Introduction to

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Overview

- Introduction to Lucene & Solr
- Getting started
  - Indexing using Solr
  - Updating & deleting files
  - Searching using Solr
- Solr Configuration

What is Lucene?

- Lucene is:
  - NOT a crawler
    - see Apache Nutch
  - NOT an application
    - See PoweredBy on the Wiki
  - NOT a library for doing Google pageRank
  - An open source Java-based IR **library** enabling text based search
  - Metaphor: Lucene is an engine

What is Solr?

- Solr is:
  - An open source enterprise search server
  - Based on the Lucene Java search library
  - A web based application that processes HTTP request and returns HTTP responses
  - completed with XML/HTTP APIs, caching, replication, and web administration interface.
  - Metaphor: Solr is a car

Why Solr?

- Some reasons of using Solr:
  - Using many Lucene best practices
  - uncomplicated setup, configuration and Easy to extend
  - Providing faceted navigation, spell checking, highlighting, clustering, grouping, & any other search features
  - Supporting clients in:
    - HTTP
    - Java
    - Python
    - PHP
    - Ruby
    - JSON

Why Solr?

- Some reasons of using Solr:
  - Flexible index formats
    - New posting list codecs: block, simple text, Append (HDFS)
  - Good indexing performance
  - SolrCloud feature (Solr 4.x above)
  - Geospatial searches
  - Who uses Lucene/Solr?
    - Cisco, ebay, Boeing, AT& T, Ford and many, many others...!

Comparison to Database Technology

- The most important comparison to make is the data model
  - Data model is the organizational structure of data
- RDBMS:
  - Its data model is based on multiple tables with lookup keys between them
  - A ***join*** capability for querying across tables
  - A flexible data model
- Lucene Solr:
  - Has a more limiting ***document oriented*** data model
    - Analogous to a single table without join possibilities
    - Document-oriented databases have a rich nested structure similar to XML/JSON → MongoDB (NoSQL)
  - Has a flat document structure
    - Supporting multi-valued fields with an array of values

Comparison to Database Technology

- RDBMS:
  - Excell at:
    - insert/update efficiency, in-place schema changes,
    - multi-user access control, bulk data retrieval
    - Supporting rich ad-hoc query features
- Solr:
  - Falls short in all of above areas:
    - **No Updates**: if any part of a document in Solr needs to be updated, the entire document must be replaced.
    - **Slow commits**:
      - Solr's search performance & certain features are made due to extensive caches.
      - When a commit operation is done to finalize added documents, the chaches are rebuilt.

Solr as NoSQL

- NoSQL : not only SQL
- Characteristics:
  - Non-traditional data stores
  - Not designed for SQL type query
  - Document oriented, data format agnostic (JSON, XML, CSV, binary)
- Versioning and optimistic locking
  - with Real Time GET, allows read/write/update with without conflict.
- Atomic updates:
  - Can add/remove/change and increment a field in existing index with/witout re-indexing

Important Terminologies in Solr

- A Lucene Index is a collection of documents
- A document is a collection of fields
- A field is a content along with metadata describing the content
- Field content can have several attributes, eg:
  - Tokenized – analyze the content, extracting Tokens and adding them to inverted index.
  - Stored – keep the content in a storage data structure for use by application.

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

Important Terminologies in Solr

- Solr Core:
  - A running instance of a Lucene index along with all Solr configurations required to use it
  - A single application may have 0 or more cores which are run in isolation
- Request Handler:
  - A Solr component that processes requests.
- Commit:
  - Solr always attempts to optimize the rate of incoming data that can be indexed by buffering data in memory before writing it to the index.
  - The downside is that data is not available for queries untill it has been writen to the index.
  - A commit operation is necessary to write all the buffered data to the index & make it available for queries.

Getting Started

- https://lucene.apache.org/solr/tutorial.html
- Unzip your Solr release

  user:~solr$ unzip -g solr-version.zip

  user:~solr$ tar xvzf solr-version.tgz
- Go to the solr directory and change your working directory to the 'example' directory:
  - To the example path and type:

