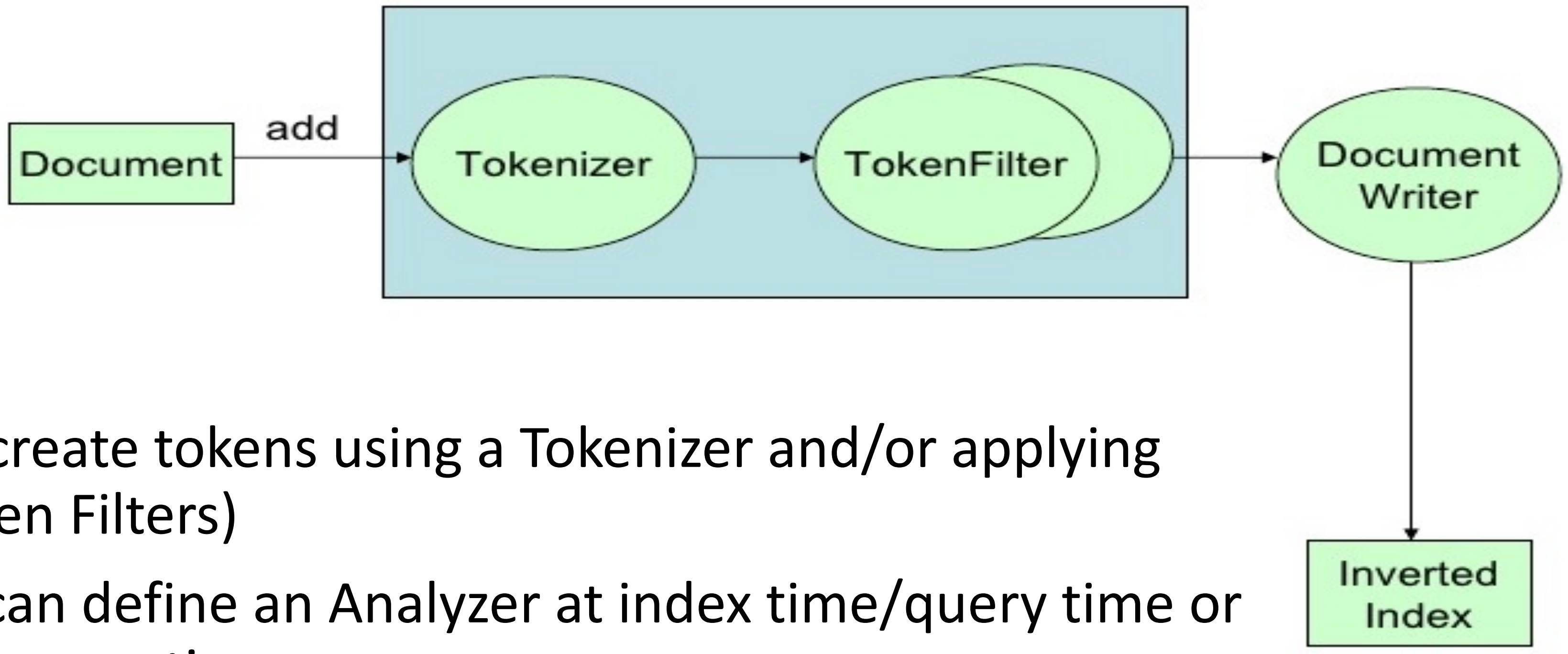
Document reference	Relevance
3	100%

Credit: https://developer.apple.com/library/mac/documentation/userexperience/conceptual/SearchKitConcepts/searchKit_basics/searchKit_basics.html

Lucene - Indexing



Indexing Pipeline



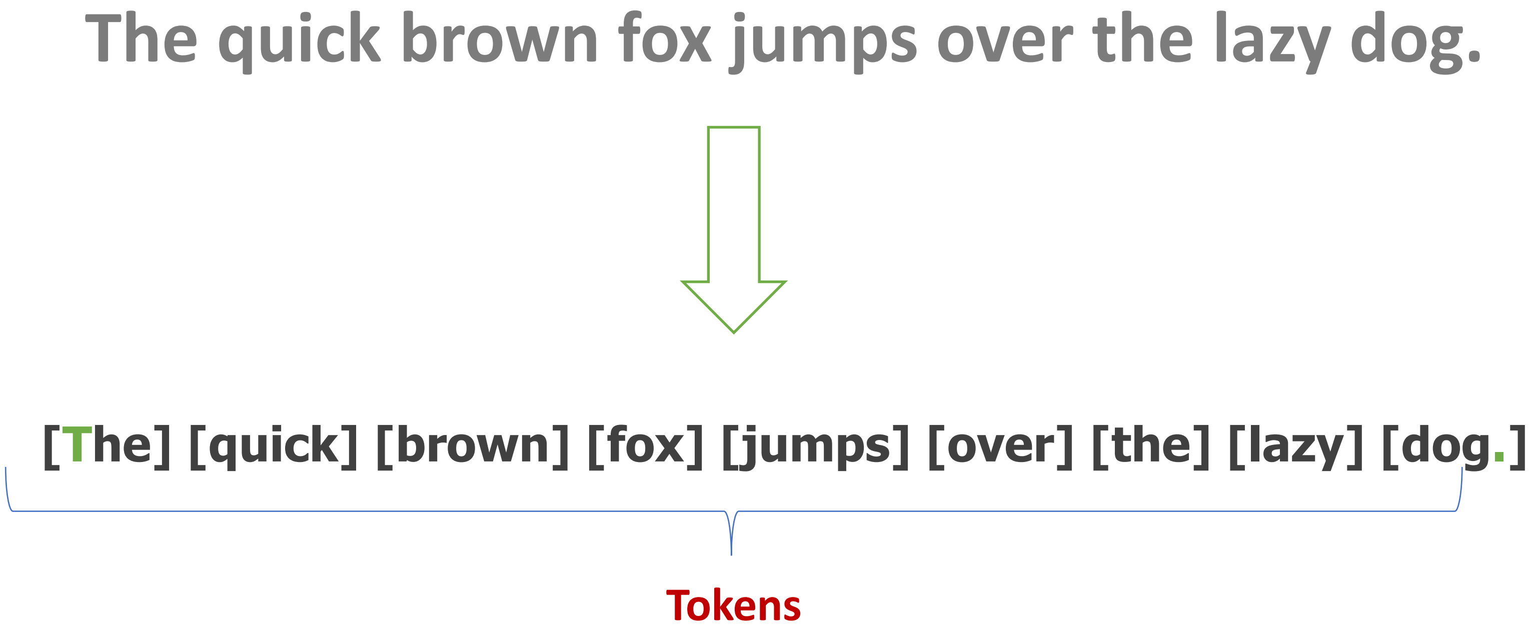
- Analyzer : create tokens using a Tokenizer and/or applying Filters (Token Filters)
- Each field can define an Analyzer at index time/query time or the both at same time.

Credit : http://www.slideshare.net/otisg/lucene-introduction

Analysis Process - Tokenizer

WhitespaceAnalyzer

Simplest built-in analyzer



The quick brown fox jumps over the lazy dog.

