RICE®

Web Development

COMP 431 / COMP 531

Databases

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March 24, 2016

Part II – Back End Development

- Homework Assignment 6 (Draft Back-End)
  - Due TONIGHT 3/24

Part II

~~Web Servers~~
~~Backend Architecture~~
~~Unit Testing~~
~~Web Hosting~~
Databases

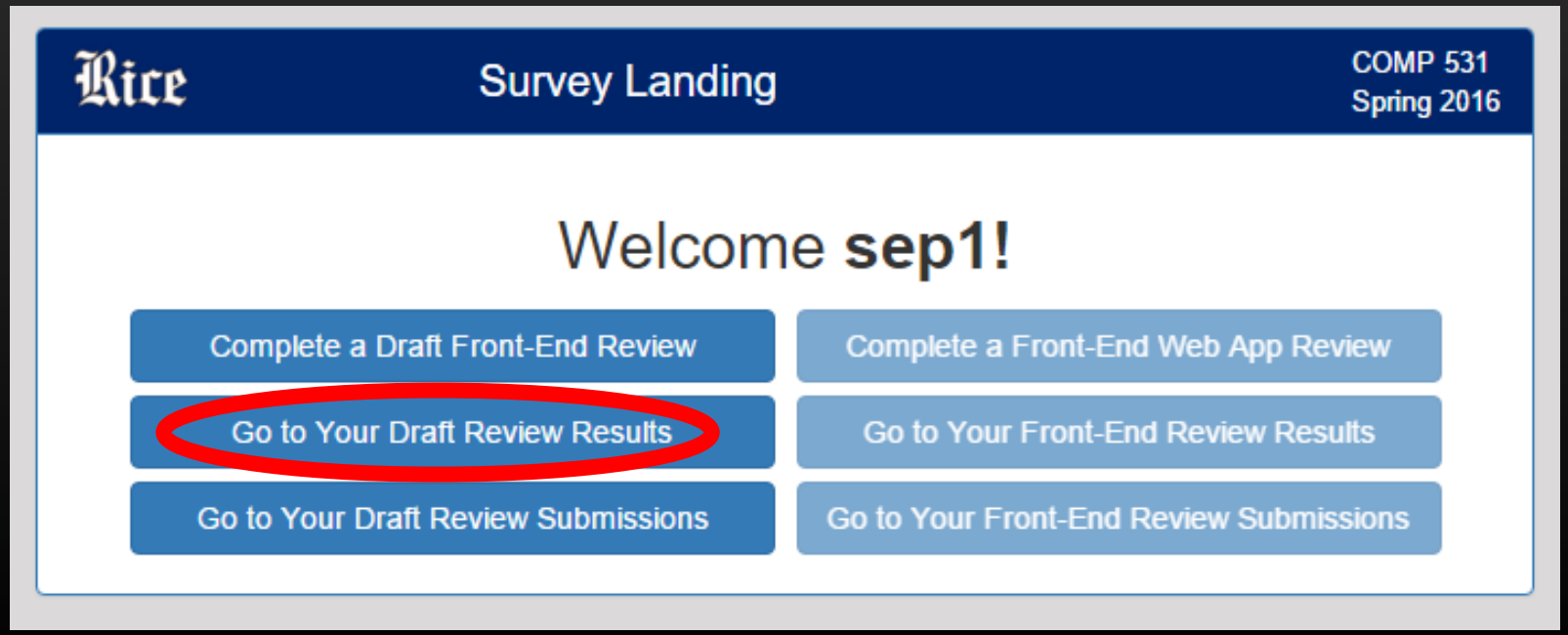
COMP 531
Front-End Review
Due Tuesday 4/5

Homework Assignment 7
(Integrated Web App)
Due Tuesday 4/12

Draft Front-End Reviews *are available!*

http://webdev-dummy.herokuapp.com/survey

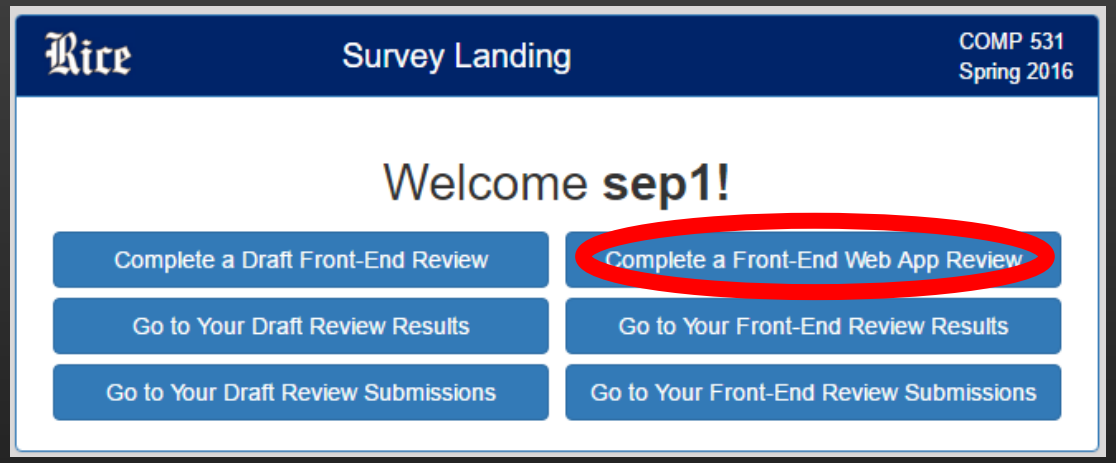
- Go to this address and log in using your netid and 3-word password supplied to you by email for the dummy server