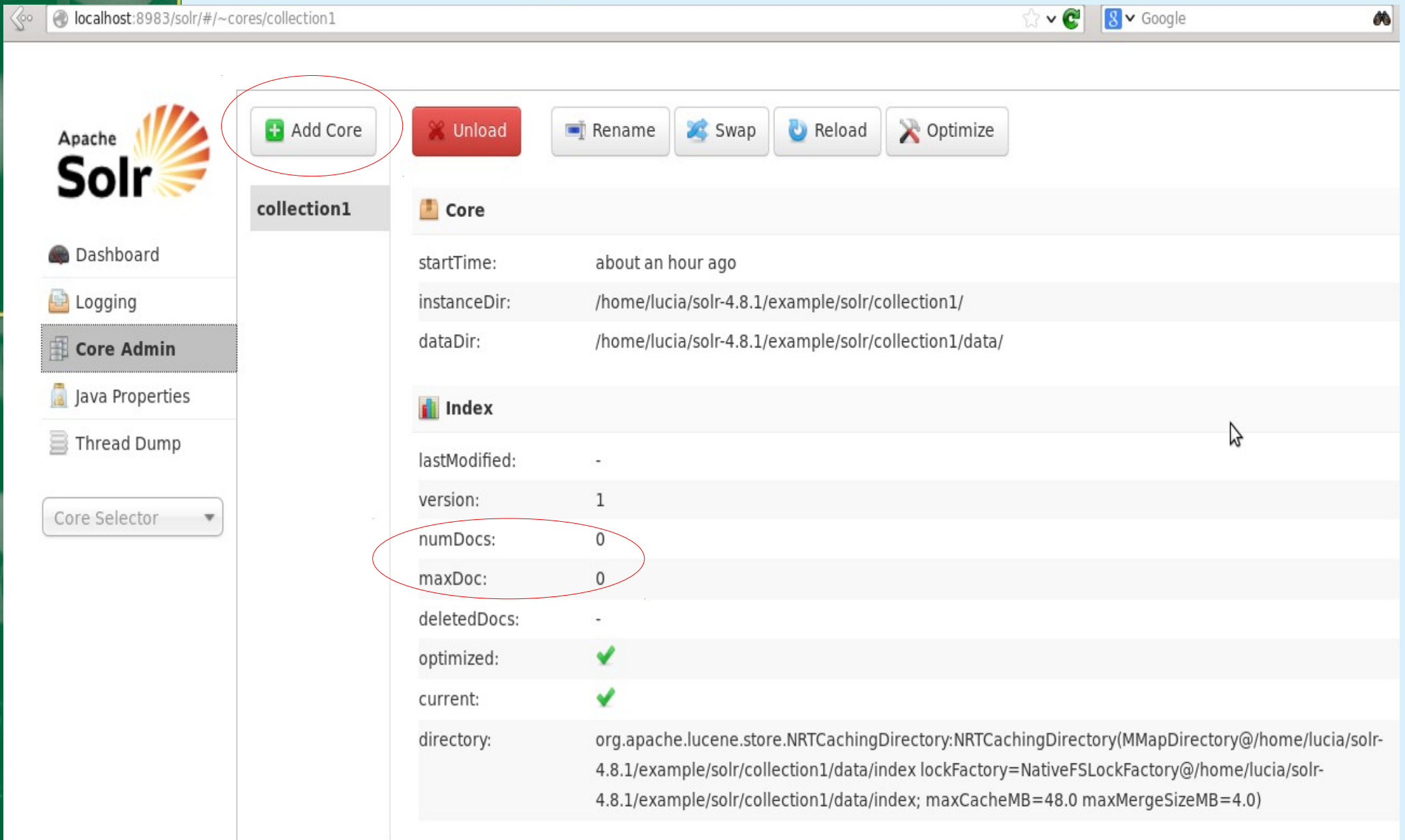
    user:~solr/example$ java -jar start.jar
  - Under windows, start the Web Server by running *start.bat* instead.
    c:\Applications\sorl\example > start.bat
- Solr can run in any Java Servlet Container & the example index includes an installation of Jetty
- The 'start.jar' command:
  - launches Jetty with the Solr WAR
  - Launches the example configs
  - starts up the Jetty application server on port 8083

