Get to know CouchDB

Why i made this talk

My struggle:

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Let me tell you how it works in ~40 Minutes!

Agenda

- What is CouchDB?
- Simple usage
  - Databases, Documents, CRUD
- How CouchDB works
  - B-tree, ranges, pagination
- Advanced usage
  - Views, Grouping
- Extended topics
  - More fancy stuff if time left...

About Me

Julius Beckmann

Silpion IT-Solutions

- PHP / Symfony2
- Erlang / Elixir
- NodeJS
- Continuous Everything!

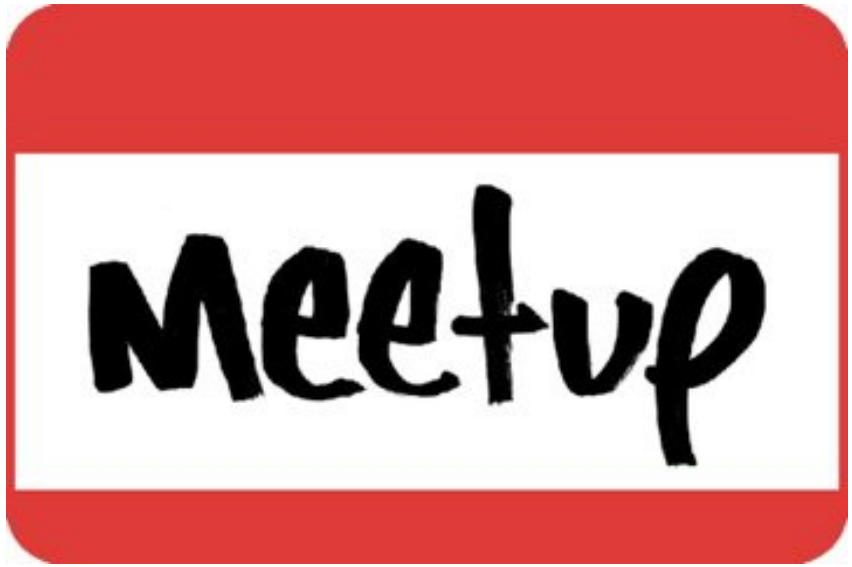
What is CouchDB?

What is CouchDB?

- **C**luster **O**f **U**nreliable **C**ommodity **H**ardware **DB**
- Started 2005 by @damienkatz at Lotus Notes.
- Since 2008 Apache Project.
- Open Source: Apache Software license 2.0.

- RESTful HTTP as Interface.
- Schemaless JSON documents.
- Written in Erlang.
- Version 1.6 is current.
- Version 2.0 with *real clustering* on the way!

CouchDB Meetup Hamburg



www.meetup.com/CouchDB-Meetup-Hamburg

Organized by

- Robert Kowalski @robinson_k
- Andreas Wenk @awenkhh
- Klaus Trainer @KlausTrainer

Installation

Webinterface: http://localhost:5984/_utils/.

Debian/Ubuntu

```
apt-get install couchdb
```

http://wiki.ubuntuusers.de/couchdb

Docker image

Using this Image: klaemo/docker-couchdb

- `docker pull klaemo/couchdb:latest`
- `docker run -d -p 5984:5984 --name couchdb klaemo/couchdb`

Stop and start container:

- `docker stop couchdb`
- `docker start couchdb`

Simple usage

Say hello to CouchDB

```
$ curl -X GET http://localhost:5984/
```

```
{
  "couchdb":"Welcome",
  "uuid":"460a0cc31a109fe7cdcdd17f2109e515",
  "version":"1.6.1",
  "vendor":{
    "version":"1.6.1",
    "name":"The Apache Software Foundation"
  }
}
```

List Databases

```
$ curl -X GET http://localhost:5984/_all_dbs
```

```
[
  "_replicator",
  "_users"
]
```

Database and Documents

1. What is a Database
2. What is a Document
3. CRUD for Documents
4. CRUD for Attachments

1. What is a Database

- Single container = No tables.
- Permissions granted on database level by CouchDB.

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- Permissions granted on database level by CouchDB.

Create Database

```
$ curl -X PUT http://localhost:5984/my_database


{"ok":true}
```

1. What is a Database

- Single container = No tables.
- Permissions granted on database level by CouchDB.