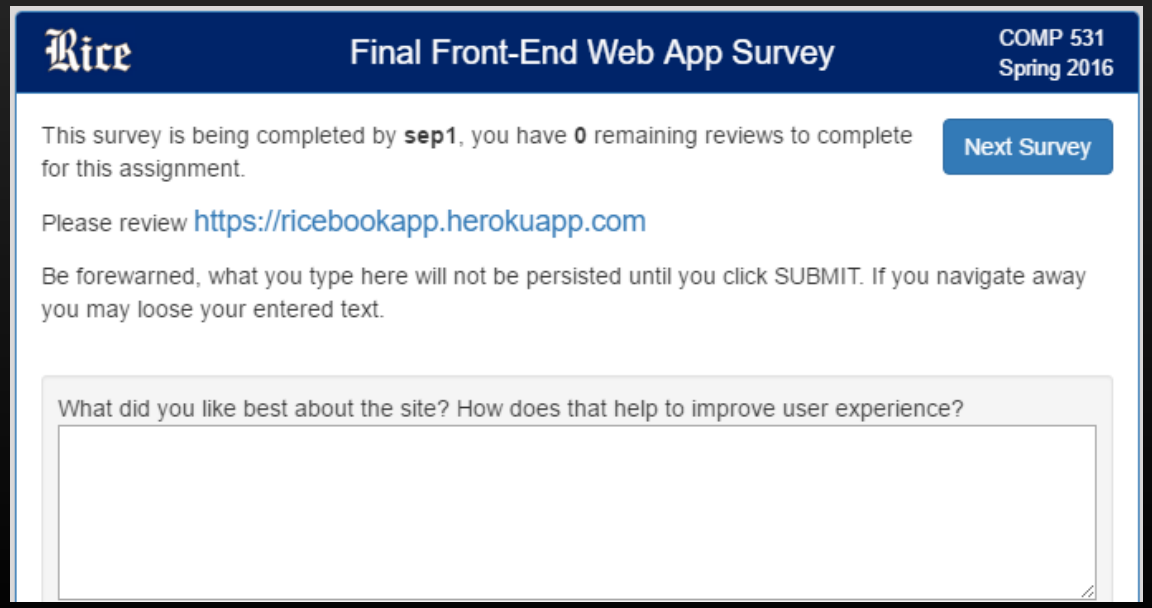


http://webdev-dummy.herokuapp.com/survey

COMP 531 Front-End Review

- Go to this address and log in using your netid and 3-word password supplied to you previously for the dummy server
- You will be asked to review 5 websites of your peers
- Provide useful, constructive feedback
- Provide a critical comparative evaluation of each site with yours





Assignment 7: Integrated Web App

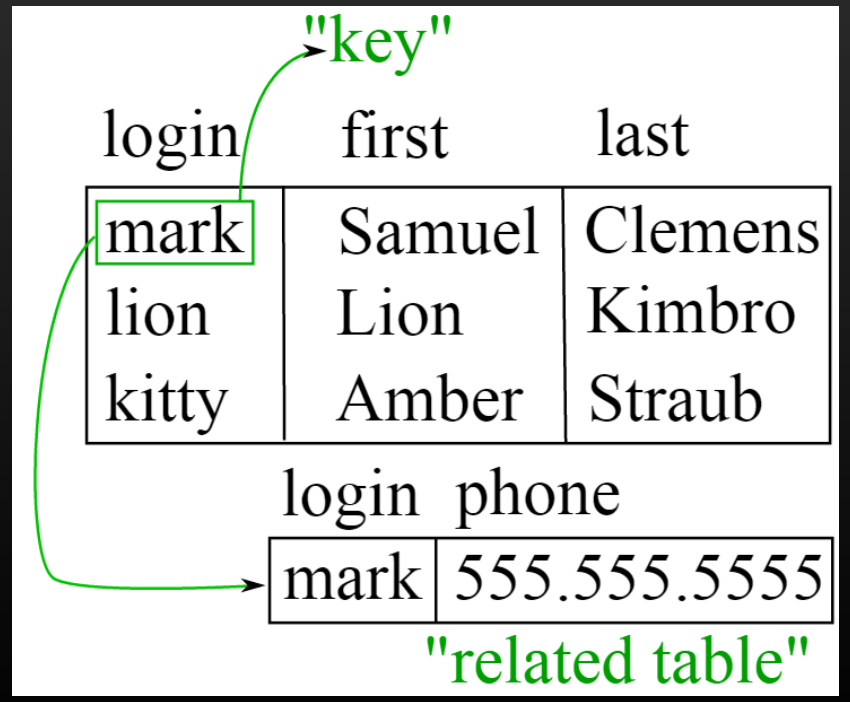
- Connect to MongoDB for persistence Inclass 20
- Authentication for user login Inclass 21
- Manually store session as a cookie (no third-party modules) Inclass 21
- Point your Frontend App at your Backend App Inclass 22
- All backend endpoints are implemented
  - login, logout, register, add post, get posts, statuses, followers, pictures
  - BUT! only a stub for upload profile pictures
  - BUT! only make posts with body, no picture

Data, data, data

- It's all about the data
- Entities
  - A "thing"
- Properties
  - The properties of the thing
- Relationships
  - Things are related to other things
- Triggers
  - When something happens do something

Databases

- A database management system (DBMS) allows for the definition, creation, querying, update, and administration of databases
- RDBMS where "R" is for relational



Relational Database

- Composed of tables
- Tables have rows (entities) and columns (fields or properties)

prices

column	datatype	nullable
date	datetime	NOT NULL
iid	int	NOT NULL
open	float	NOT NULL
high	float	NOT NULL
low	float	NOT NULL
close	float	NOT NULL
volume	long	NOT NULL
adj_close	float	NOT NULL

tickers

column	datatype	nullable
iid	int	NOT NULL
ticker	varchar(8)	NOT NULL
name	varchar(80)	NULL

Why we want seperate tables?

