A FIRST TOUCH ON NOSQL SERVERS: COUCHDB

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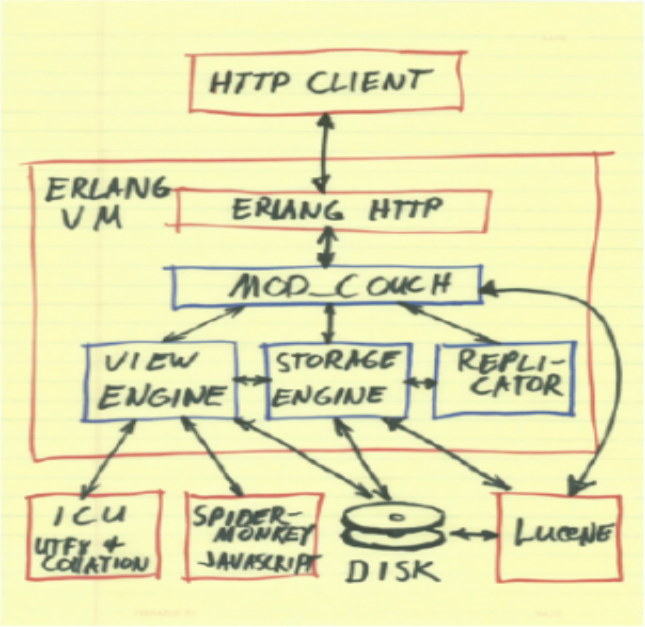
ARCHITECTURE

HTTP
the access protocol

JavaScript
the query language

JSON
the storage format



DOWNLOADS

- For executing these examples download CouchDB:
  - Binary version for windows
  - http://wiki.apache.org/couchdb/Installing_on_Windows
- For communicating with the server we can use a browser or the tool cURL:
  - cURL is a tool for transfering data from the server using different protocols including HTTP
  - http://curl.haxx.se/download.html

COUCHDB (1)

- CouchDB is a document oriented DBMS, *i.e.*, it is not relational:
  - Without database schema
  - Key-value model
  - Distributed and fault tolerant
- Data are modeled as autocontained documents:
  - A document is represented by a JSON structure with attributes of any type
  - Queries are done via JavaScript

COUCHDB (2)

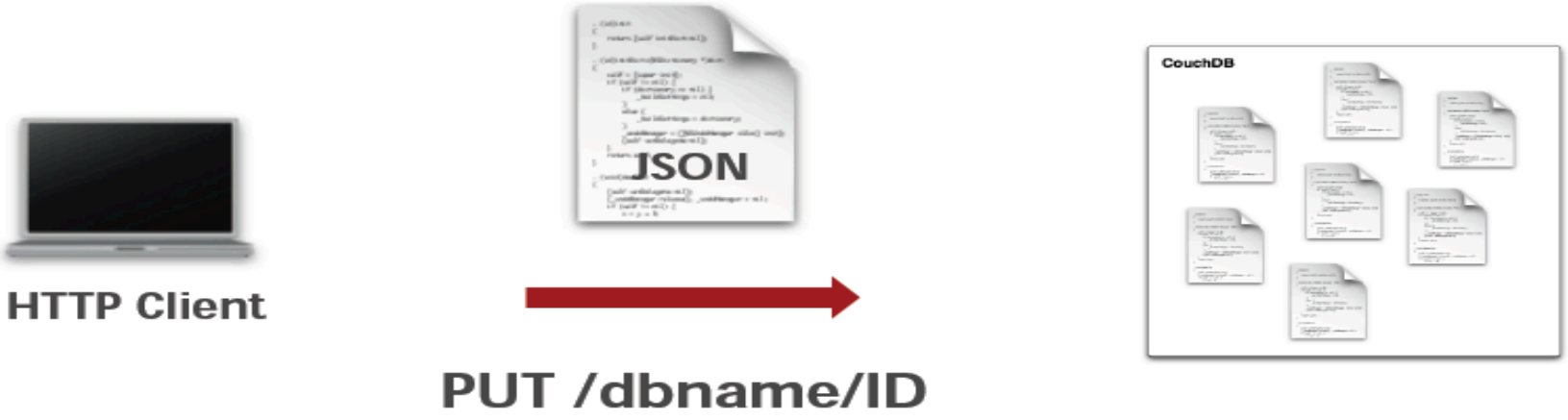
- Different data types are supported as add-in documets (video, audio, images, etc.)
- Communication with applications and users is done via RESTful services:
  - «*Representational State Transfer*» is a software client-server architecture model used for distributed hypermedia systems
  - The communication protocol HTTP:
    - Used the HTTP methods explicitly
    - Stateless
    - Exposes the structure via URIs
    - Data transfered are XML or JSON (for CouchDB)