Getting Started

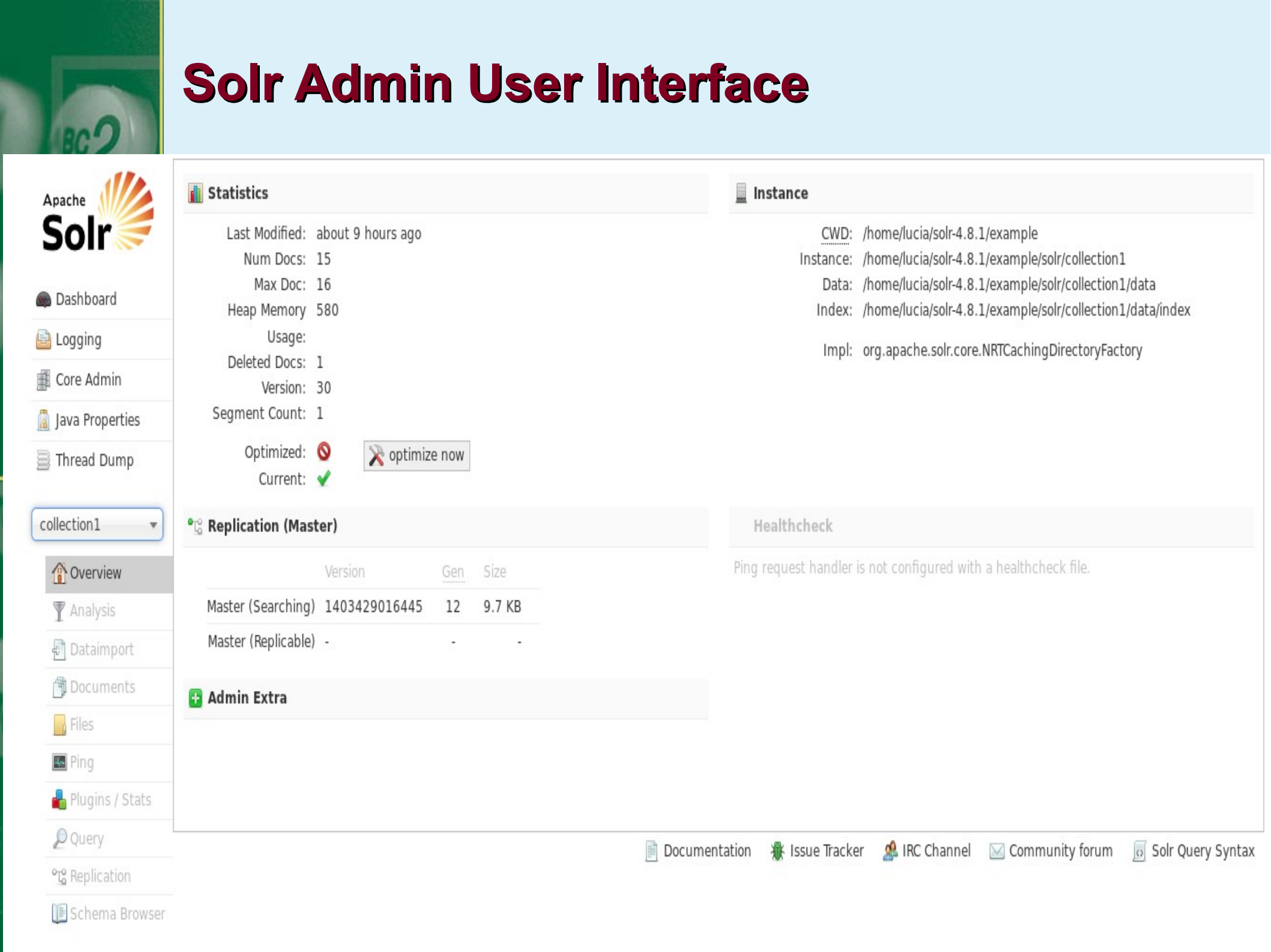
- Use your terminal to display the logging information from Solr.
- Solr is running in your port 8983
- Check it by:
  - Open your browser and type:

    http://localhost:8983/solr/
- Your Solr server is running but it has no data or document at all
- Modifying a Solr index can be done by POSTing commands in variety of formats:
  - XML
  - JSON
  - CSV
  - JAVABIN

Solr Core Admin



Solr Admin User Interface



Solr Admin User Interface (UI)

- Pages describing each screen of admin UI:
  - **Dashboard** provides link for system-level information & Solr cores configured for this instance.
  - **Logging** explains the various logging level available and how to invoke them
  - **Core Admin** explains how to get management information about each core
  - **Java Properties** shows the java information about each core
  - **Thread Dump** lets you see detailed information about each thread, along with state information.

Solr Admin User Interface (UI)