Because the info stored in tickers is unlikely to be changed frequently, which is different from the data in prices.
We do not want to store these two types of data together.

Structured Query Language

```
SELECT p.date, t.ticker, p.close, p.volume
  FROM price p
  JOIN tickers t ON p.iid = t.iid
 WHERE t.ticker IN ( 'AAPL', 'GOOG' )
   AND p.date BETWEEN '2012-01-01' AND '2012-02-01'
 ORDER BY p.date DESC, t.ticker
 LIMIT 6 ;
```

date	ticker	close	volume
2012-02-01	AAPL	456.19	9644500
2012-02-01	GOOG	580.83	2320700
2012-01-31	AAPL	456.48	13988700
2012-01-31	GOOG	580.11	2142400
2012-01-30	AAPL	453.01	13547900
2012-01-30	GOOG	577.69	2330500

“SQLite is a software library that implements a self-contained, serverless, zero-configuration, transactional SQL database engine. SQLite is the most widely deployed database engine in the world. The source code for SQLite is in the public domain”

```
> sqlite3 db.sqlite3
SQLite version 3.8.11.1 2015-07-29 20:00:57
Enter ".help" for usage hints.
sqlite> .tables
prices   tickers
sqlite> select * from prices limit 10;
2000-02-01|1|104.0|105.0|100.0|100.25|11380000|24.96
2000-02-01|4|67.5|70.63|64.37|67.44|13404600|67.44
```

SQLite from Node

```
var sqlite3 = require('sqlite3').verbose()
var memdb = new sqlite3.Database(':memory:')
var dskdb = new sqlite3.Database('db.sqlite3')

// needs to be serial because we add then query
memdb.serialize(function() {
    memdb.run("CREATE TABLE summary ("
        + "  month TEXT, iid INTEGER, ticker TEXT,"
        + "  total_dollar_volume REAL, count INTEGER"
        + ")");

    var p = "INSERT INTO summary VALUES (?, ?, ?, ?, ?)"
    dskdb.all(
        "SELECT strftime('%Y-%m-01', date) as month, "
        +"  p.iid, t.ticker, "
        +"  sum(p.close * p.volume) as total_dollar_volume, "
        +"  count(*) as count"
        +" FROM prices p JOIN tickers t ON p.iid = t.iid"
        +" GROUP BY strftime('%Y%m', date), p.iid "
        +" ORDER BY 1, 2"
        , [], function(err, rows) {
            var stmt = memdb.prepare(p);
```

Using a prepared statement

```
, [], function(err, rows) {
    var stmt = memdb.prepare(p);
    rows.forEach(function(row) {
        stmt.run([row.month, row.iid, row.ticker, row.total_dollar_volume, row.count])
    })
    stmt.finalize(function() {
        // here we are in callback hell
        console.log('month    \tticker\ttotal$vol\tavg$vol')
        memdb.each("SELECT * FROM summary WHERE ticker in ('AAPL', 'GOOG')"
            + " AND month >= '2012-01-01' LIMIT 6", function(err, row) {
          console.log(row.month + '\t' + row.ticker
            + '\t ' + parseFloat(row.total_dollar_volume/1e9).toFixed(4)
            + '\t ' + parseFloat(row.total_dollar_volume/row.count/1e9).toFixed(4));
        })
        memdb.close();
        dskdb.close();
    })
```

month	ticker	total$vol	avg$vol
2012-01-01	AAPL	105.5770	5.2788
2012-01-01	GOOG	45.0750	2.2538
2012-02-01	AAPL	204.6089	10.2304
2012-02-01	GOOG	28.7218	1.4361
2012-03-01	AAPL	322.1652	14.6439
2012-03-01	GOOG	29.6942	1.3497

TDD

```
it("should give me the status of the requested user", function(done) {
    var user = 'sep1'
    request(url('/status/'+user), function(err, res, body) {
        var s = JSON.parse(body)
        expect(s.username).toEqual(user)
        expect(s.status).toBeDefined()
        done()
    })
}, 200)
```

```
app.get('/', index)
app.get('/status/:user', getStatus)
app.put('/status', putStatus)
app.get('/count', countAll)

function index(req, res) {
    res.send("Hello World")
}
```

Using databases asynchronously

```
function countStatus(user, callback) {
    db.query("SELECT count(*) as count FROM statuses WHERE username=?", [user])
        .then(function(result) {
            callback(result[0].count)
        })
}
```

```
function getStatus(req, res) {

    function getUserStatus(user, res) {
        db.query("SELECT * FROM statuses WHERE username=?", [user])
            .then(function(result) {
                res.send(result[0])
            })
    }

    countStatus(req.params.user, function(count) {
        if (count == 0) {
            console.log('GET /status/'+req.params.user
                + ' found nothing, so call PUT')
            // let's make a new status then
            req.body = { username: req.params.user, status: 'I am okay'}
            putStatus(req, res)
        } else {
            getUserStatus(req.params.user, res)
        }
    })
}
```

No assumptions! Be explicit:

SELECT username, status FROM …

```
function countAll(req, res) {
    var payload = { users: 0, statuses: 0 }
    function queryStatuses(callback) {
        db.query("SELECT count(*) as count FROM statuses")
            .then(function(result) {
                payload.statuses = result[0].count
                callback()
            })
    }
    function queryUsers(callback) {
        db.query("SELECT count(*) as count FROM users")
            .then(function(result) {
                payload.users = result[0].count
                callback()
            })
    }
    queryStatuses(function() {
        queryUsers(function() {
            res.send(payload)
        })
    })
}
```

Node and PostgreSQL on Heroku

```
> heroku addons:create heroku-postgresql:hobby-dev
```

IDEA

Use postgres on Heroku but sqlite3 locally

WHY?