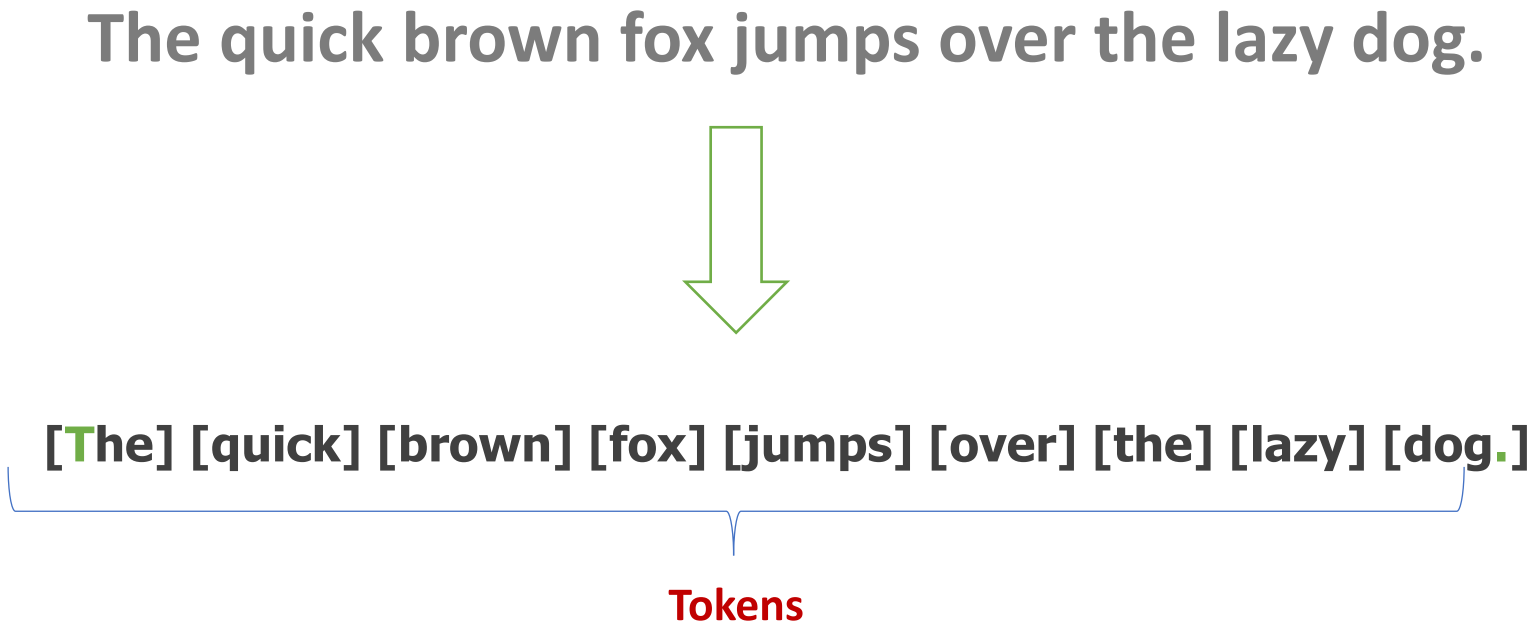
[The] [quick] [brown] [fox] [jumps] [over] [the] [lazy] [dog.]

Tokens

Analysis Process - Tokenizer

SimpleAnalyzer

Lowercases, split at non-letter boundaries



The quick brown fox jumps over the lazy dog.

[The] [quick] [brown] [fox] [jumps] [over] [the] [lazy] [dog.]

Tokens

Some common analyzer

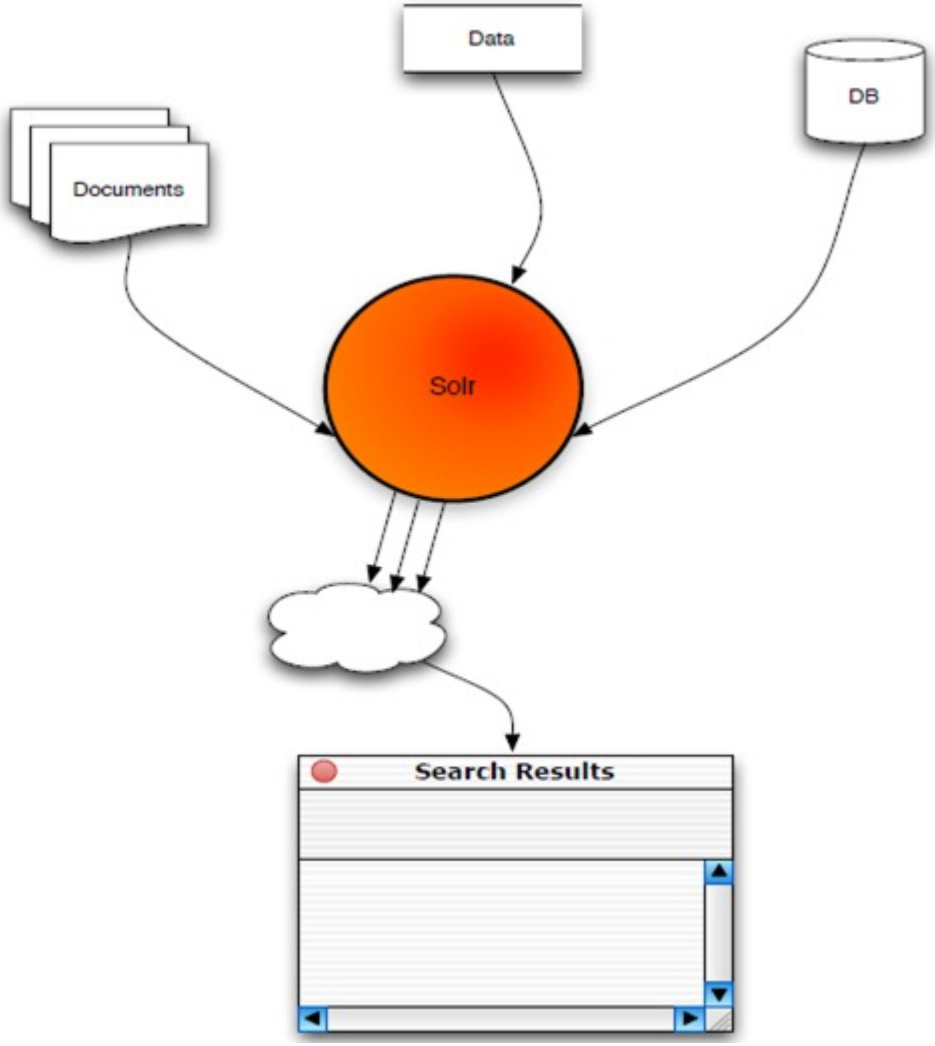
- **WhitespaceAnalyzer** : Splits text at whitespaces, just as the name indicates. In fact, this is the only thing this analyzer does.
- **SimpleAnalyzer** : Splits text at non-letter characters and lowercases resulting tokens.
- **StopAnalyzer** : Splits text at non-letter characters, lowercases resulting tokens, and removes stopwords.
- **StandardAnalyzer** : Splits text using a grammar-based tokenization, normalizes and lowercases tokens, removes stopwords, and discards punctuations. It can be used to extract company names, e-mail addresses, model numbers, and so on. This analyzer is great for general usage.
- **SnowballAnalyzer**: This analyzer is similar to StandardAnalyzer with an additional SnowballFilter for stemming.

Apache Solr

Apache Solr

- Created by Yonik Seeley for CNET
- Enterprise Search platform for Apache Lucene
- Open source
- Highly reliable, scalable, fault tolerant
- Support distributed Indexing (SolrCloud), Replication, and load balanced querying
- http://lucene.apache.org/solr

High level overview



Source: http://www.slideshare.net/erikhatcher/solr-search-at-the-speed-of-light

Apache Solr - Features

- Full-text search
- Faceted search (similar to groupby clause in RDBMS)
- Scalability
  - Caching
  - Replication
  - Distributed search
- Near real-time indexing
- Geospatial search
- And many more : highlighting, database integration, rich document (e.G., Word, PDF) handling

Solr – schema.xml

- Types with index and query Analyzers - similar to data type
- Fields with name, type and options
- Unique Key : Unique Identifier of a document. For e.g. “id”
- Dynamic Fields : *Dynamic fields* allow Solr to index fields that you did not explicitly define in your schema. For e.g. fieldName: *_i or *_txts
- Copy Fields : Solr has a mechanism for making copies of fields so that you can apply several distinct field types to a single piece of incoming information. field ‘a‘ populates field ‘b’ with its value before tokenizing (having different analyzer/filter).