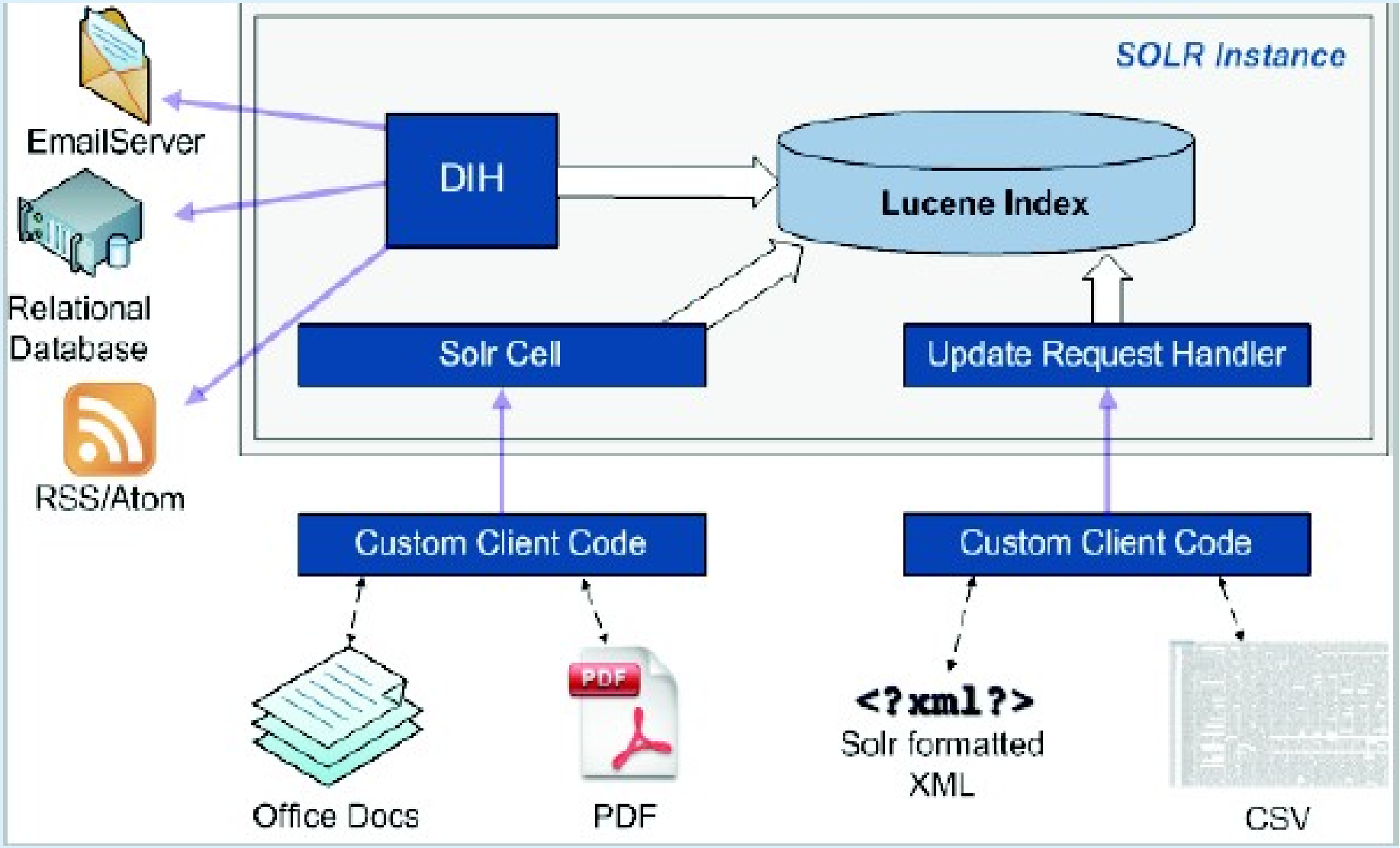
- Core-Specific Tools is a section explaining each named core:
  - **Analysis** lets us analyze the data found in specific fields
  - **Dataimport** shows information about the current status of the Data Import Handler
  - **Documents** provides a form allowing us to execute various Solr indexing commands directly from browser
  - **Files** shows the current core configuration files such as *solrconfig.xml* & *schema.xml*
  - **Ping** lets us ping a named core & determine whether it is active
  - **Plugins/Stats** shows statistics for plugins & other installed components
  - **Query** Let us submit a structured query
  - **Replication** shows the current replication status for the core
  - **Schema Browser** displays schema data in a browser window

Getting started to Indexing

- An easiest way to indexing:
  - Open a new terminal window
  - Go to *exampledocs* directory that contains sample files & SimplePost Tool, a java-based command line tool, *post.jar*
  - choose some files and run „java -jar post.jar“:

    user:~solr/example/exampledocs$ java -jar post.jar *doc_name.xml*
  - To check that you have successfully indexed those document:
    - go to admin interface to „query“ tab, and enter a query(ies) relating to your indexed documents.
    - Click „execute query“ button.
    - You will see the result in the format you choose

Solr Indexing Option



[Hatcher, 2011]