Easier than setting up a PostgreSQL server locally

HOW?

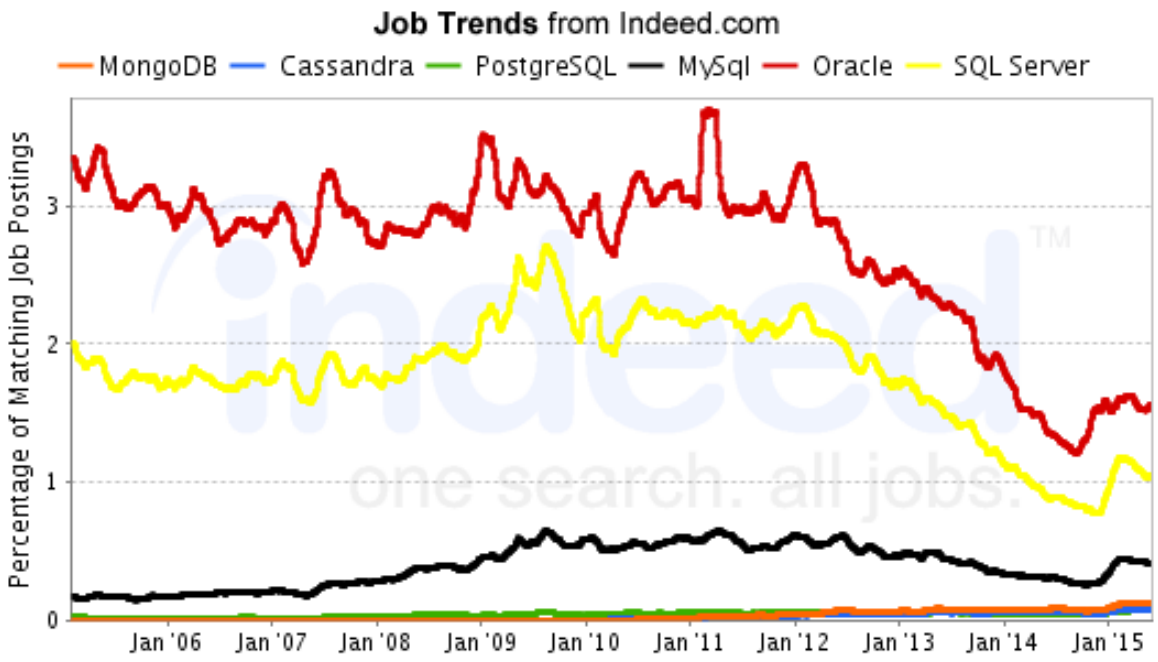
process.env.NODE_ENV = “production”