Create Database

```
$ curl -X PUT http://localhost:5984/my_database

{"ok":true}
```

Remove Database

```
$ curl -X DELETE http://localhost:5984/my_database

{"ok":true}
```

Database Metadata

```
$ curl -X GET http://localhost:5984/my_database
```


```
{
  "db_name":"my_database",
  "doc_count":0,
  "doc_del_count":0,
  "update_seq":0,
  "purge_seq":0,
  "compact_running":false,
  "disk_size":79,
  "data_size":0,
  "instance_start_time":"1441012193869017",
  "disk_format_version":6,
  "committed_update_seq":0
}
```

2. What are Documents

- JSON-Format.
- Unicode charset.
- Schemaless structure.
- Underscore prefix is reserved for first level keys:
  - `_id`
  - `_rev`
  - `_attachments`
  - `_deleted`

Creating a Document

```
// test.json
{
  "hello":"world",
  "age":42,
  "tags":["couchdb", "is", "cool"]
}
```

Creating a Document

```
// test.json
{
  "hello":"world",
  "age":42,
  "tags":["couchdb", "is", "cool"]
}
```

```
$ curl -X POST http://localhost:5984/my_database
    -H "Content-Type: application/json"
    --data-binary @test.json
```

```
{
  "ok":true,
  "id":"22d26e752e31bd1572f1d20d94000c47",
  "rev":"1-ff73263039516726e7917f24111c80ec"
}
```

CouchDB IDs

- By default UUIDs.
- Must be unicode **string**.
- Will be part of URL.
- Can be choosen for each document.

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```
$ curl -X PUT http://localhost:5984/my_database/hello-world
    -H "Content-Type: application/json"
    --data-binary @test.json
```

```
{
  "ok":true,
  "id":"hello-world",
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```

CouchDB Revisions

- *Multi-Version Concurrency Control*.
- ‘Strictly monotonic ascending’.
- Revision of document.

CouchDB Revisions

- *Multi-Version Concurrency Control*.
- 'Strictly monotonic ascending'.
- Revision of document.

- Optimistic locking => lock-free access.
- Needed for replication.
- Initial `i = 1`.

```
rev = i + "-" + md5(body,attachments,deleted)


"1-ff73263039516726e7917f24111c80ec"
```

Fetching a Document

*Skipping **http://localhost:5984** in url from now on...*

```
$ curl -X GET /my_database/hello-world
```

```
{
  "_id":"hello-world",
  "_rev":"1-ff73263039516726e7917f24111c80ec",
  "hello":"world",
  "age":42,
  "tags":["couchdb", "is", "cool"]
}
```

Updating a Document

```
// test_update.json
{
  "hello":"world!",
  "age":43,
  "tags":["couchdb", "is", "cooler"]
}
```

Updating a Document

```
// test_update.json
{
  "hello":"world!",
  "age":43,
  "tags":["couchdb", "is", "cooler"]
}
```

```
$ curl -X PUT /my_database/hello-world?rev=1-ff732630...
    -H "Content-Type: application/json"
    --data-binary @test_update.json
```

```
{
  "ok":true,
  "id":"hello-world",
  "rev":"2-b9f6bbfa08e0f6a8cf3d0dcd4c153fc7"
}
```

Deleting a Document

```
$ curl -X DELETE /my_database/hello-world?rev=2-b9f6bbfa...
```

```
{
  "ok":true,
  "id":"hello-world",
  "rev":"3-e4f06ea31419b24495c94bcd952777b6"
}
```

Deleting a Document

```
$ curl -X DELETE /my_database/hello-world?rev=2-b9f6bbfa...
```

```
{
  "ok":true,
  "id":"hello-world",
  "rev":"3-e4f06ea31419b24495c94bcd952777b6"
}
```

```
$ curl -X GET http://localhost:5984/my_database/hello-world
{"error":"not_found","reason":"deleted"}
```

- Document attribute `_deleted: true`
- *OLD* revisions still there till ***compact***:

```
$ curl -X GET /my_database/hello-world?rev=2-b9f6bbfa...
```

Attachments

- Files attached to documents
- Binary data of any kind: Images, PDF, Mails ...