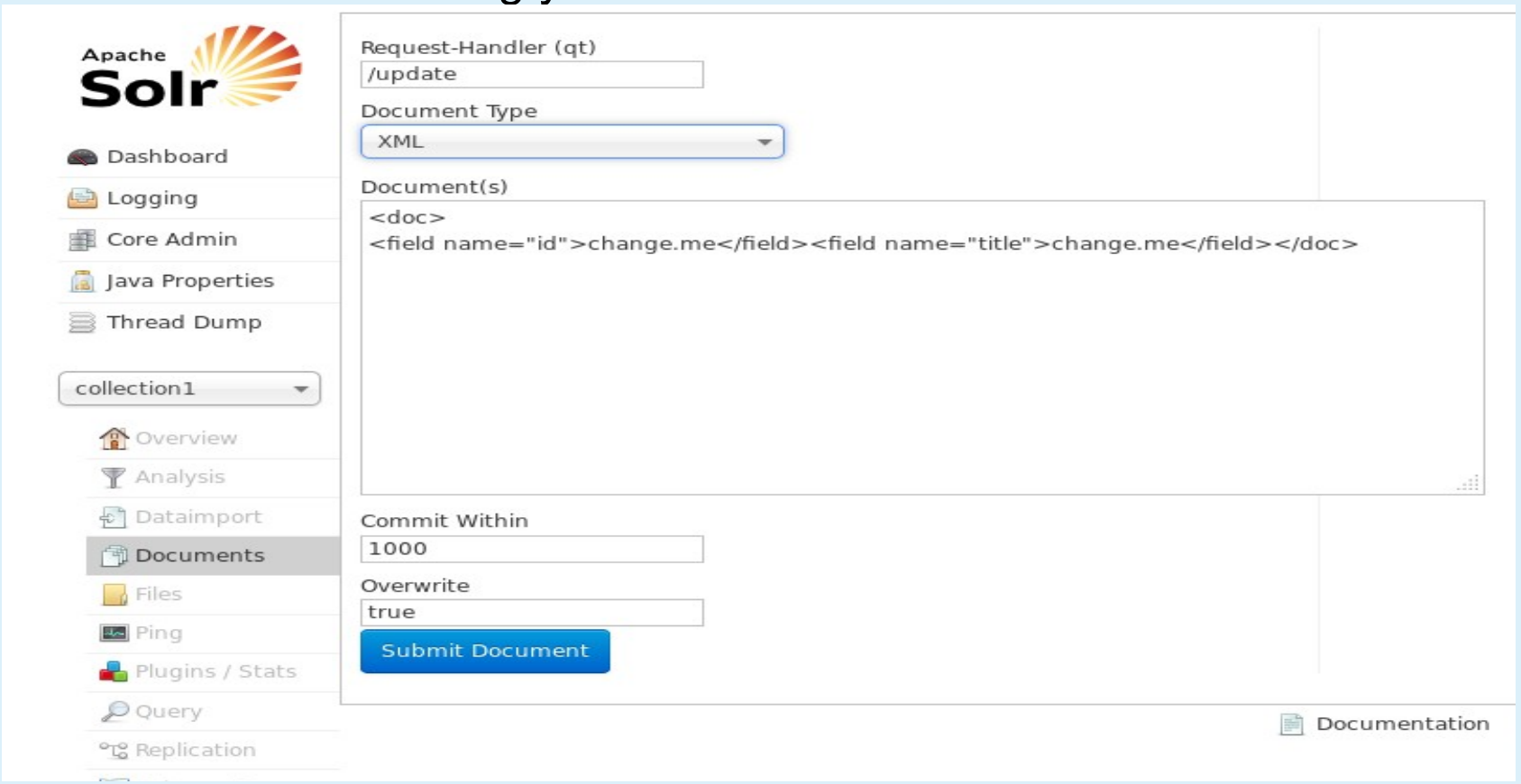
Indexing through Request Handler

- Updating a Solr Index with XML
- Techniques:
  - /update POST to with post.jar command

```
<add>
  <doc>
    <field name="id">rawxml1</field>
    <field name="content_type">text/xml</field>
    <field name="category">index example</field>
    <field name="title">Simple Example</field>
    <field name="filename">addExample.xml</field>
    <field name="text">A very simple example of
         adding a document to the index.</field>
  </doc>
</add>
```

Indexing through Request Handler

- Using Admin Interface:
  - Go to tab Documents
  - Choose the document type:
    - File upload (from your file system)
    - Creating your own document on the chosen format



Indexing CSV Files

- Beside using request-handler, indexing csv files to Solr can be done by
  - Sending files over HTTP:

    cd example/exampledocs

    curl http://localhost://8983/solr/update/csv --data-binary @books.csv -H 'content-type:text/csv; charset=utf-8'
  - Or streaming from the file system:

    cd example/exampledocs

    curl http://localhost:8983/solr/update/csv?stream.file= exampledocs /data.csv&stream.contentType=text/csv; charset=utf-8

Updating Documents

- Solr uses the „UniqueKey“ to determine the „identity“ of a document
- Adding the same document to the index with the same uniqueKey as an existing document means the new document will replace the original.
- An „update“ is actually 2 steps, internally:
  - Delete a document with that id
  - Add the new document
  - So documents are „replaced“, not deleted
  - No field-level updating – a whole document has to be replaced

Deleting Documents

- Document can be deleted using SimplePost Tool that sends raw XML to a Solr port:
  - Using a delete by id:

    <delete><id>001</id></delete>

    user:~solr/example/exampledocs$ java -Dcommit=false -Ddata=args -jar post.jar “<delete><id>001</id></delete>“
  - Using a delete by query:

    <query><delete>name:information</delete></query>

    user:~solr/example/exampledocs$ java -Ddata=args -Dcommit=yes -jar post.jar “<query><delete>name:information</delete></query>“

Deleting Documents

- When a document is deleted it still exists in an index segment:
  - The example configuration uses Solr's „autoCommit“ → automatically persist this change to the index
  - Check in the admin GUI, 'plugin/stats' for *updateHandler*
  - If *deleteById* value drops as the *cumulative_deletesById* & *autocommit* values increase, the delete to disk has been done.
- You can force a new searcher to be opened to reflect these changes by sending an explicit commit command:

```
java -jar post.jar -
```