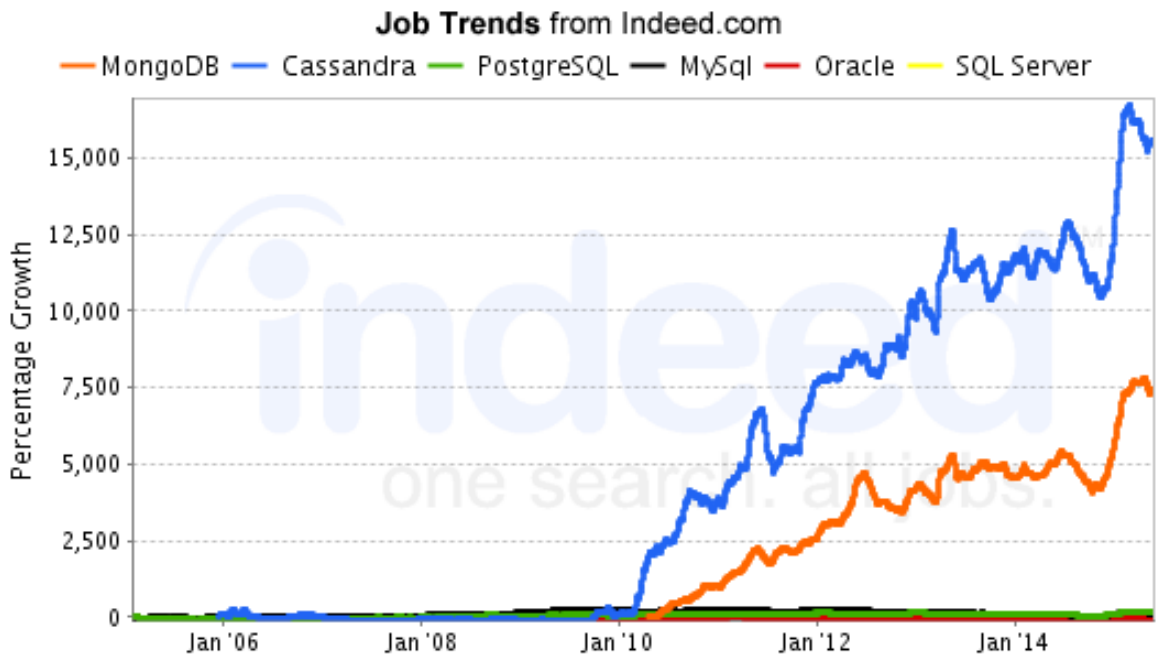
Unified database access

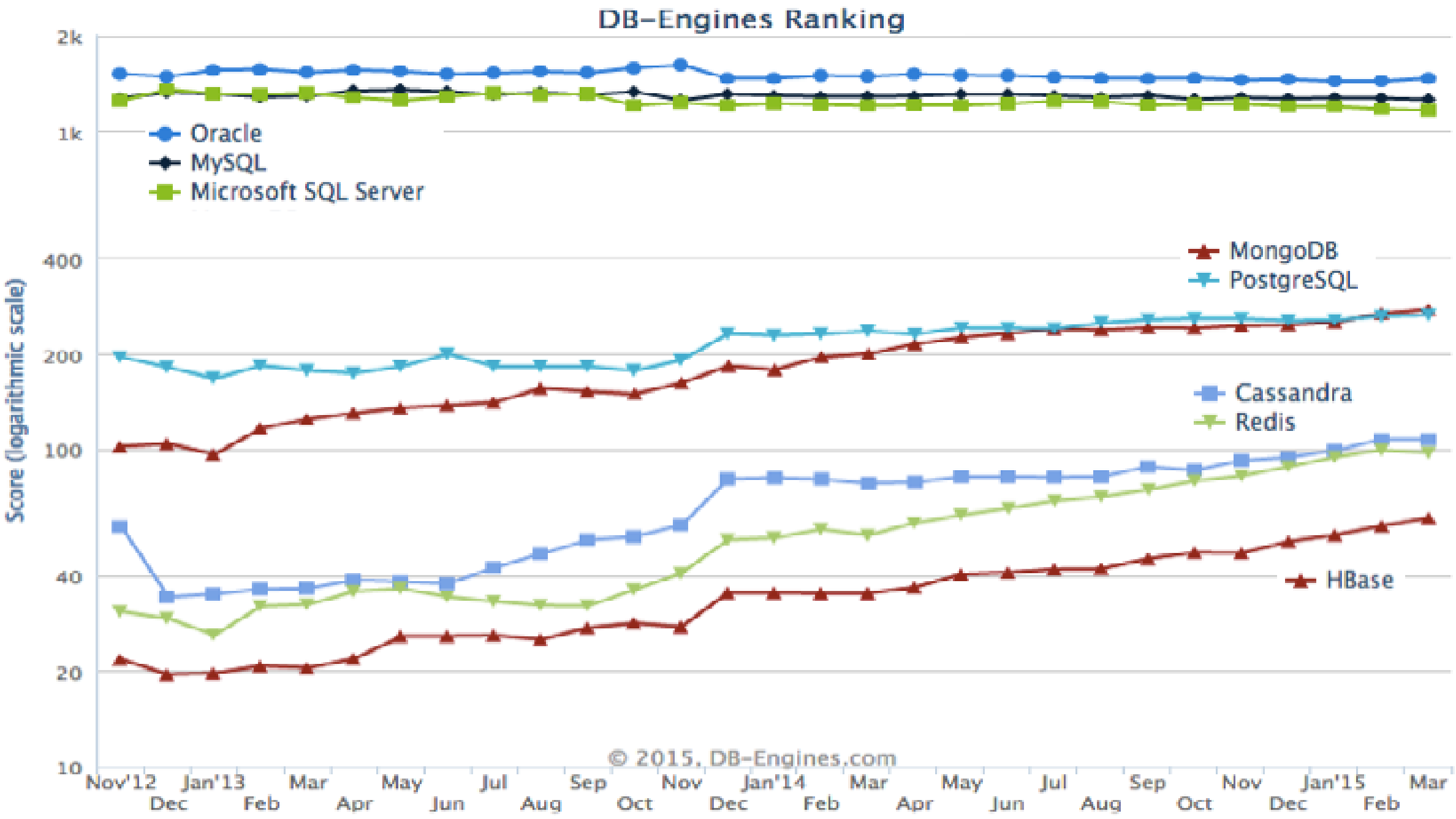
```
var query;
if (process.env.NODE_ENV == "production") {
    console.log('production mode using pg')
    var pg = require('pg')

    query = exports.query =
                ...
        pg.connect(process.env.DATABASE_URL, function(err, client, done) {
            client.query(queryString, args, function (err, result) {
                done();
                if (cb) {
                    cb(err, result ? result.rows : result)
```

```
} else {
    console.log('development mode use sqlite3')
    var sqlite3 = require('sqlite3').verbose()




}
```