CLIENT INTERFACE (2)

- `Update` – includes functions for:
  - Updating directly the whole content of the database
  - Executing simple operations such as conecting information to an existing register or decrementing integer values
- `Delete` – includes an explicit command for deleting a pair key-value from the database:
  - Information can have associated invalidity values for indicating when the data must be automatically deleted
  - For example, 60 seconds, 31 December 2012, 12:00 pm

➢ The protocol «*memcached*» must be used for updating or deleting information from the database

INTERACTING WITH COUCHDB



INTERACTING WITH COUCHDB

HTTP Client

GET /dbname/ID

INTERACTING WITH COUCHDB

HTTP Client

DELETE /dbname/ID

CREATING AND RETRIEVING

- Creating the database "albums":

```
curl -X PUT http://localhost:5984/albums
```

- Creating the document "album1":

```
curl -X PUT http://localhost:5984/albums/album1 -d @-
{
    "artista": "Megadeth",
    "titulo": "Endgame",
    "anio": 2009
}
<EOF>    // en Windows es ^z y en Unix ^d
```

- Retrieving the created document:

```
curl -X GET http://localhost:5984/albums/album1
```

UPDATING (I)

- For updating a document:
  - Give the last version
  - Otherwise an error (code 409) will be generated, as shown in the following example:

```
curl -X PUT http://localhost:5984/albums/album1  -d @-
{
   "artista": "Megadeth",
   "titulo": "Endgame",
   "anio": 2010
}
^z
```

UPDATING (2)

- The attribute "_rev" specifies the version that will be updated:

```
curl -X PUT http://localhost:5984/albums/album1  -d @-
{
    "_rev": "1-142438dc8c583cda2a1f292c62291215",
    "artista": "Megadeth",
    "titulo": "Endgame",
    "anio": 2010
}
^z
```

DELETING (1)

- Delete the document "album1":
  - `curl -X DELETE http://localhost:5984/albums/album1?rev=2-d05127b44500ec19a2e5a25adc610380`
- If you try to retrieve it, an error is generated:
  - `curl -X GET http://localhost:5984/albums/album1`
  - `{"error":"not_found","reason":"deleted"}`
- You have access to the version generated by the deletion operation:
  - `curl -X GET http://localhost:5984/albums/album1?rev=3-fac16c94309ed5ff842ffa89cc6048b1`
  - `{"_id":"album1","_rev":"3-fac16c94309ed5ff842ffa89cc6048b1","_deleted":true}`

DELETING (2)

- We purge the document from the database:

```
curl -X POST -H "Content-Type: application/json"  http://localhost:5984/albums/_purge -d @-
{
   "album1": ["3-fac16c94309ed5ff842ffa89cc6048b1"]
}
```

- We try to query the version again:
  - `curl -X GET http://localhost:5984/albums/album1?rev=3-fac16c94309ed5ff842ffa89cc6048b1`
  - `{"error":"not_found","reason":"missing"}`

ATTACHMENTS (1)

- Any binary type can be stored by adding it to a document
- Let us create again "album1":

```
curl -X PUT http://localhost:5984/albums/album1  -d @-
{
   "artista": "Megadeth", "titulo": "Endgame", "anio": 2010
}
```

- The method HTTP PUT is used for attaching a file to the document using the attribute "cover.jpg":

```
curl -X PUT -H 'Content-Type: image/jpg' --data-binary @300px-Endgame_album_art.jpg
http://localhost:5984/albums/album1/cover.jpg?rev="1-8a015dd26403219af66f05542cb540b2"
```

ATTACHMENTS (2)

- On adding an attachment to a document its version number changes:
  - For adding an attachment it is imperative to specify the version number of the document object
  - Whe an attachment is created, the special attribute "_attachments" is created
- The method GET enables the retrieval of the attachment through the corresponding attribute:

```
curl -X GET http://localhost:5984/albums/album1/cover.jpg?rev="2-
31e1ce62601aac5b9de7059788361641" > tmp.jpg
```

DEFINING VIEWS (1)