Searching in Solr

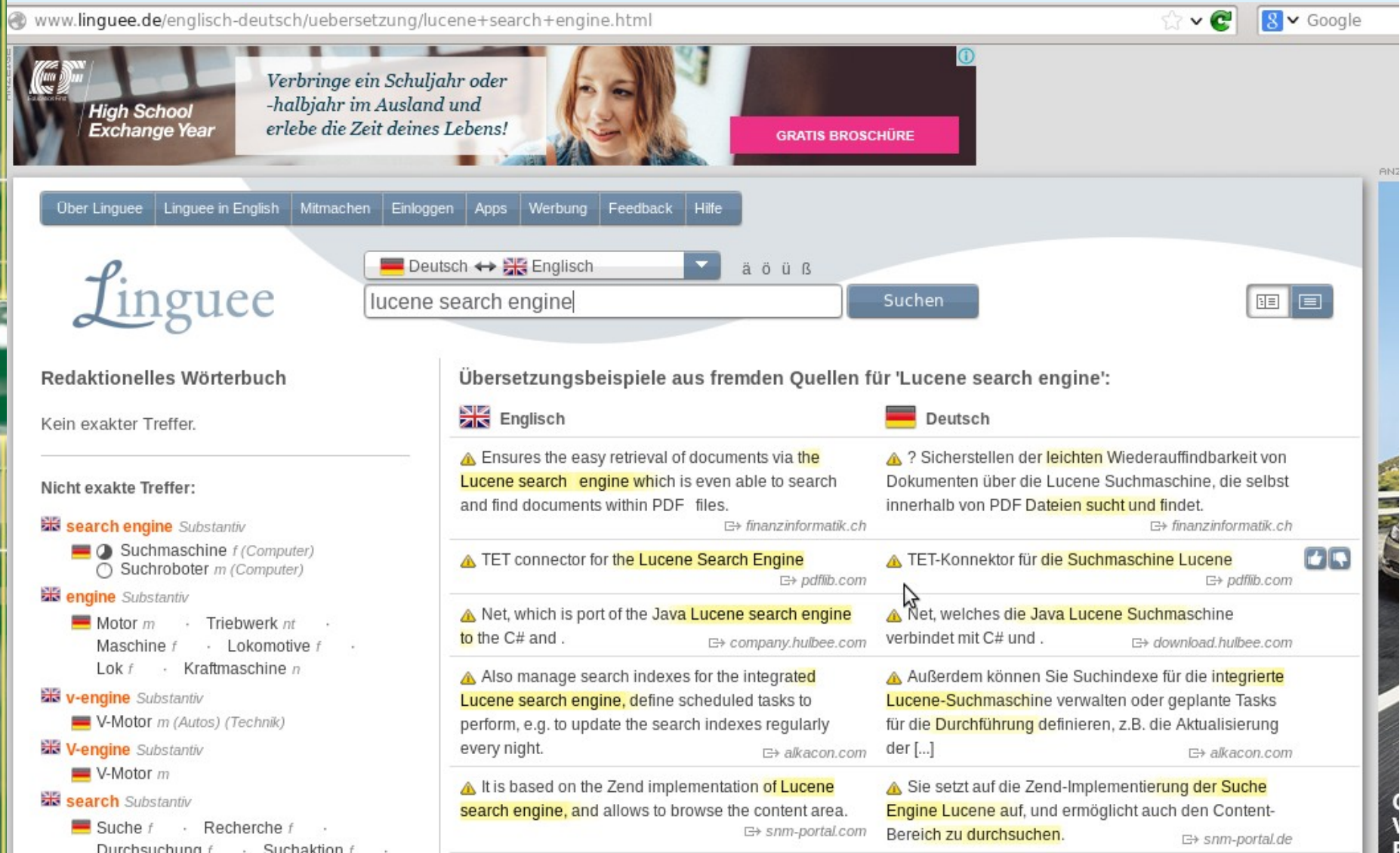
- The search query is processed by a Request Handler:
  - Request Handler calls a query parser
  - Query parser interprets query's term & parameters
  - Input to a query parser can include:
    - Search strings – common terms
    - Parameters for fine tuning, eg. Boolean logic
    - Parameters for controlling the presentation of the query response, eg. Specifying the order in which results are diplayed.
  - Solr supports:
    - Highlighting to relevant terms
    - Snippets → 3-4 lines of texts offering a description of a search result
    - Faceting → arrangement of search results into categories which are based on index terms.

Searching in Solr: Faceting

To see the faceting, access the Velocity sample search UI: http://localhost:8983/solr/browse