What's hot in databases? NoSQL






DB-Engines Ranking
Score (logarithmic scale)
2k
1k
400
200
100
40
20
10
Oracle
MySQL
Microsoft SQL Server
MongoDB
PostgreSQL
Cassandra
Redis
HBase
© 2015, DB-Engines.com
Nov'12
Dec
Jan'13
Feb
Mar
Apr
May
Jun
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Jan'14
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Jan'15
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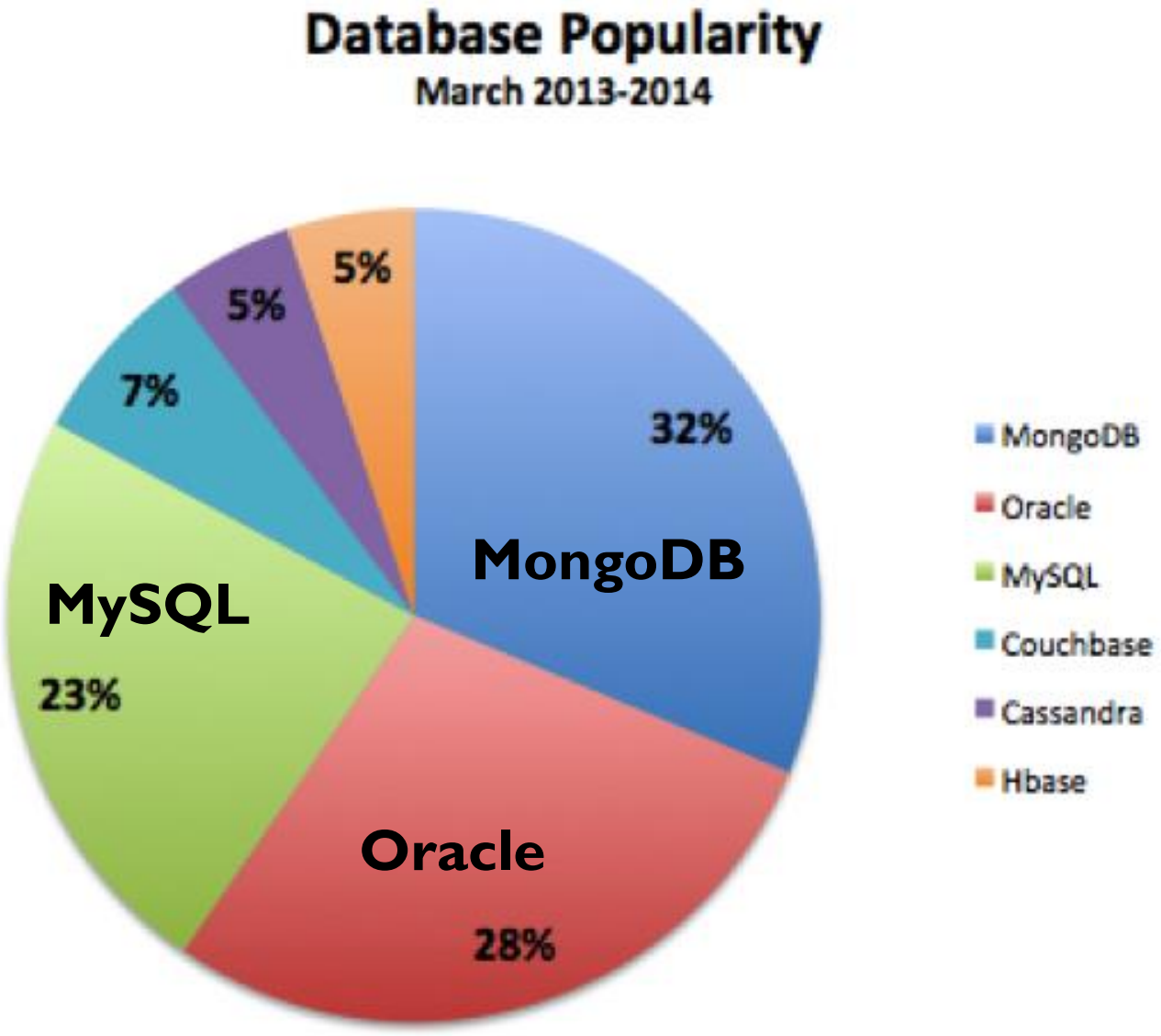
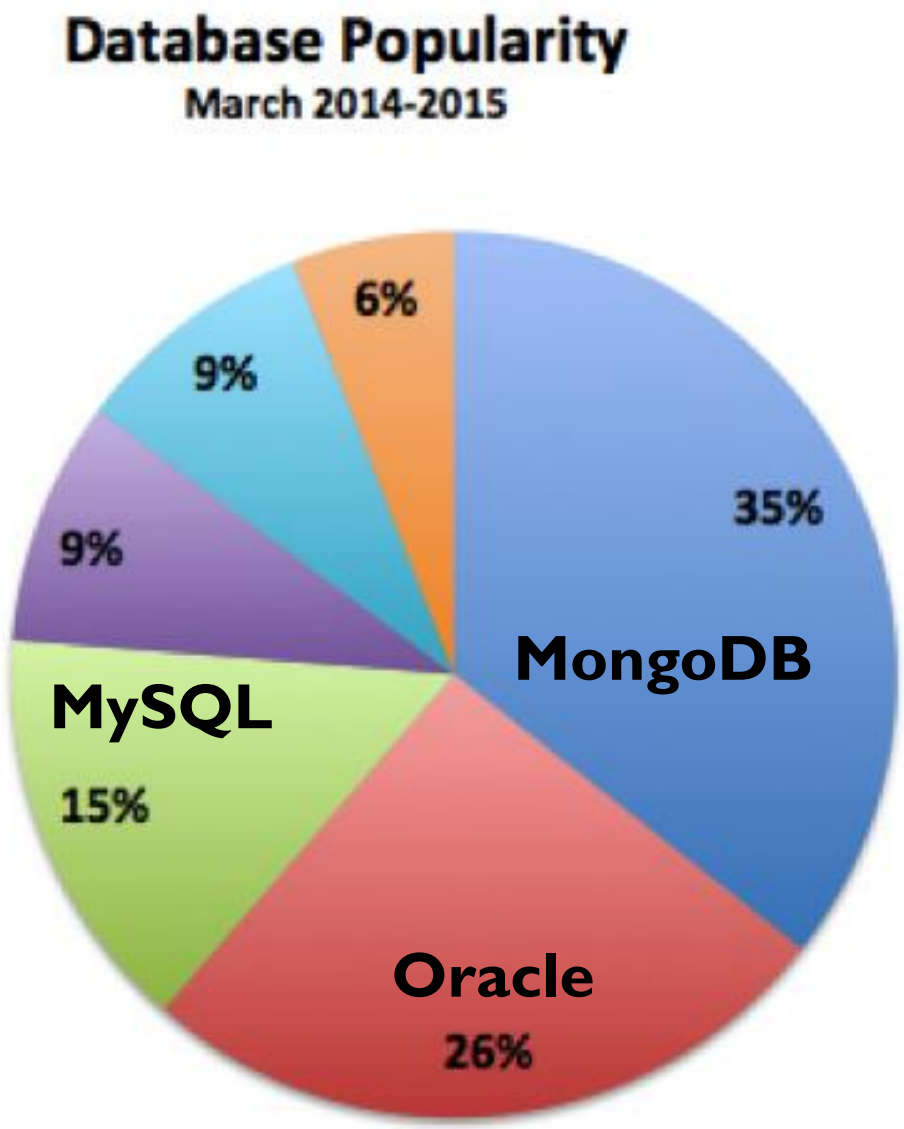
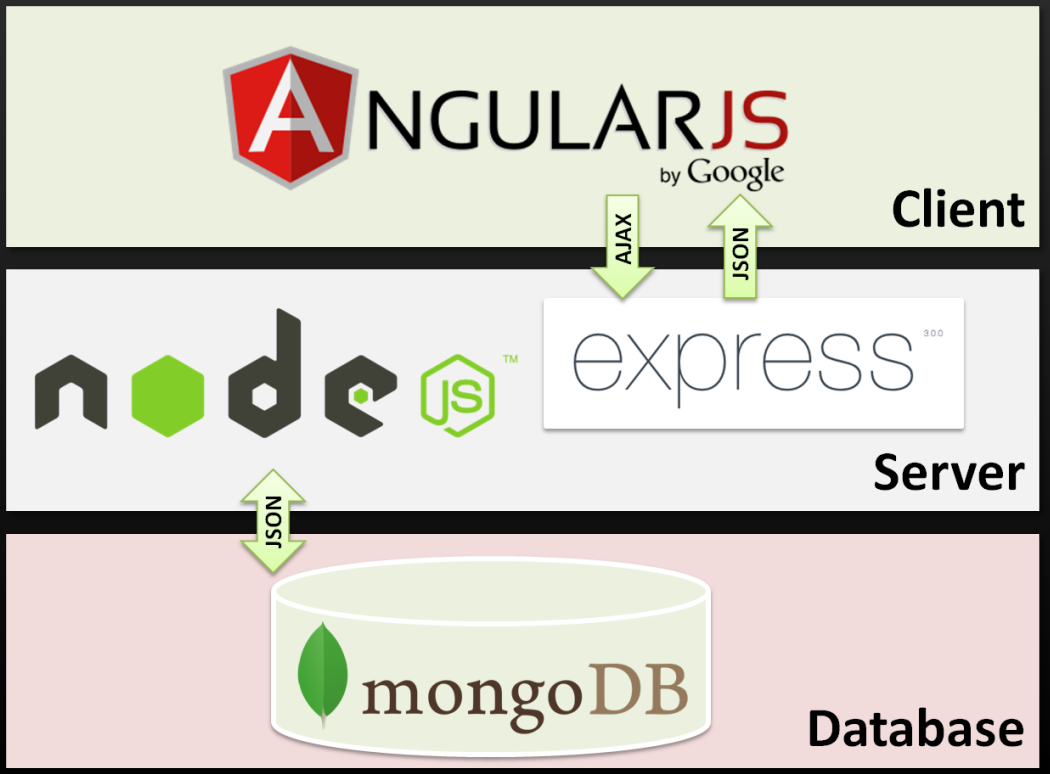