- Views are based on the working model MapReduce:
  - The keys of the B-tree that stores the view are computed by a map function
  - The values computed by the map function correspond the nodes sheet of the B-tree
  - A node of the B-tree stores the result of a reduce function applied to the values of its children
- Map and reduce function are specified in javascript
- Built-in views are provided
  - `curl -X GET http://localhost:5984/albums/_all_docs`

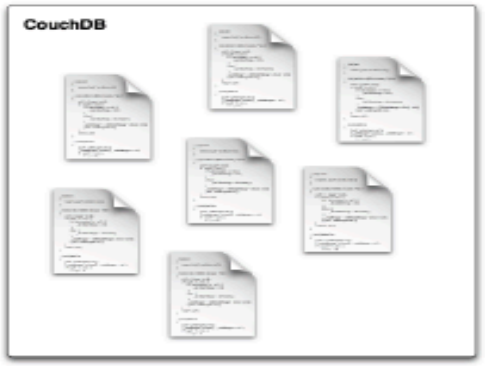
EXAMPLE: DEFINING A VIEW

```
curl -X PUT http://localhost:5984/albums/_design/vistas1 -d @-
      {
          "language": "javascript",
          "views": {
              "por_anio": {
                  "map": "function( doc ) { if( doc.anio ) { emit( doc.anio, 1 );}}",
                  "reduce": "function( keys, values, rereduce ) {return sum( values );}"
              }
          }
      }
```

QUERYING A VIEW

GET /dbname/_design/hats/_view/all?
include_docs=true

HTTP Client



EXAMPLE: USING A VIEW

- Reduce values retrieved without considering the keys:
  - `curl http://localhost:5984/albums/_design/vistas1/_view/por_anio`
  - `curl -X GET http://localhost:5984/albums/_design/vistas1/_view/por_anio`
- Reduce the values retrieved considering the values of the different keys:
  - `curl http://localhost:5984/albums/_design/vistas1/_view/por_anio?group=true`

MANAGEMENT TOOLS

- **Web management console** : complete interface for configuring , managing and monitoring a CouchDB instalation
- REST **API**: management interface exported under a REST HTTP protocol
- **Command interface**: tools providing information and control of a CouchDB instalation
  - Use the REST API
  - Can be used with scripts and management proceedures (*failover*, *backups*)

USING COUCHDB WITH JAVA (1)

- There are several projects that enable the use of CouchDB with Java
- Visit the following links:
  - CouchDB4Java (http://github.com/mbreese/couchdb4j)
  - JRelax (https://github.com/isterin/jrelax/wiki)

USING COUCHDB WITH JAVA (2)

- CouchDB4Java is easy to use, you only have to download the application and integrate the JARs located in the folder lib

- Java code for connecting an application:

```
public static void main( String [] args ) throws Exception {
Session s = new Session( "localhost", 5984 );
Database db = s.getDatabase( "albums" );
Document newdoc = new Document();
newdoc.put( "artista", "Megadeth" );
newdoc.put( "titulo", "Endgame" );
newdoc.put( "anio", 2010 );
db.saveDocument( newdoc, "album1" );
}
```

USING COUCHDB WITH JAVA (3)

JRelax

- For this case you have to download the project and its dependencies:
  - Restlet 2.0 (http://www.restlet.org/)
  - Jackson (JSON process - http://jackson.codehaus.org/)
- Particularly the following JARs:
  - `org.json.jar`
  - `jackson-all-1.6.2.jar`
  - `org.restlet.jar`
  - `org.restlet.ext.json.jar`

USING COUCHDB WITH JAVA (4)

Java code for connecting a JRelax application

```
public static void main( String[] args ) {
        ResourceManager resourceMgr = new
            DefaultResourceManager( "http://localhost:5984" );
        List<String> dbs = resourceMgr.listDatabases();
        for( String db : dbs ) {
            System.out.println( db );
        }
        Document doc = resourceMgr.getDocument( "albums", "album1" );
        System.out.println( doc.asJson() );
          }
```

EXAMPLE: ALBUM DB

Adding more documents to the Albums database

```
curl -X PUT http://localhost:5984/albums/album4 -d @-
{
    "artista": "Pantera",
    "titulo": "Reinventing the Steel",
    "anio": 2009
}

curl -X PUT http://localhost:5984/albums/album5 -d @-
{
    "artista": "Slayer",
    "titulo": "South of Heaven",
    "anio": 2009
}
```