Solr – Content Analysis

- Field Attributes
  - Name : Name of the field
  - Type : Data-type (FieldType) of the field
  - Indexed : Should it be indexed (indexed="true/false")
  - Stored : Should it be stored (stored="true/false")
  - Required : is it a mandatory field (required="true/false")
  - Multi-Valued : Would it will contains multiple values e.g. text: pizza, food (multiValued="true/false")

e.g. <field name="id" type="string" indexed="true" stored="true" required="true" multiValued="false" />

Solr – solrconfig.xml

- Data dir: where all index data will be stored
- Index configuration
- Cache configurations
- Request Handler configuration
- Search components, response writers, query parsers

Query Types

- Single and multi term queries
  - ex fieldname:value or title: software engineer
- +, -, AND, OR NOT operators.
  - ex. title: (software AND engineer)
- Range queries on date or numeric fields,
  - ex: timestamp: [* TO NOW] or price: [1 TO 100]
- Boost queries:
  - e.g. title:Engineer ^1.5 OR text:Engineer
- Fuzzy search : is a search for words that are similar in spelling
  - e.g. roam~0.8 => noam
- Proximity Search : with a sloppy phrase query. The close together the two terms appear, higher the score.
  - ex “apache lucene”~20 : will look for all dcuments where “apache” word occurs within 20 words of “lucene”

Solr/Lucene Use-cases

- Search
- Analytics
- NoSQL datastore
- Auto-suggestion / Auto-correction
- Recommendation Engine (MoreLikeThis)
- Relevancy Engine (Feedback to other applications)
- Solr as a White-List
- GeoSpatial based Search

Search

- **Application**
  - Eclipse, Hibernate search
- **E-Commerce** :
  - Flipkart.com, Infibeam.com, Buy.com, Netflix.com, ebay.com
- **Jobs**
  - Indeed.com, Simplyhired.com, Naukri.com
- **Auto**
  - AOL.com
- **Travel**
  - Cleartrip.com
- **Social Network**
  - Twitter.com, LinkedIn.com, mylife.com

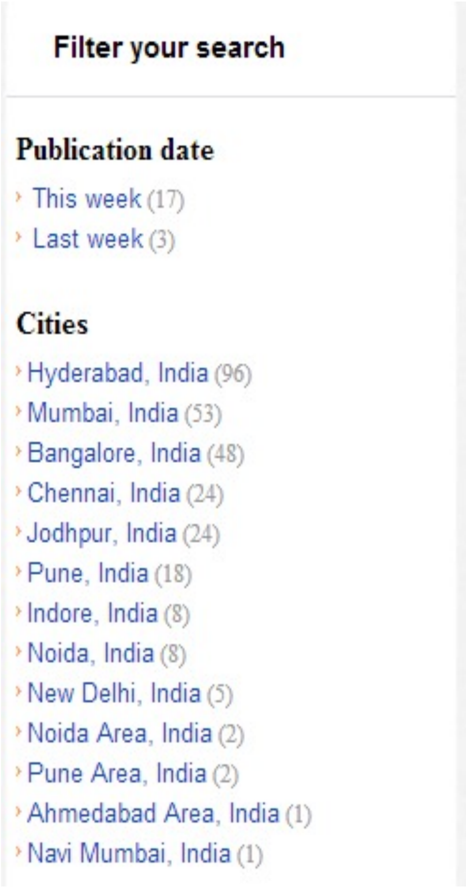
Source: http://www.quora.com/Which-major-companies-are-using-Solr-for-search

Search (Contd.)

- **Search Engine**
  - Yandex.ru, DuckDuckGo.com
- **News Paper**
  - Guardian.co.uk
- **Music/Movies**
  - Apple.com, Netflix.com
- **Events**
  - Stubhub.com, Eventbrite.com
- **Cloud Log Management**
  - Loggly.com
- **Others**
  - Whitehouse.gov

Faceting

- Grouping results based on field value
- Facet on: field terms, queries, date ranges
- &facet=on
  &facet.field=job_title
  &facet.query=salary:[30000 TO 100000]
- http://wiki.apache.org/solr/SimpleFacetParameters



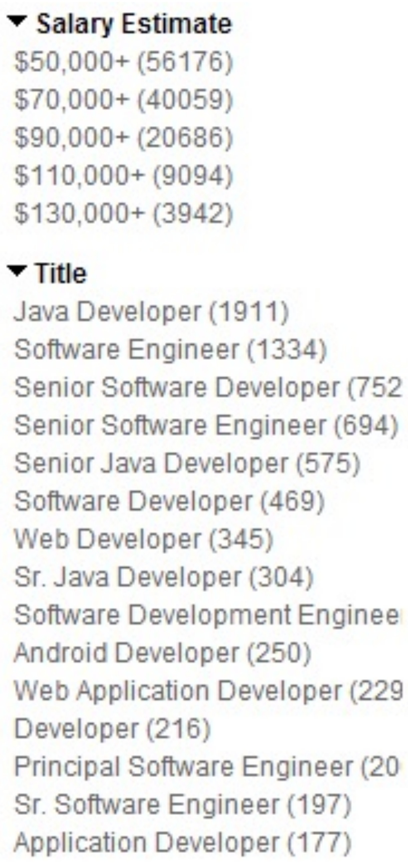
Filter your search

Publication date

- This week (17)
- Last week (3)

Cities

- Hyderabad, India (96)
- Mumbai, India (53)
- Bangalore, India (48)
- Chennai, India (24)
- Jodhpur, India (24)
- Pune, India (18)
- Indore, India (8)
- Noida, India (8)
- New Delhi, India (5)
- Noida Area, India (2)
- Pune Area, India (2)
- Ahmedabad Area, India (1)
- Navi Mumbai, India (1)



▼ Salary Estimate

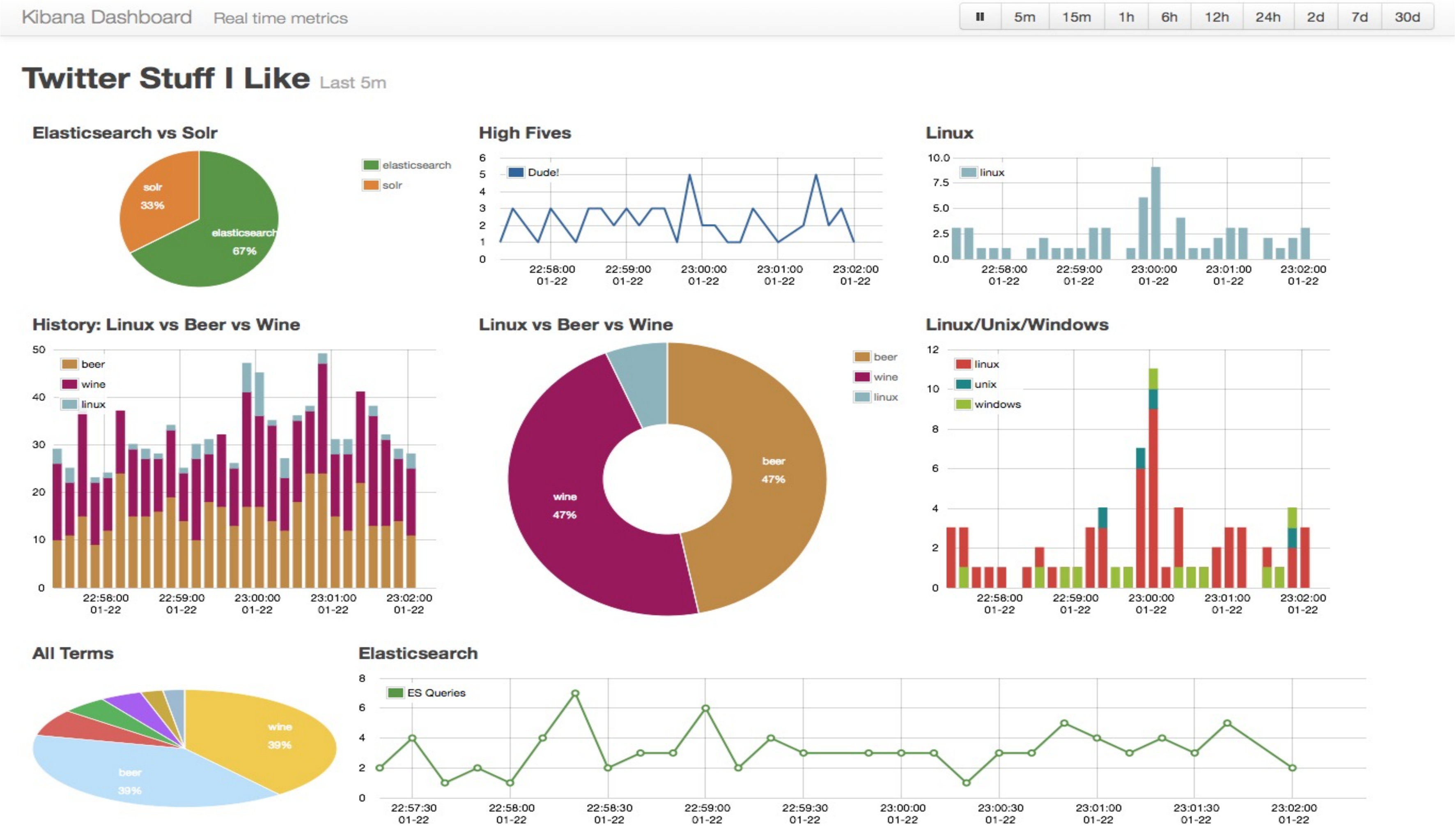
$50,000+ (56176)
$70,000+ (40059)
$90,000+ (20686)
$110,000+ (9094)
$130,000+ (3942)