Database Popularity
March 2013-2014
5%
5%
7%
32%
MongoDB
MySQL
23%
Oracle
28%
MongoDB
Oracle
MySQL
Couchbase
Cassandra
Hbase


Database Popularity
March 2014-2015
6%
9%
9%
35%
MongoDB
MySQL
15%
Oracle
26%

MongoDB

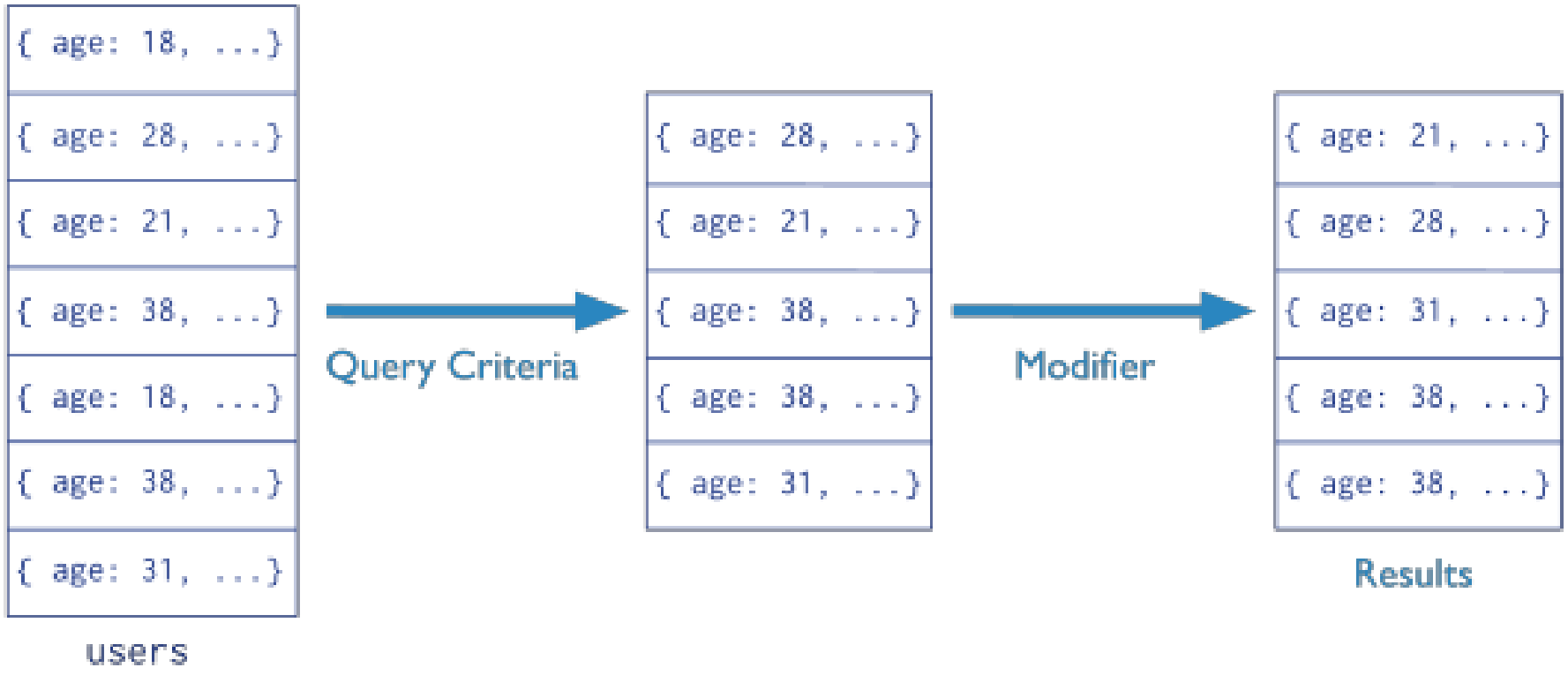
- Designed for humongous volumes of data
- Document-oriented (not row+column)
- Schema-less
  - Extensible
  - No "error" checking…
- JSON oriented
  - Binary JSON (BSON)
- Documents within Documents