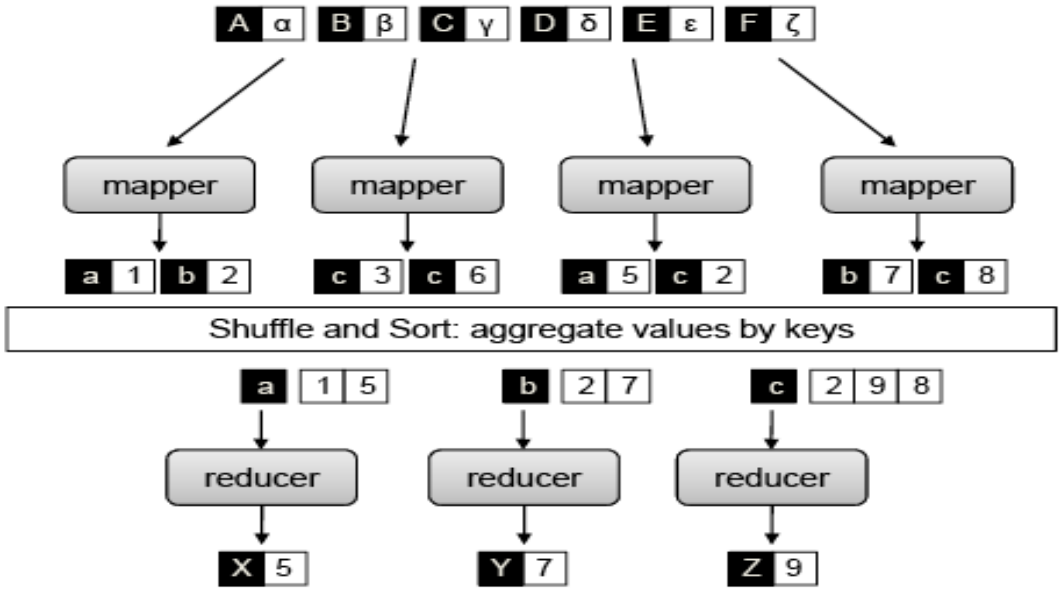
MAP-REDUCE PRINCIPLE

$$\text{map: } (k_1, v_1) \longrightarrow [(k_2, v_2)]$$
$$\text{reduce: } (k_2, [v_2]) \longrightarrow [(k_3, v_3)]$$

- **Stage 1**: Apply a user-specified computation over all input records in a dataset.
  - These operations occur in parallel and yield intermediate output (**key-value** pairs)
- **Stage 2**: Aggregate intermediate output by another user-specified computation
  - Recursively applies a function on every pair of the list

MAP REDUCE EXAMPLE

Count the number of occurrences of every word in a text collection



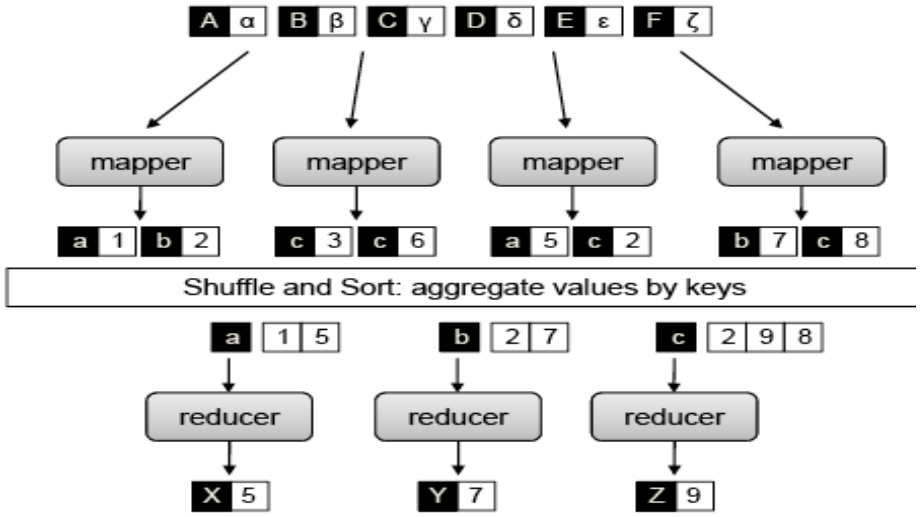
KEY-VALUE PAIRS

- Basic data structure in MapReduce, keys and values may be
  - primitive such as integers, floating point values, strings, and raw bytes
  - arbitrarily complex structures (lists, tuples, associative arrays, etc.)
- Part of the design of MapReduce algorithms involves imposing the key-value structure on arbitrary datasets
  - For a collection of web pages, keys may be URLs and values may be the actual HTML content.
  - For a graph, keys may represent node ids and values may contain the adjacency lists of those nodes

HOW DOES A MAP REDUCE JOB WORK?