▼ Title

Java Developer (1911)
Software Engineer (1334)
Senior Software Developer (752
Senior Software Engineer (694)
Senior Java Developer (575)
Software Developer (469)
Web Developer (345)
Sr. Java Developer (304)
Software Development Enginee
Android Developer (250)
Web Application Developer (229
Developer (216)
Principal Software Engineer (20
Sr. Software Engineer (197)
Application Developer (177)

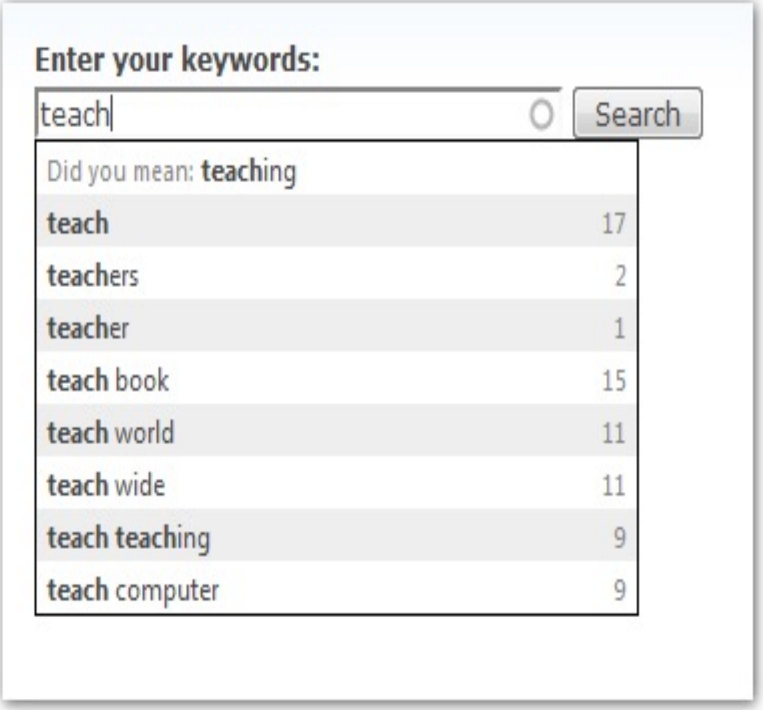
Source: www.career9.com, www.indeed.com

Analytics



- Analytics source : Kibana.org based on ElasticSearch and Logstash
- Image Source : http://semicomplete.com/presentations/logstash-monitorama-2013/#/8

Autosuggestion

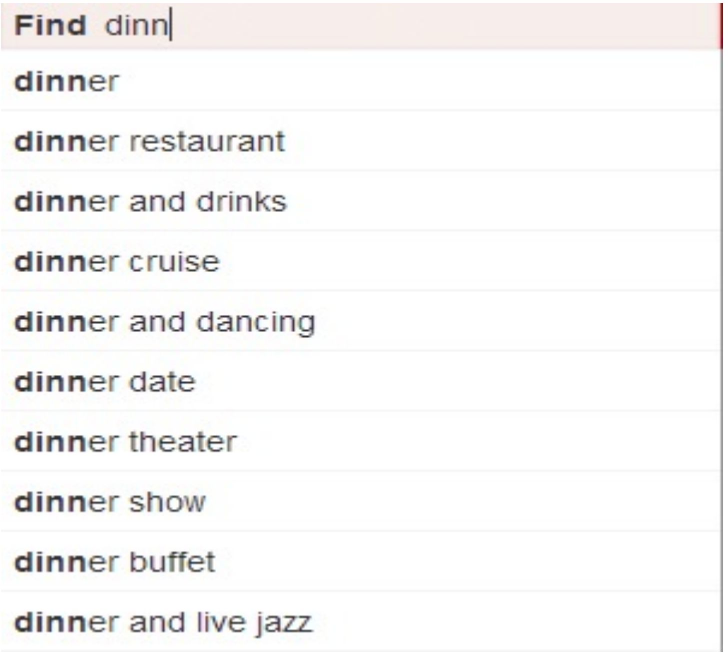


Enter your keywords:

teach

Did you mean: **teaching**

teach	17
teachers	2
teacher	1
teach book	15
teach world	11
teach wide	11
teach teaching	9
teach computer	9



Find dinn

dinner
dinner restaurant
dinner and drinks
dinner cruise
dinner and dancing
dinner date
dinner theater
dinner show
dinner buffet
dinner and live jazz

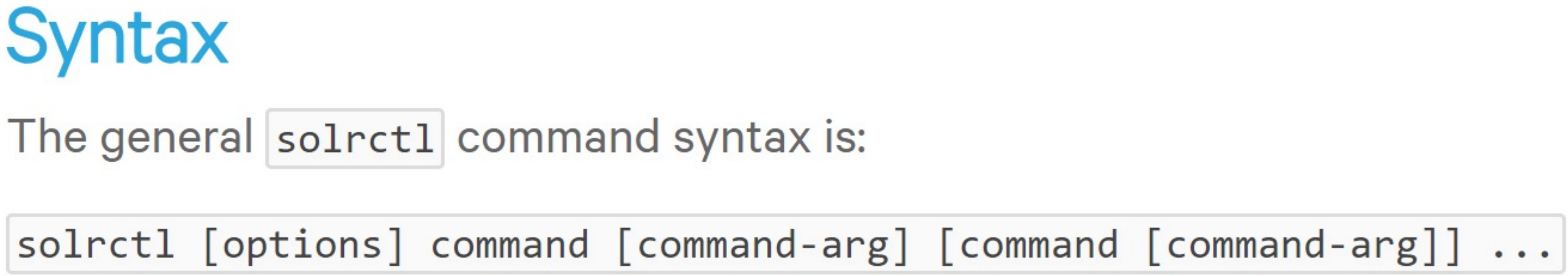
Source: www.drupal.org , www.yelp.com

Integration

- Clustering (Solr-Carrot2)
- Named Entity extraction (Solr-UIMA)
- SolrCloud (Solr-Zookeeper)
- Parsing of many Different File Formats (Solr-Tika)
- Machine Learning/Data Mining (Apache Mahout)
- Large scale Indexing (Hadoop)

SolrCtl Command

- The solrctl utility is a wrapper shell script included with Cloudera Search for managing collections, instance directories, configs, Apache Sentry permissions, and more.