MongoDB Query

Collection | Query Criteria | Modifier

```
db.users.find( { age: { $gt: 18 } } ).sort( {age: 1 } )
```



MongoDB in Node

```
var MongoClient = require('mongodb').MongoClient
var url = 'mongodb://localhost:27017/webdev'
function mc(execute) {
    var args = Array.prototype.slice.call(arguments, 1)
    MongoClient.connect(url, function(err, db) {
        if (err) {
            console.err('There was a problem', err)
        } else {
            args.unshift(db)
            execute.apply(null, args)
        }
    })
}
exports.mc = mc
```

Insert some documents

```
var MongoClient = require('mongodb').MongoClient
var url = 'mongodb://localhost:27017/webdev'
function mc(execute) {
    var args = Array.prototype.slice.call(arguments, 1)
    MongoClient.connect(url, function(err, db) {
        if (err) {
            console.err('There was a problem', err)
        } else {
            args.unshift(db)
            execute.apply(null, args)
        }
    })
}
exports.mc
```

```
mc(insertDocs)
```

```
function insertDocs(db) {
    request('https://webdev-dummy.herokuapp.com/sample', function(err, res, body) {
        var posts = JSON.parse(body).posts
        // put these into a collection
        var c = db.collection('posts', function() { })
        c.insert(posts, {w:1}, function(err, result) {
            db.close()
        })
    })
}
```

Query documents

```
function queryByAuthor(db, author) {
    var c = db.collection('posts')
    c.find({ author: author }).toArray(function(err, items) {
        console.log('There are ' + items.length + ' entries for ' + author)
        var totalLength = 0
        items.forEach(function(post) {
            totalLength += post.body.length
        })
        console.log('average length', totalLength / items.length)
        db.close()
    })
}

mc(queryByAuthor, 'sep1')
mc(queryByAuthor, 'jmg3')
```

```
There are 16 entries for sep1
average length 428.8125
There are 16 entries for jmg3
average length 428.126
```

```
exports.mc = mc
```

MongooseJS: *an Object Document Model*

```
1  var mongoose = require('mongoose')
2  var url = 'mongodb://localhost:27017/webdev'
3  mongoose.connect(url)
4  function done() {
5      mongoose.connection.close()
6  }
7
8  var commentSchema = new mongoose.Schema({
9      commentId: Number, author: String, date: Date, body: String
10 })
11 var postSchema = new mongoose.Schema({
12     id: Number, author: String, img: String, date: Date, body: String,
13     comments: [ commentSchema ]
14 })
15 var Post = mongoose.model('post', postSchema)
16
```

```
exports.Post = Post
```

Direct vs ODM

```
function queryByAuthor(db, author) {
    var c = db.collection('posts')
    c.find({ author: author }).toArray(function(err, items) {
        console.log('There are ' + items.length + ' entries for ' + author)
        var totalLength = 0
        items.forEach(function(post) {
            totalLength += post.body.length
```

```
function findByAuthor(author, callback) {
    Post.find({ author: author }).exec(function(err, items) {
        console.log('There are ' + items.length + ' entries for ' + author)
        var totalLength = 0
        items.forEach(function(post) {
            totalLength += post.body.length
        })
        console.log('average length', totalLength / items.length)
        callback()
    })
}
```

Other Solutions

SQL, noSQL, newSQL

In-Class Exercise: Setting up MongoDB

http://www.clear.rice.edu/comp431/sample/mongooseTest.js *rename this model.js*
http://www.clear.rice.edu/comp431/sample/db.js

- Add a free mongoDB instance to your backend
  https://www.clear.rice.edu/comp431/data/database.html

```
> heroku addons:create mongolab
```

- Install mongoose

```
> npm install mongoose --save
```

- Put your mongoDB connection url in db.js

```
process.env.MONGOLAB_URI
heroku config | grep MONGOLAB
```

- Integrate your backend for "posts" with MongoDB

```
GET /posts/:id*?
POST /post
```

- Test using e.g. curl

Turnin your *posts.js* and *model.js*
COMP431-S16:inclass-20