API

- **PUT** /products/apple-macbook-air/preview.jpg?rev=XXX
- **GET** /products/apple-macbook-air/preview.jpg
- **DELETE** /products/apple-macbook-air/preview.jpg?rev=XXX

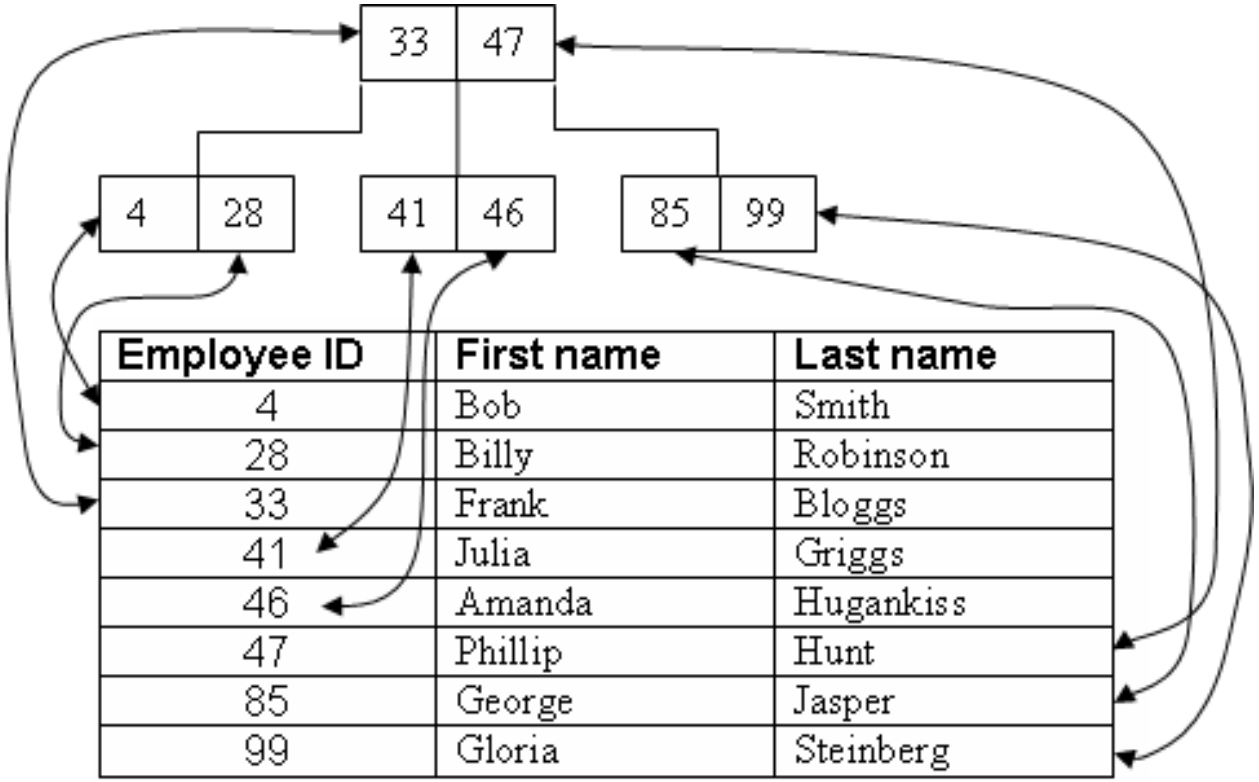
Insights we learned:

1. Documents have `_id`'s and `_rev`'s.
2. Update/Delete needs latest `_rev`.
3. Optimistic locking via `_rev`.
4. Update **replaces** document.
5. Binary attachments.