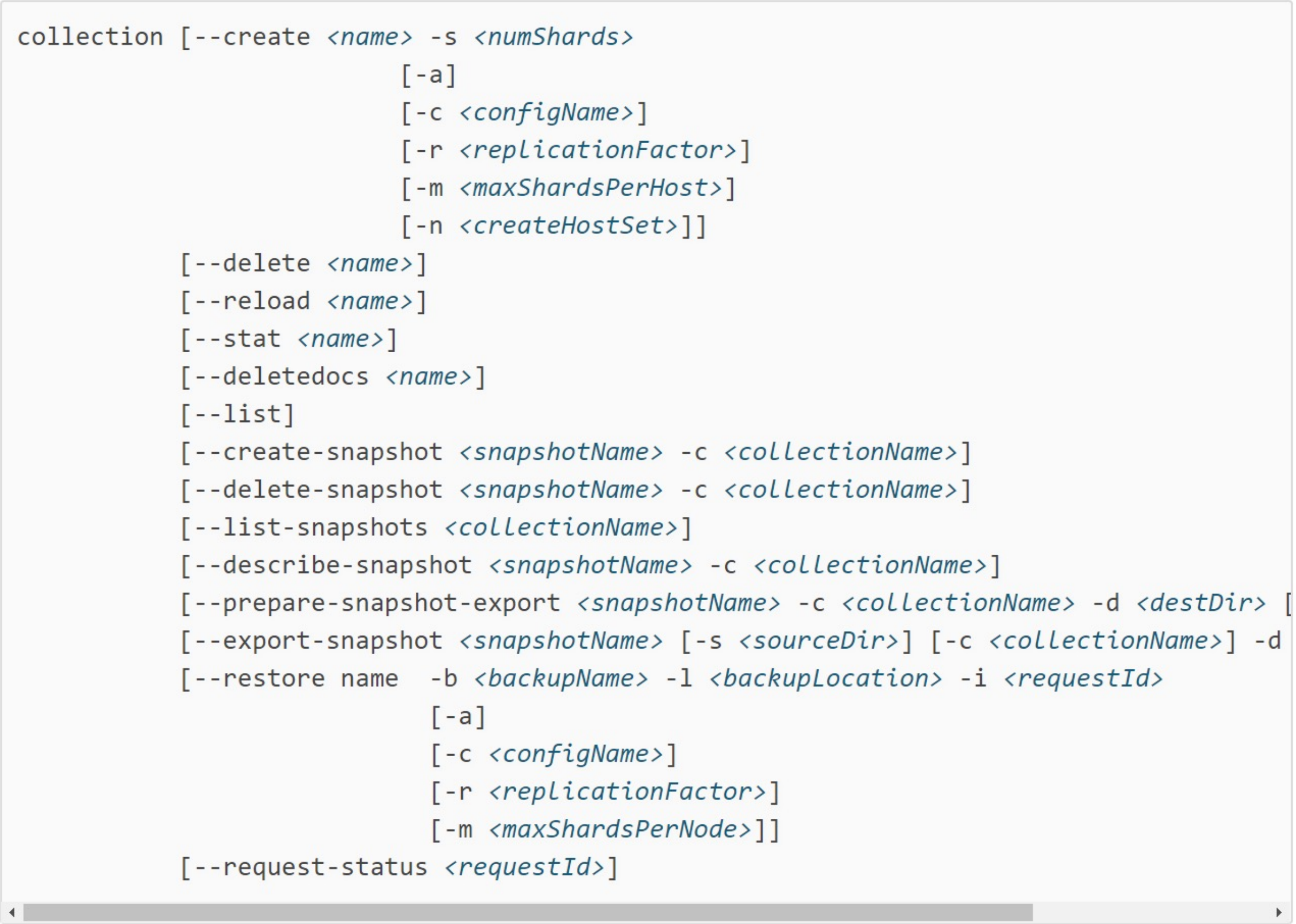
Syntax

The general `solrctl` command syntax is:

```
solrctl [options] command [command-arg] [command [command-arg]] ...
```

Source: https://www.cloudera.com/documentation/enterprise/5-14-x/topics/search_solrctl_ref.html

SolrCtl Collection Commands



```
collection [--create <name> -s <numShards>
                          [-a]
                          [-c <configName>]
                          [-r <replicationFactor>]
                          [-m <maxShardsPerHost>]
                          [-n <createHostSet>]]
           [--delete <name>]
           [--reload <name>]
           [--stat <name>]
           [--deletedocs <name>]
           [--list]
           [--create-snapshot <snapshotName> -c <collectionName>]
           [--delete-snapshot <snapshotName> -c <collectionName>]
           [--list-snapshots <collectionName>]
           [--describe-snapshot <snapshotName> -c <collectionName>]
           [--prepare-snapshot-export <snapshotName> -c <collectionName> -d <destDir> [
           [--export-snapshot <snapshotName> [-s <sourceDir>] [-c <collectionName>] -d
           [--restore name  -b <backupName> -l <backupLocation> -i <requestId>
                            [-a]
                            [-c <configName>]
                            [-r <replicationFactor>]
                            [-m <maxShardsPerNode>]]
           [--request-status <requestId>]
```

Source: https://www.cloudera.com/documentation/enterprise/5-14-x/topics/search_solrctl_ref.html

- solrctl collection –list

Lists the collection

- solrctl config --create logs_config predefinedTemplate -p immutable=false

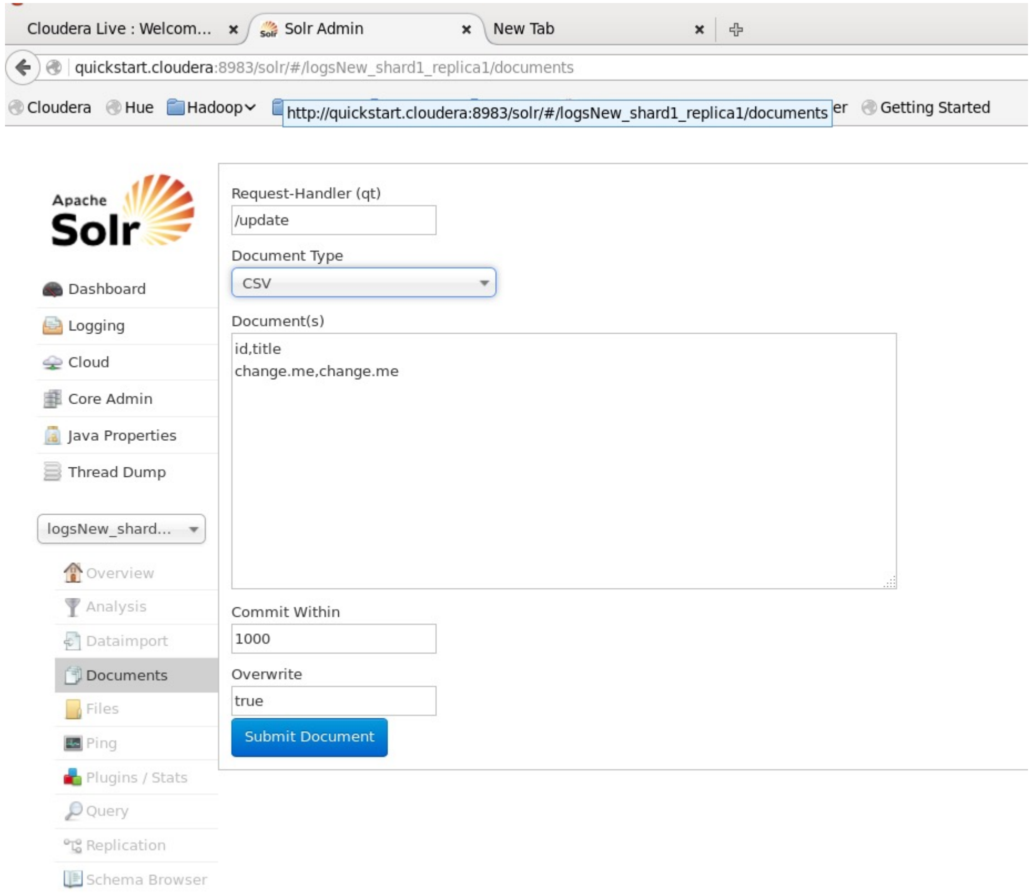
logs_config => config name

predefinedTemplate => existing config template

- solrctl instancedir --generate $HOME/logs_config
- solrctl collection --create logNew2 -c logs_config