- MapReduce job starts as data stored on the underlying distributed file system
- The mapper
  - is applied to every input key-value pair (split across an arbitrary number of files)
  - to generate an arbitrary number of intermediate key-value pairs.
- The reducer
  - is applied to all values associated with the same intermediate key
  - to generate output key-value pairs
- Intermediate data arrive at each reducer in order, sorted by the key: "group by" operation on intermediate keys
- Output key-value pairs from each reducer are written persistently back onto the distributed file system (intermediate key-value pairs are transient and not preserved)

MAP REDUCE EXAMPLE



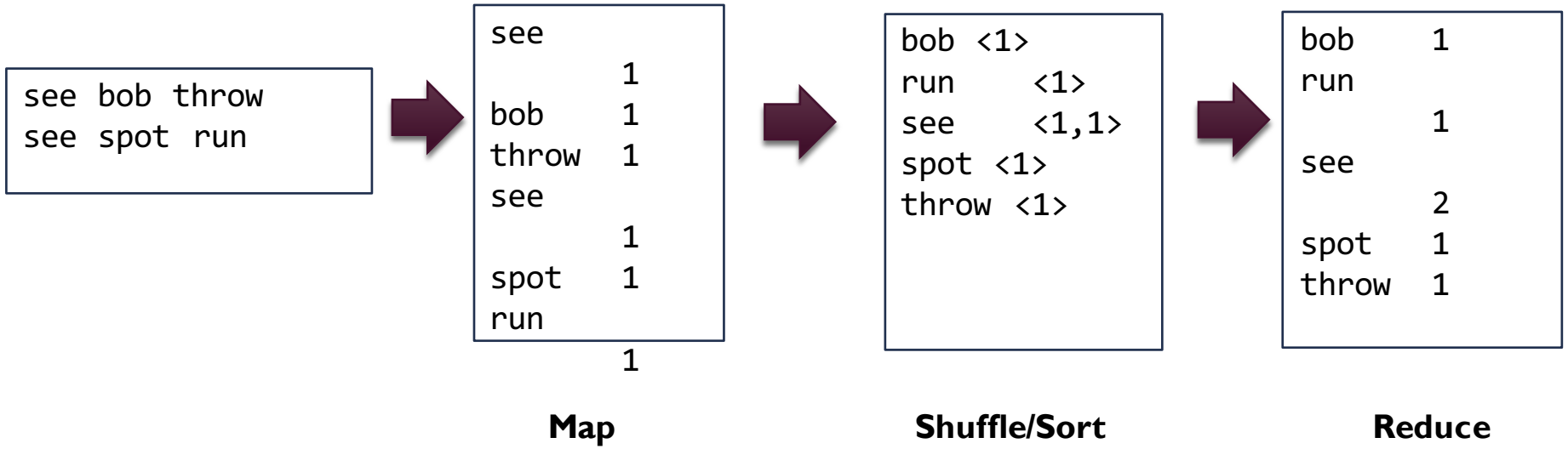

```
1: class Mapper
2:     method Map(docid a, doc d)
3:         for all term t ∈ doc d do
4:             Emit(term t, count 1)

1: class Reducer
2:     method Reduce(term t, counts [c1, c2, ...])
3:         sum ← 0
4:         for all count c ∈ counts [c1, c2, ...] do
5:             sum ← sum + c
6:         Emit(term t, count sum)
```

MAP REDUCE EXAMPLE

- Input key-values pairs take the form of (docid, doc) pairs stored on the distributed file system,
  - the former is a unique identifier for the document
  - the latter is the text of the document itself
- The **mapper** takes an input key-value pair, tokenizes the document, and emits an intermediate key-value pair for every word:
  - the word itself serves as the key, and the integer one serves as the value (denoting that we've seen the word once)
  - the MapReduce execution framework guarantees that all values associated with the same key are brought together in the reducer
- The reducer sums up all counts (ones) associated with each word
  - emits final key- value pairs with the word as the key, and the count as the value.
  - output is written to the distributed file system, one file per reducer

COUNTING WORDS

(URI, document) → (term, count)



HAND ON…