How CouchDB works

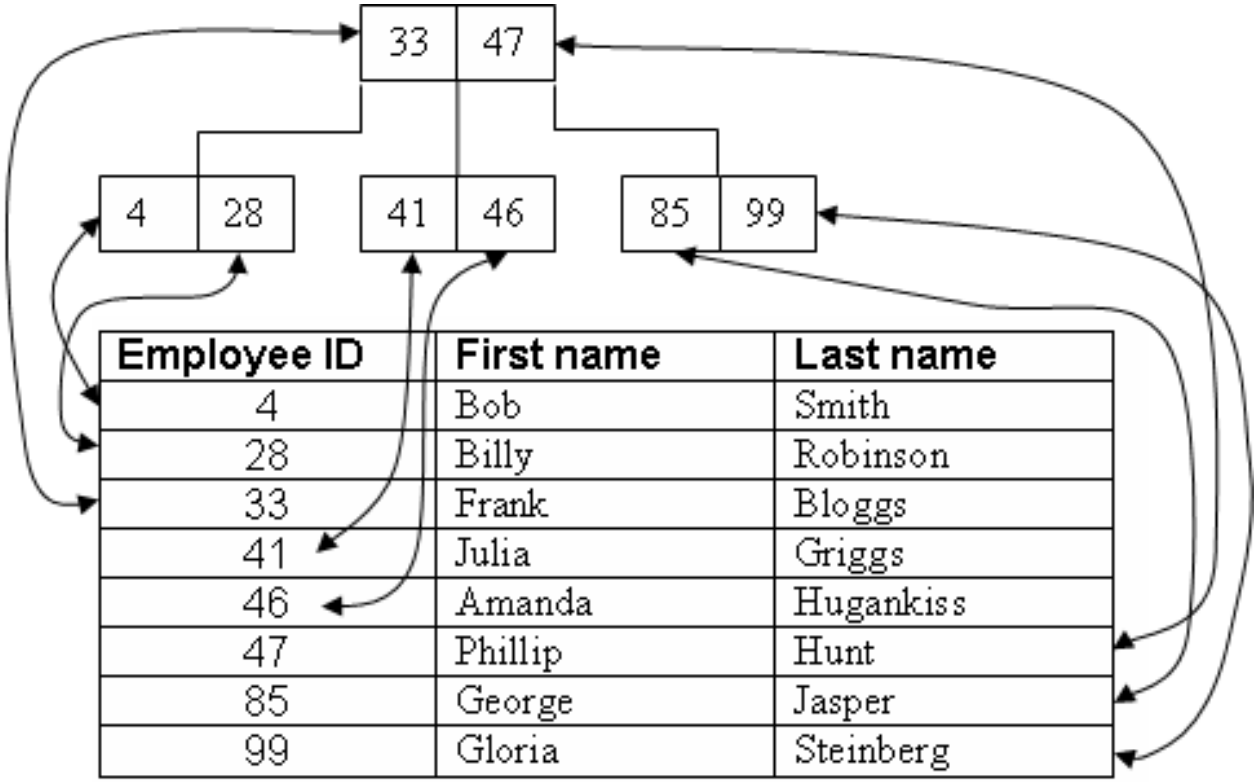
Databases use Trees to be efficient

Databases use Trees to be efficient



Employee ID	First name	Last name
4	Bob	Smith
28	Billy	Robinson
33	Frank	Bloggs
41	Julia	Griggs
46	Amanda	Hugankiss
47	Phillip	Hunt
85	George	Jasper
99	Gloria	Steinberg

Databases use Trees to be efficient



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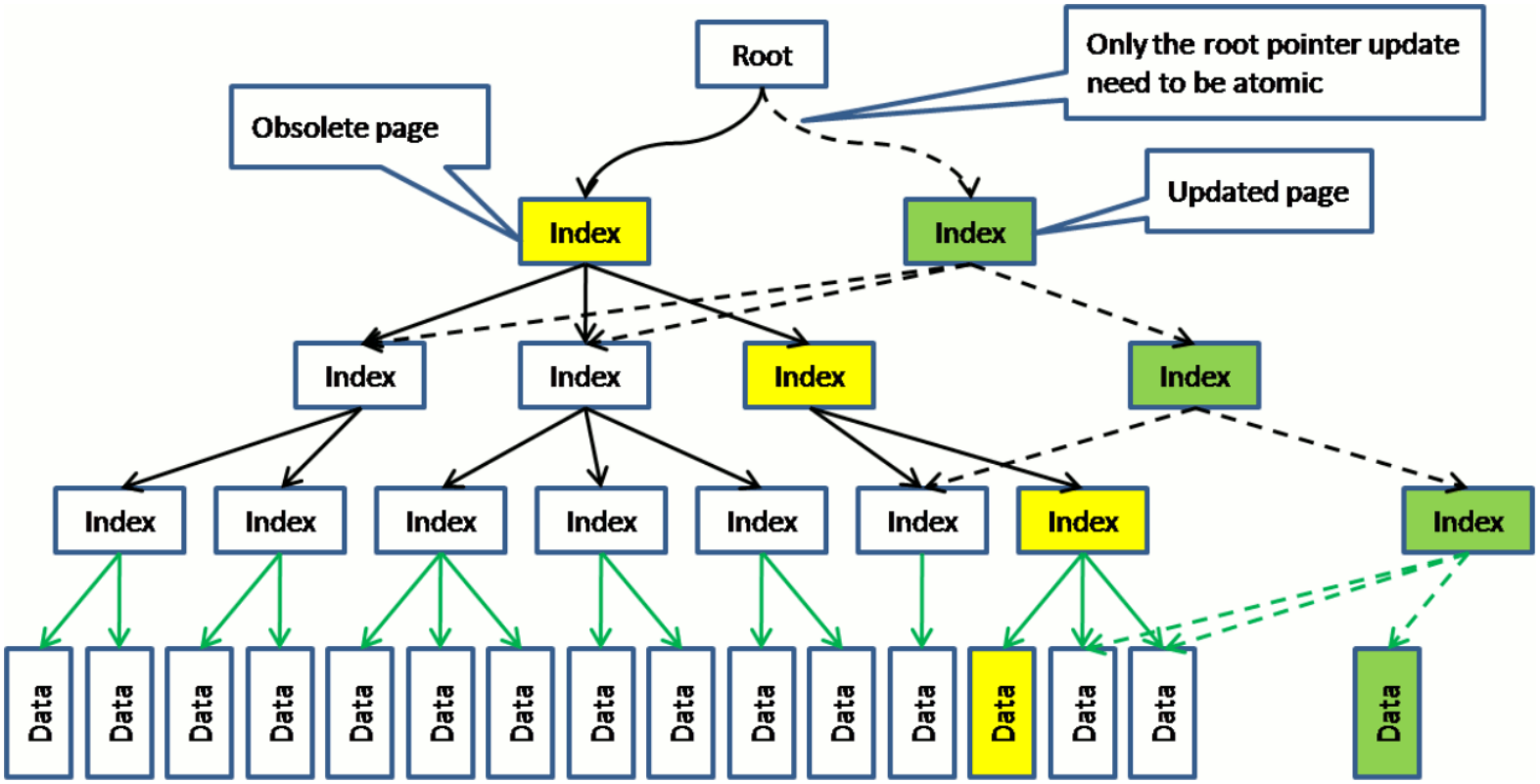
CouchDB is using a B+ Tree