Faceting

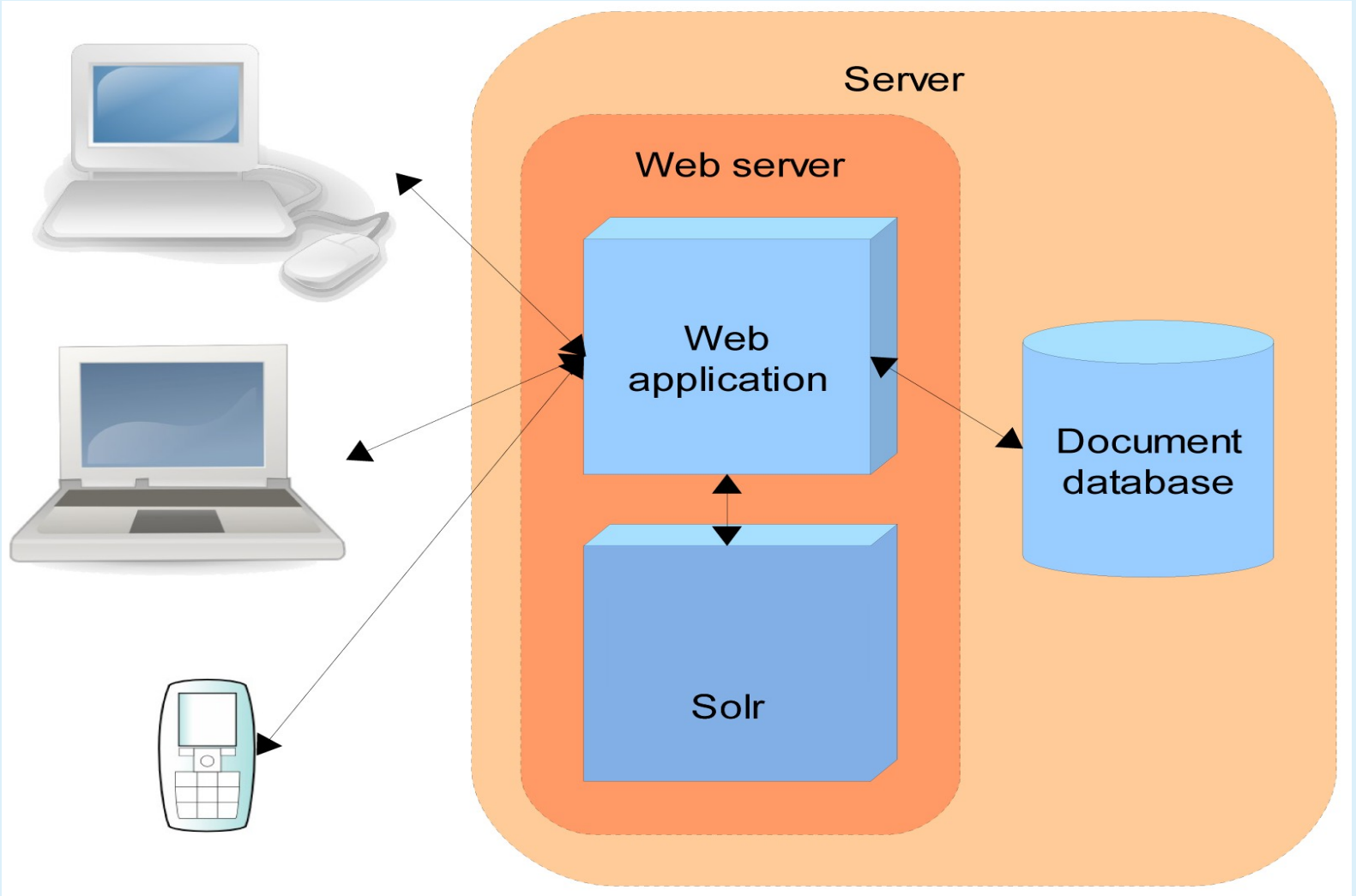
Searching in Solr: Higlighting & Faceting



Searching in Solr

- Searching in Solr can be done by:
  - Sending HTTP Get or Post requests
    - http://localhost:8983/solr/select?q=dell
  - The Query Form provided in the Web Admin
- Sorting:
  - Solr provides a simple method to sort on 1 or more indexed fields.
  - Use the „sort“ parameter:
    - …?q=lcd&sort=price asc
- Higlighting:
  - …?q=lcd&fl=name,price&hl=true&hl.fl=name,price

Solr's Use Case scenario



https://cwiki.apache.org/confluence/display/solr/A+quick+overview

Solr's Use Case Scenario

- Solr runs alongside another application in web serve, eg. an online store application.
- Solr makes it easy to add capability to search through, eg the online store through the following steps:
  - Define schema:
    - The schema tells Solr about the contents of documents it will be indexing:
    - The schema would define fields for: product name, description, price, manufacturer, etc.
  - Deploy Solr to your application server
  - Feed Solr the documents for which your users will search
  - Expose search functionality in your application

Solr Configuration

- Solr is configured using 3 main files:
  1. solr.xml:
     - Specifying configuration options for Solr core
     - Allowing to configure multiple cores
  2. solrconfig.xml:
     - controlling high-level behaviour
     - defining Solr's behaviour as it indexes content and responds to queries
     - Being able to specify an alternate location for the data directory
     - an example of solrconfig.xml can be found in Solr Administration UI, tab Config.

Solr Configuration

- Solr is configured using 3 main files:

  3. schema.xml:
     - Describing the documents indexed by Solr.
     - Defining a document as a collection of fields

Solr Configuration: solr.xml

- The default format → solr/example/solr/solr.xml
- Solr cores are configured by placing a file name *core.properties* in subdirectory under solr.home.
  - Cores maybe anywhere in the tree with an exception that they may not be defined under the existing core.