logNew2 => collection Name

Update or add data to collection



Request-Handler (qt): /update

Document Type: CSV

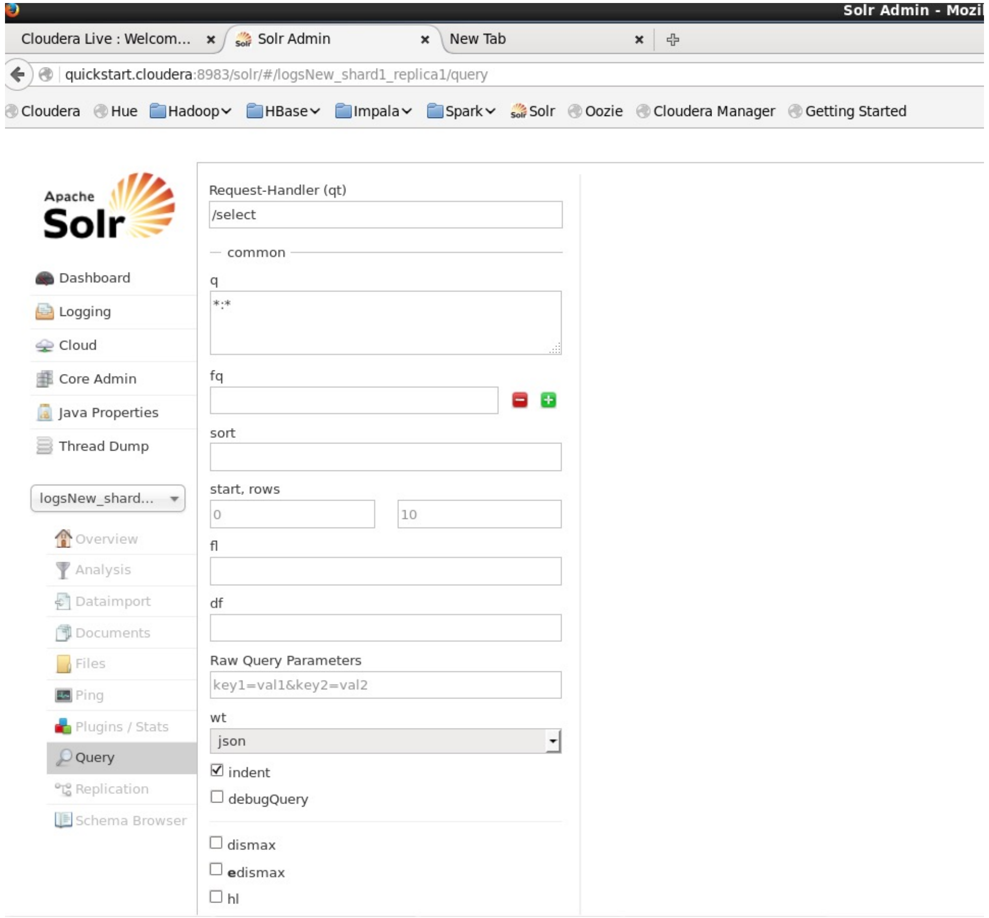
Document(s)

```
id,title
change.me,change.me
```

Commit Within: 1000

Overwrite: true

Query Syntax



quickstart.cloudera:8983/solr/#/logsNew_shard1_replica1/query

Request-Handler (qt)
/select

common

q
:

fq

sort

start, rows
0
10

fl

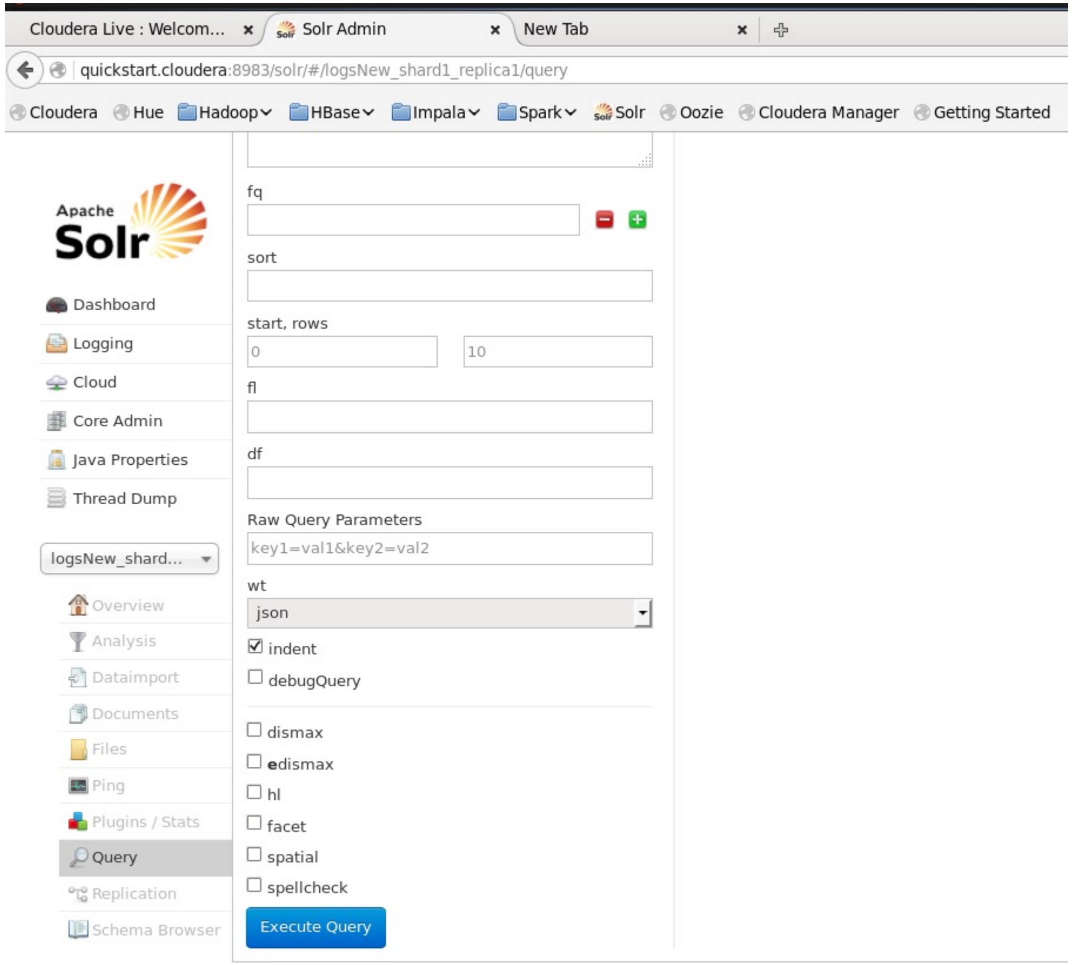
df

Raw Query Parameters
key1=val1&key2=val2

wt
json

☑ indent
□ debugQuery

□ dismax
□ edismax
□ hl



quickstart.cloudera:8983/solr/#/logsNew_shard1_replica1/query

fq

sort

start, rows
0
10

fl

df

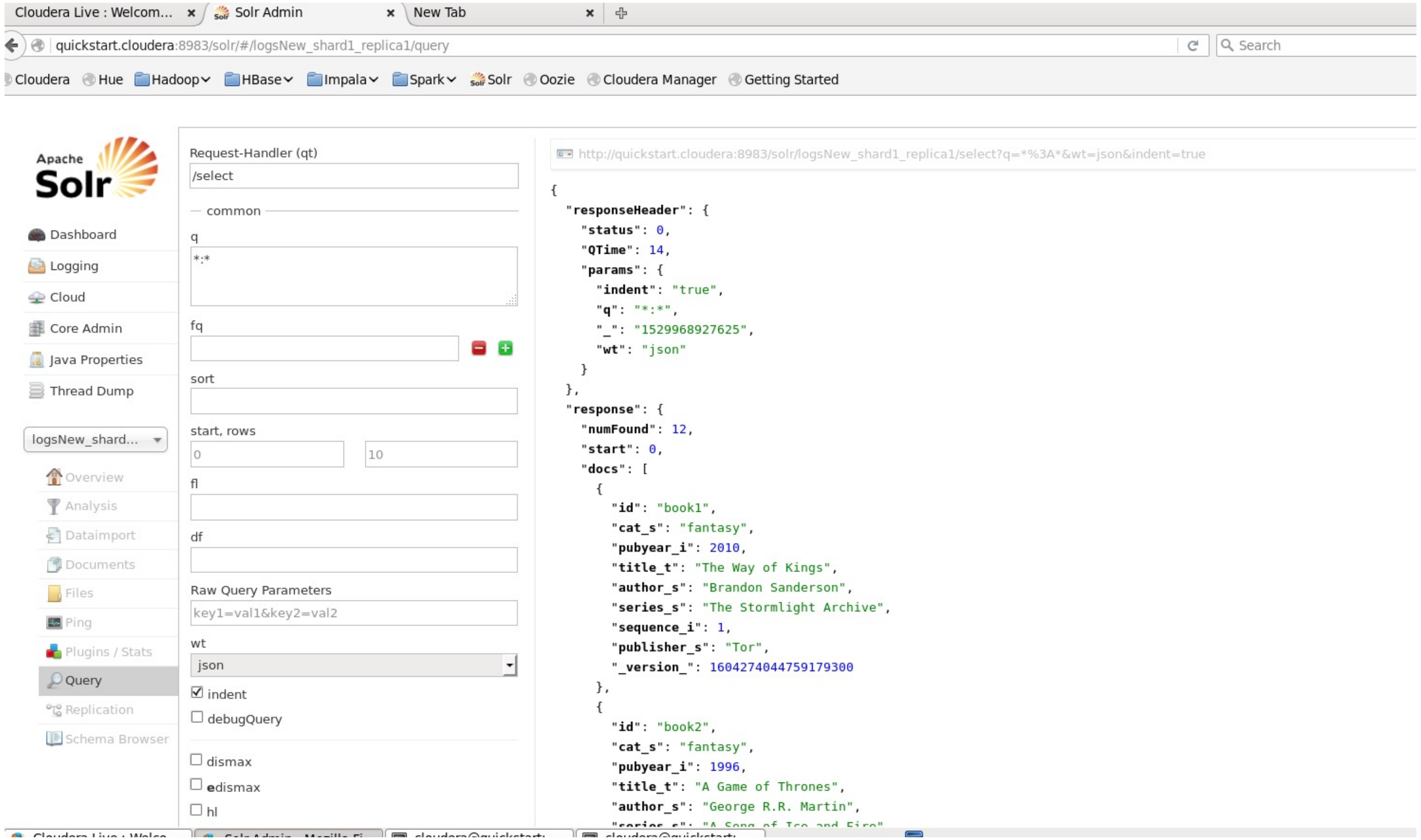
Raw Query Parameters
key1=val1&key2=val2

wt
json

☑ indent
□ debugQuery

□ dismax
□ edismax
□ hl
□ facet
□ spatial
□ spellcheck

Results



quickstart.cloudera:8983/solr/#/logsNew_shard1_replica1/query

Request-Handler (qt): /select

common

q: *:*

fq:

sort:

start, rows: 0 10

fl:

df:

Raw Query Parameters: key1=val1&key2=val2

wt: json

☑ indent

☐ debugQuery

☐ dismax

☐ edismax

☐ hl

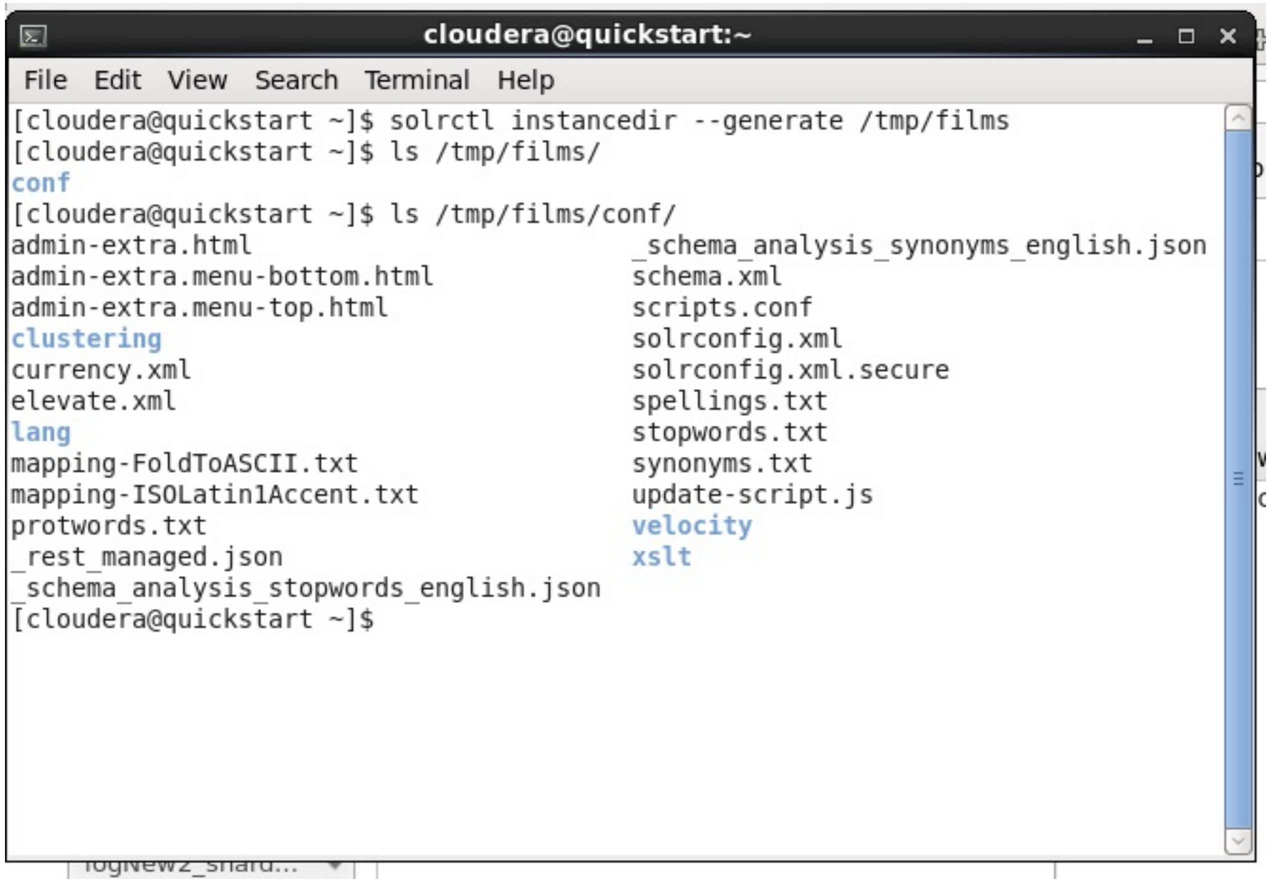
http://quickstart.cloudera:8983/solr/logsNew_shard1_replica1/select?q=*%3A*&wt=json&indent=true

```
{
  "responseHeader": {
    "status": 0,
    "QTime": 14,
    "params": {
      "indent": "true",
      "q": "*:*",
      "_": "1529968927625",
      "wt": "json"
    }
  },
  "response": {
    "numFound": 12,
    "start": 0,
    "docs": [
      {
        "id": "book1",
        "cat_s": "fantasy",
        "pubyear_i": 2010,
        "title_t": "The Way of Kings",
        "author_s": "Brandon Sanderson",
        "series_s": "The Stormlight Archive",
        "sequence_i": 1,
        "publisher_s": "Tor",
        "_version_": 1604274044759179300
      },
      {
        "id": "book2",
        "cat_s": "fantasy",
        "pubyear_i": 1996,
        "title_t": "A Game of Thrones",
        "author_s": "George R.R. Martin",
        "series_s": "A Song of Ice and Fire",
```