Understanding the B-Tree



- Using B-Tree to access documents.
- Efficient low tree structure.

Ordering Document IDs

IDs are unicode *strings*!

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There is a order defined by their binary value:

- A = U0041 to Z = U005A
- First: U0000 - Last: UFFFF

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There is a order defined by their binary value:

- A = U0041 to Z = U005A
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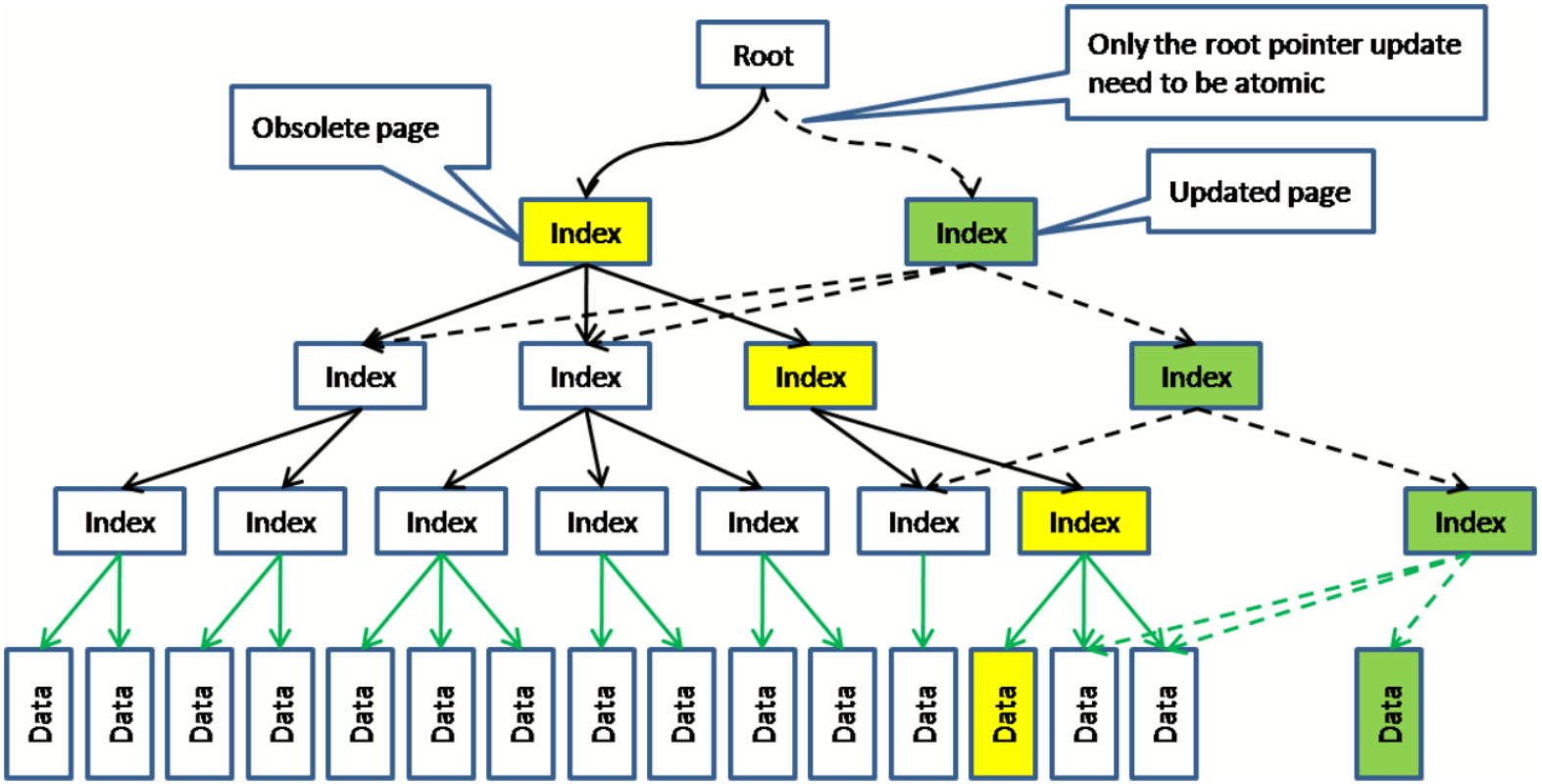
IDs are held in *index* of Tree, not in *data*.