    This is not allowed:

    ./cores/collection1/core.properties

    ./cores/colection1/coremore/collection2/core.properties

    but this is legal/allowed:

    ./cores/somecores/collection1/core.properties

    ./cores/somecores/collection2/core.properties
  - A minimal *core.properties* file looks like this:

    name=collection1

Solr Configuration: solr.xml

- Solr.xml parameters:
  - The <solr> element:
    - The root element of solr.xml
    - There are no attribute that can be specified in the <solr>
    - Nodes: adminHandler, collectionsHandler, infoHandler, coreLoadThreads, etc (see cwiki.apache.org for node functions)
  - <solrcloud>: defines several paremeters that relate to solrCloud.
  - <logging>: defines classes to use for logging
  - <logging><watcher>: defines the size & threshold of log events
  - <shardHandlerFactory>: costumize share handlers defined in solr.xml

Solr Configuration: solr.xml

- The core.properties file:
  - Is a simple java properties where each line is a key=value pair
  - Use hash(#) or bang (!) characters to specify comment-to-end-of-line.
  - The recognized properties:

    name → specifying the name of the SolrCore

    config → specifying the configuration file name for a given core, default is solrconfig.xml.
  - Schema → specifying schema file name for a given core, default is schema.xml.
  - Datadir → specifying core's data directory as a path relative to the instance dir
  - Properties → specifying the name of properties file for this core. The value can be an absolute pathname to the value of instanceDir.

Configuring Solrconfig.xml

- The solrconfig.xml file is found in solr/conf directory
- In solrconfig.xml, the important features that need to configure are:
  - Request handler
  - Listeners (processes that listen for particular query-related events).
  - The Request Dispatcher for managing HTTP communications
  - The Admin Web interface
  - Parameters related to replication and duplication

Configuring Solrconfig.xml

- Request Handler:
  - Processes requests coming to Solr.
  - The requests might take in the form of queries or index updates.
  - Every request handler is defined with a name and a class.
  - The name of the request handler is referenced with the request to solr, eg. If '/select' is appended to the end, then a query can be made:

    http://localhost:8983/solr/collection1/select?q=solr
  - The primary request handler defined is SearchHandlers.
  - The default solrconfig.xml for request handler looks like:

```
<requestHandler name="/select" class="solr.SearchHandler">
    <lst name="defaults">
        <str name="echoParams">explicit</str>
        <int name="rows">10</int>
     <str name="df">text</str>
    </lst>
 </requestHandler>
```

Configuring Solrconfig.xml

- Request Handler:
  - The default example defines the following parameters:
    - rows → how many search results to return, eg. 10 rows
    - df → the default field to search is 'text' field
    - EchoParams → the parameters defined in the query should be returned when debug information is returned.
  - Other options for SearchHandler besides defaults:
    - appends: allows definition of parameters that are added to user query, eg. We define fq for filter query

```
<lst name="append">
    <str name="fq">inStock:true</str>
</lst>
```

Configuring Solrconfig.xml

- Request Handler:
  - Other options for SearchHandler besides defaults:
    - Invariants: allows definition of parameters that can't be overriden by a client.
      - The values defined in 'invariants' is always used regardless of the values specified by user, client in 'defaults' or in 'appends', eg

```
<lst name="invariants">
  <str name="facet.field">cat</str>
  <str name="facet.query">price:[* to 500]</str>
</lst>
```

Configuring Schema.xml

- **Schema.xml** is usually the first file to configure.
- The schema declares:
  - What kind of fields there are
  - Which fields shoud be us as unique/primary key
  - Which fields are required
  - How to index and search each field
- The most important tags in schema.xml are:
  - <fieldtypes> : Specifying and defining all types of fields
  - <field> : Defining your document structures

Configuring Schema.xml

```
<schema name="example" version="1.5">
  <field name="content" type="text_general" indexed="false" stored="true"
  multiValued="true"/>
  <field name="text" type="text_general" indexed="true" stored="false"
     multiValued="true"/>
   <fieldType name="text_general" class="solr.TextField" positionIncrementGap="100">
      <analyzer type="index">
         <tokenizer class="solr.StandardTokenizerFactory"/>
         <filter class="solr.StopFilterFactory" ignoreCase="true" words="stopwords.txt" />
         <filter class="solr.LowerCaseFilterFactory"/>
       </analyzer>
       <analyzer type="query">
            <tokenizer class="solr.StandardTokenizerFactory"/>
            <filter class="solr.StopFilterFactory" ignoreCase="true" words="stopwords.txt" />
            <filter class="solr.LowerCaseFilterFactory"/>
       </analyzer>
   </fieldType>
</schema>
```

References

- Smiley, D. & Pugh, E. (2011). Apache Solr 3 Enterprise Search Server. Birmingham: Packt Publishing.
- Solr Wiki: http://wiki.apache.org/solr/
- Apache solr Tutorial: https://lucene.apache.org/solr/tutorial.html