Creating Schema Config

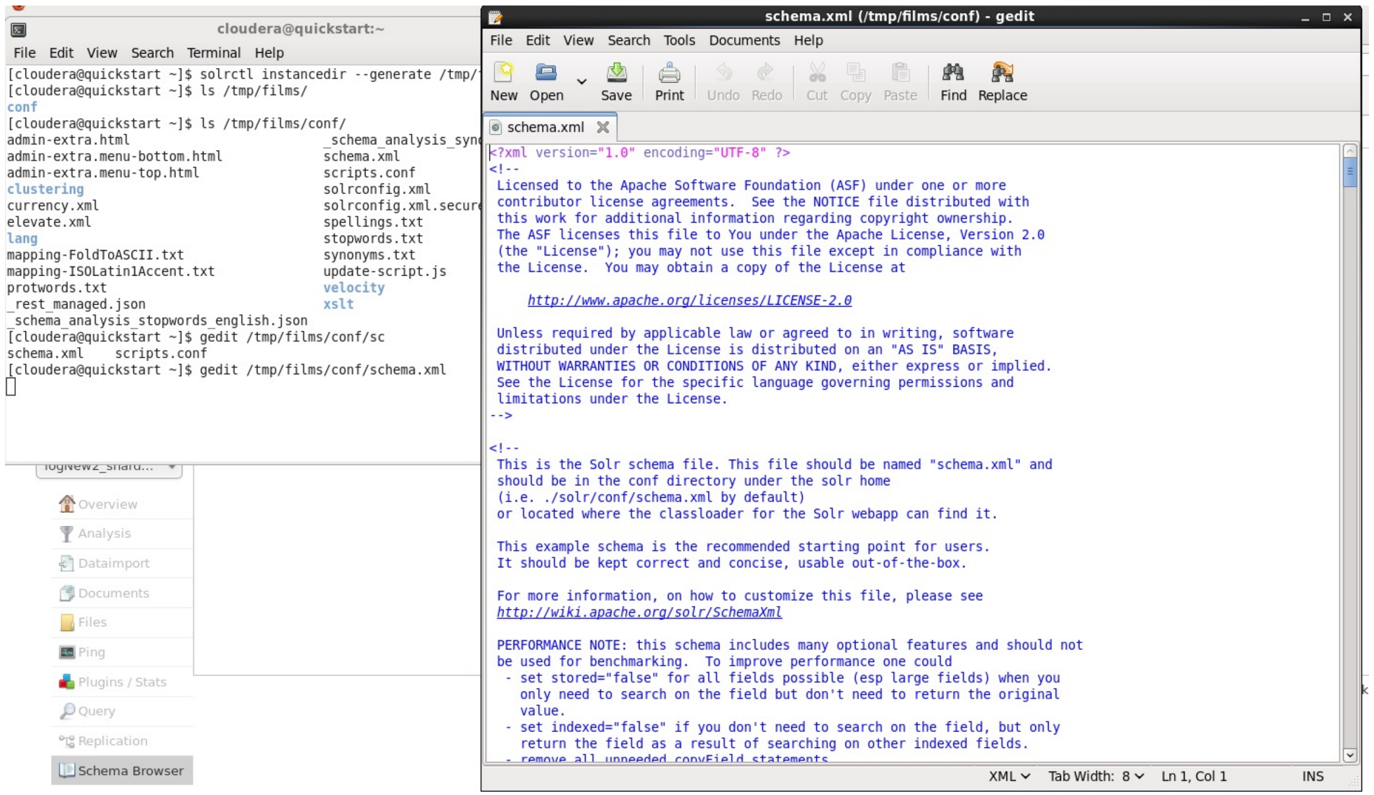
- solrctl instancedir --generate /tmp/films

Editing Schema Config



```
[cloudera@quickstart ~]$ solrctl instancedir --generate /tmp/films
[cloudera@quickstart ~]$ ls /tmp/films/
conf
[cloudera@quickstart ~]$ ls /tmp/films/conf/
admin-extra.html                         _schema_analysis_synonyms_english.json
admin-extra.menu-bottom.html             schema.xml
admin-extra.menu-top.html                scripts.conf
clustering                               solrconfig.xml
currency.xml                             solrconfig.xml.secure
elevate.xml                              spellings.txt
lang                                     stopwords.txt
mapping-FoldToASCII.txt                  synonyms.txt
mapping-ISOLatin1Accent.txt              update-script.js
protwords.txt                            velocity
_rest_managed.json                       xslt
_schema_analysis_stopwords_english.json
[cloudera@quickstart ~]$
```

Editing Schema Config :
gedit /tmp/films/conf/schema.xml



```
[cloudera@quickstart ~]$ solrctl instancedir --generate /tmp/
[cloudera@quickstart ~]$ ls /tmp/films/
conf
[cloudera@quickstart ~]$ ls /tmp/films/conf/
admin-extra.html                          _schema_analysis_sync
admin-extra.menu-bottom.html              schema.xml
admin-extra.menu-top.html                 scripts.conf
clustering                                solrconfig.xml
currency.xml                              solrconfig.xml.secure
elevate.xml                               spellings.txt
lang                                      stopwords.txt
mapping-FoldToASCII.txt                   synonyms.txt
mapping-ISOLatin1Accent.txt               update-script.js
protwords.txt                             velocity
_rest_managed.json                        xslt
_schema_analysis_stopwords_english.json
[cloudera@quickstart ~]$ gedit /tmp/films/conf/sc
schema.xml    scripts.conf
[cloudera@quickstart ~]$ gedit /tmp/films/conf/schema.xml
```

```
<?xml version="1.0" encoding="UTF-8" ?>
<!--
 Licensed to the Apache Software Foundation (ASF) under one or more
 contributor license agreements.  See the NOTICE file distributed with
 this work for additional information regarding copyright ownership.
 The ASF licenses this file to You under the Apache License, Version 2.0
 (the "License"); you may not use this file except in compliance with
 the License.  You may obtain a copy of the License at

     http://www.apache.org/licenses/LICENSE-2.0

 Unless required by applicable law or agreed to in writing, software
 distributed under the License is distributed on an "AS IS" BASIS,
 WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
 See the License for the specific language governing permissions and
 limitations under the License.
-->

<!--
 This is the Solr schema file. This file should be named "schema.xml" and
 should be in the conf directory under the solr home
 (i.e. ./solr/conf/schema.xml by default)
 or located where the classloader for the Solr webapp can find it.

 This example schema is the recommended starting point for users.
 It should be kept correct and concise, usable out-of-the-box.

 For more information, on how to customize this file, please see
 http://wiki.apache.org/solr/SchemaXml

 PERFORMANCE NOTE: this schema includes many optional features and should not
 be used for benchmarking.  To improve performance one could
  - set stored="false" for all fields possible (esp large fields) when you
    only need to search on the field but don't need to return the original
    value.
  - set indexed="false" if you don't need to search on the field, but only
    return the field as a result of searching on other indexed fields.
  - remove all unneeded copyField statements
```

Creating new fieldType (Use this to create your own directed_by field)

- http://www.solrtutorial.com/schema-xml.html
-
  ```
  <fields>
    <field name="id" type="string" indexed="true" stored="true" required="true" />
    <field name="name" type="textgen" indexed="true" stored="true"/>
  ...
  </fields>
  ```

Film Dataset commands

Instancedir and collection

- solrctl instancedir --create films /tmp/films
- solrctl collection --create films

Edit Schema

- ls /tmp/films/conf/
- gedit /tmp/films/conf/schema.xml

References

- http://www.lucenetutorial.com/lucene-vs-solr.html
- https://lucene.apache.org/solr/
- https://lucene.apache.org/solr/guide/6_6/the-standard-query-parser.html
- https://lucene.apache.org/solr/guide/8_5/solr-tutorial.html

Commands Details

- solrctl instancedir -- generate - Use this command to generate new instance.
- solrctl instancedir -- create <collection_name> - To upload the contents of instance directory to Zookeeper.
- solrctl collection -- create <collection_name> - Used to create new collection.

Commands

- solrctl config --create logs_config predefinedTemplate -p immutable=false
- solrctl instancedir --generate $HOME/logs_config
- solrctl collection --create logNew2 -c logs_config
- solrctl instancedir --generate /tmp/films
- ls /tmp/films/conf