=> **Range iteration** possible.

Understanding the B-Tree



- From U0000 on the *left*
- To UFFFF on the *right*

Usefull IDs

Documents

```
{ "_id": "lenovo-thinkpad-t440", ... }
{ "_id": "lenovo-edge-e130", ... }
{ "_id": "apple-macbook-2013", ... }
{ "_id": "apple-macbook-pro-2015", ... }
```

Usefull IDs

Documents

```
{ "_id": "lenovo-thinkpad-t440", ... }
{ "_id": "lenovo-edge-e130", ... }
{ "_id": "apple-macbook-2013", ... }
{ "_id": "apple-macbook-pro-2015", ... }
```

"Query" all apple products

```
$ curl '/products/_all_docs?startkey="apple-"\
                           &endkey="apple-\\uffff"'
```

- `_all_docs` is the resource of the *whole B-Tree* of the database.

CouchDB is a restfull HTTP API for B+ Trees!

Typical CouchDB IDs

- user-alice, user-bob
- product-apple-macbook-2013, product-lenovo-thinkpad-t440
- order-user-alice-20150102, order-user-bob-20141212

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- user-alice, user-bob
- product-apple-macbook-2013, product-lenovo-thinkpad-t440
- order-user-alice-20150102, order-user-bob-20141212

All users

```
$ curl '/my_database/_all_docs?startkey="user-"\
                              &endkey="user-\\uffff"'
```

Typical CouchDB IDs

- user-alice, user-bob
- product-apple-macbook-2013, product-lenovo-thinkpad-t440
- order-user-alice-20150102, order-user-bob-20141212

All users

```
$ curl '/my_database/_all_docs?startkey="user-"\
                              &endkey="user-\\uffff"'
```

All products by lenovo

```
$ curl '/my_database/_all_docs?startkey="product-lenovo-"\
                              &endkey="product-lenovo-\\uffff"'
```

Typical CouchDB IDs

- user-alice, user-bob
- product-apple-macbook-2013, product-lenovo-thinkpad-t440
- order-user-alice-20150102, order-user-bob-20141212

All users

```
$ curl '/my_database/_all_docs?startkey="user-"\
                              &endkey="user-\\uffff"'
```

All products by lenovo

```
$ curl '/my_database/_all_docs?startkey="product-lenovo-"\
                              &endkey="product-lenovo-\\uffff"'
```

All orders by bob in 2014

```
$ curl '/my_database/_all_docs?startkey="order-user-bob-2014"\
                              &endkey="order-user-bob-2014\\ufff
```

Pagination using Keys

Simple pagination

```
$ curl '/my_database/_all_docs?limit=10&skip=0'
$ curl '/my_database/_all_docs?limit=10&skip=10'
```

Pagination using Keys

Simple pagination

```
$ curl '/my_database/_all_docs?limit=10&skip=0'
$ curl '/my_database/_all_docs?limit=10&skip=10'
```

Paginate user documents

```
# First page:
$ curl '/my_database/_all_docs?startkey="user-"\
                  &endkey="user-\\uffff"&limit=10'

# Second page via `skip`:
$ curl '/my_database/_all_docs?startkey="user-"\
                  &endkey="user-\\uffff"&limit=10&skip=10'

# Second page via `startkey_docid`:
$ curl '/my_database/_all_docs?startkey_docid=user-alice\
                  &endkey="user-\\uffff"&limit=10'
```

Fetching multiple keys at once

```
// keys.json
{
   "keys" : [
      "user-alice",
      "order-user-alice-20150102"
   ]
}
```

```
$ curl -X POST /my_database/_all_docs
    -H "Content-Type: application/json"
    --data-binary @keys.json
```

Insights we learned:

1. Restfull HTTP API to B+ Tree.
2. Meaningfull IDs instead of UUIDs.
3. IDs can determine `type` of a document.
4. Iteration over IDs is usefull.
5. Combination of keys is very usefull.
6. Dates in IDs can be handy.

But this is not enough to work with ...

We need:

queries!

grouping!

database logic!

Advanced usage

Querys **always** need a Index
and a Index is a Tree.

Querys **always** need a Index
and a Index is a Tree.

We have build that index ourself.

Views

Create our own Index

CouchDB offers **Map**-Reduce to create indexes.

Map function

```
function(doc) {
    //   key        value
    emit(doc.age, doc.hello);
}
```

Result

- Key: 42, Value: "world"
- Key: 43, Value: "world!"

Create our own Index

CouchDB offers Map-**Reduce** to create indexes.

Reduce function

```
function (key, values, rereduce) {
    return values.join(',');
}
```

Result

- "world,world!"

Create our own Index

Map Functions:

- Each map function called *once* for any changed doc
- Define key and value of index
- Convert data to needed format
- Filter documents
- Create multiple entries from one doc

Reduce Functions:

- Will be called on collection of mapped entries
- Included functions: `_sum`, `_count`, `_stats`
- *Summarizes* mapped data

Example: Query for Tags

Map function:

```
function(doc) {
    doc.tags.forEach(function(tag) {
        emit(tag, doc._id);
    });
}
```

Result:

```
"cool": "22d26e752e31bd1572f1d20d94000c47"
"cooler": "hello-world",
"couchdb": "22d26e752e31bd1572f1d20d94000c47"
"couchdb": "hello-world"
"is": "22d26e752e31bd1572f1d20d94000c47"
"is": "hello-world"
```

Example: Query for Tags

Reduce function:

```
_count
```

Result with reduce:

```
"cool": 1
"cooler": 1
"couchdb": 2
"is": 2
```

Example: Index date ranges

Example for flexibility of CouchDB views

Map function:

```
function(doc) {

    var dates = date_range(doc.start, doc.end);
    // ['2015-04-01', '2015-04-02', '2015-04-03', ...]

    dates.forEach(function(date) {
        emit(date, doc._id);
    });
}
```

- Index will contain data, that not existed in doc!

Design Documents

Design Documents

- JSON document
- Collection of javascript code
  - for views
  - for callbacks
- Container for “application code”
- Multiple Design Documents common
  - for `users`
  - for `products`
  - …
- *Short:* ***DDoc***

Design Documents

```
{
  "_id":"_design/tags",
  "_rev":"1-753abddc330704992762 77bd90decabd",
  "language":"javascript",
  "views":{
    "by-tag":{
      "map":"function(doc) {
                doc.tags.forEach(function(tag) {
                    emit(tag, doc._id);
                });
            }",
      "reduce":"_count"
    }
  }
}
```

Query View

Access the *by-tags* view from ddoc *tags*:

```
$ curl -X GET '/my_database/_design/tags/_view/by-tag'
```

Query View

Access the *by-tags* view from ddoc *tags*:

```
$ curl -X GET '/my_database/_design/tags/_view/by-tag'
```

```
{
  "rows":[
    {
      "key": null,
      "value": 6
    }
  ]
}
```

Whats that? - Ahh, its reduced ...

Query View Reduce Flag

```
$ curl -X GET '/my_database/_design/tags/_view/by-tag\
                ?reduce=false'
```

```
{
  "offset": 0,
  "total_rows": 6,
  "rows":[
    {
      "id":"22d26e752e31bd1572f1d20d94000c47",
      "key":"cool",
      "value":"22d26e752e31bd1572f1d20d94000c47"
    },
    {
      "id":"hello-world",
      "key":"cooler",
      "value":"hello-world"
    },
    ...
  ]
```

Query View Group Level

```
$ curl -X GET '/my_database/_design/tags/_view/by-tag\
               ?group_level=0'
```

```
{
  "rows":[
    {
      "key": null,
      "value": 6
    }
  ]
}
```

The same as the **first request**.

Default is `?group_level=0`
and `reduce=true` if reduce function exists.

Query View Group Level

```
$ curl -X GET '/my_database/_design/tags/_view/by-tag\
                ?group_level=1'
```

```
{
  "rows":[
    {
      "key":"cool",
      "value":1
    },
    {
      "key":"couchdb",
      "value":2
    },
    ...
  ]
}
```

Query View by Key

```
$ curl -X GET '/my_database/_design/tags/_view/by-tag\
                ?key="couchdb"&reduce=false'
```

```
{
  "offset": 2,
  "total_rows": 6,
  "rows":[
    {
      "id":"22d26e752e31bd1572f1d20d94000c47",
      "key":"couchdb",
      "value":"22d26e752e31bd1572f1d20d94000c47"
    },
    {
      "id":"hello-world",
      "key":"couchdb",
      "value":"hello-world"
    }
  ]
}
```

Insights we learned:

1. Views instead of Queries.
2. Views programmed with **map-reduce**.
3. Each view is a own accessable Index.
4. Code for views inside a Design-Document.
5. No abitrary `WHERE this=$that AND ...`.

Extended Topics

Document ‘type’

Different documents in same database

- Using prefix for `id`
- Having `type` field

Simply using both:

```
{
  "_id":"user-alice",    // for _all_docs
  "_rev":"1-753abddc33070499276277bd90decabd",
  "type": "user",        // for views
  "name": "Alice"
}
```

Design Documents

- Can contain multiple views and other functions.
- callbacks:
  - views
  - filters
  - lists
  - rewrites
  - shows
  - updates
  - validate_doc_update
- In Javascript, Ruby, Python, Perl, Lisp, Erlang, ...
- Changing DDoc = rebuilding views.
- Building views costs time!

Changes feed

- Like twitter for your database, with less drama.
- Easy notification system.

```
$ curl /my_database/_changes?since=5
```

```
{
  "last_seq":6,
  "results":[
    {
      "changes":[{
          "rev":"3-e4f06ea31419b24495c94bcd952777b6"
      }],
      "deleted":true,
      "id":"hello-world",
      "seq":6
    }
  ]
}
```

Replication

Replication

CouchDB can **replicate DB** from other CouchDB via HTTP API.

- `1` Master - `n` Slaves
- `n` Master
- ...
- Slaves of Slaves possible
- *"Automatic conflict handling"* ...

CAP

For CouchDB in *Multi-Master cluster* Setup.

CAP

- Partition Tolerance: YES
- Availability: YES
- Consistency: Eventual

Pick Two

- CA: **MySQL**, Postgres, RDBMS
- CP: **MongoDB**, Google BigTable
- AP: **CouchDB**, Cassandra

Tipps

- CouchDB fits best for Read >> Write.

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- Use HTTP correctly (ETag, ...)

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- Create new docs instead of updating.
- Need to design to avoid conflicts.
- Design for your access pattern.

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- Reduce function `_sum` and `_count` are really cheap.

Administration

- Lots of disk space because of appending file format.
- Compaction of database/views.
  - Rewriting whole file.
  - Removing old `_rev`'s.
- Can be done automatically:
  - wiki.apache.org/couchdb/Compaction

Further Topics to explore

- Clustering
  - via HTTP Replication
  - Master-Slave
  - Master-Master
- Browser Local Storage
  - PouchDB
  - Syncing Browser of offline Apps
- Empowering HTTP
  - Proxy
  - Caching (Etag, ...)
- Fulltext search
  - River to Elasticsearch
  - Push to Lucene

Links

- couchdb.apache.org
- wiki.apache.org/couchdb
- guide.couchdb.org
- http://docs.ehealthafrica.org/couchdb-best-practices/

Other talks

- https://speakerdeck.com/renatosnrg/couchdb
- https://speakerdeck.com/dzuelke/an-introduction-to-couchdb-ipc2011se-2011-06-01

The End - Thanks!