# WQD7007 Big Data Management

# NoSQL and MongoDB

# NoSQL

- NoSQL → Not Only SQL
  - being **non-relational, distributed,** and **open source**
- Characteristics:
  - schema-free
  - easy replication support
  - simple API
  - Big data
  - Commodity
  - Flexible data model

Source: http://nosql-database.org/

# MongoDB

- A document-based (e.g. JSON or BSON) database.
- Characteristics:
    - Expressive query languages and secondary indexes
    - Strong consistency
    - Enterprise Management and Integration
    - Flexibility
    - Scalability and performance
    - Always on, global deployments

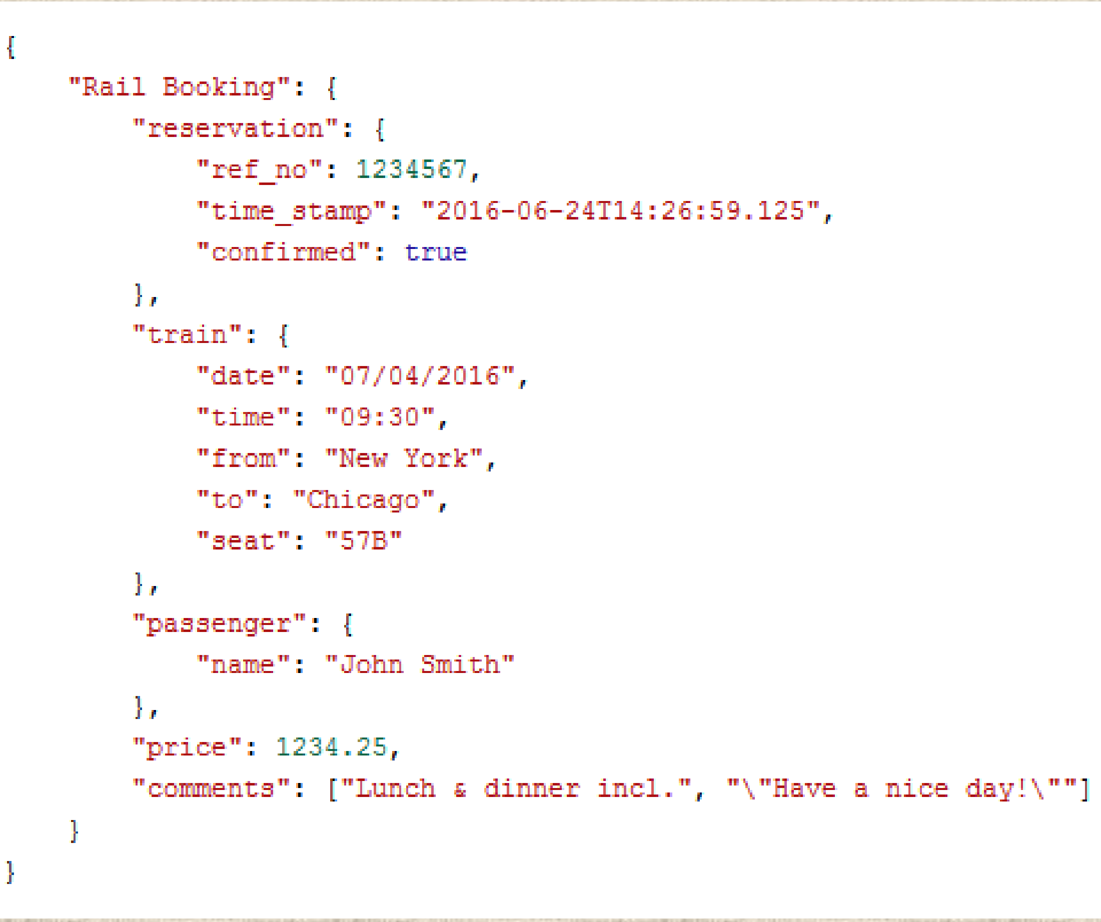
Source: https://www.mongodb.com/

# JSON and BSON

- Java Script Object Notation (JSON) is the lightweight data-interchange format to exchange data.
- Binary JSON → BSON: JSON that is serialized as a binary document
- JSON build on two structures:
  - A collection of name/value pairs. In various languages, this is realized as an *object*, record, struct, dictionary, hash table, keyed list, or associative array.
  - An ordered list of values. In most languages, this is realized as an *array*, vector, list, or sequence.

Source: https://www.json.org/

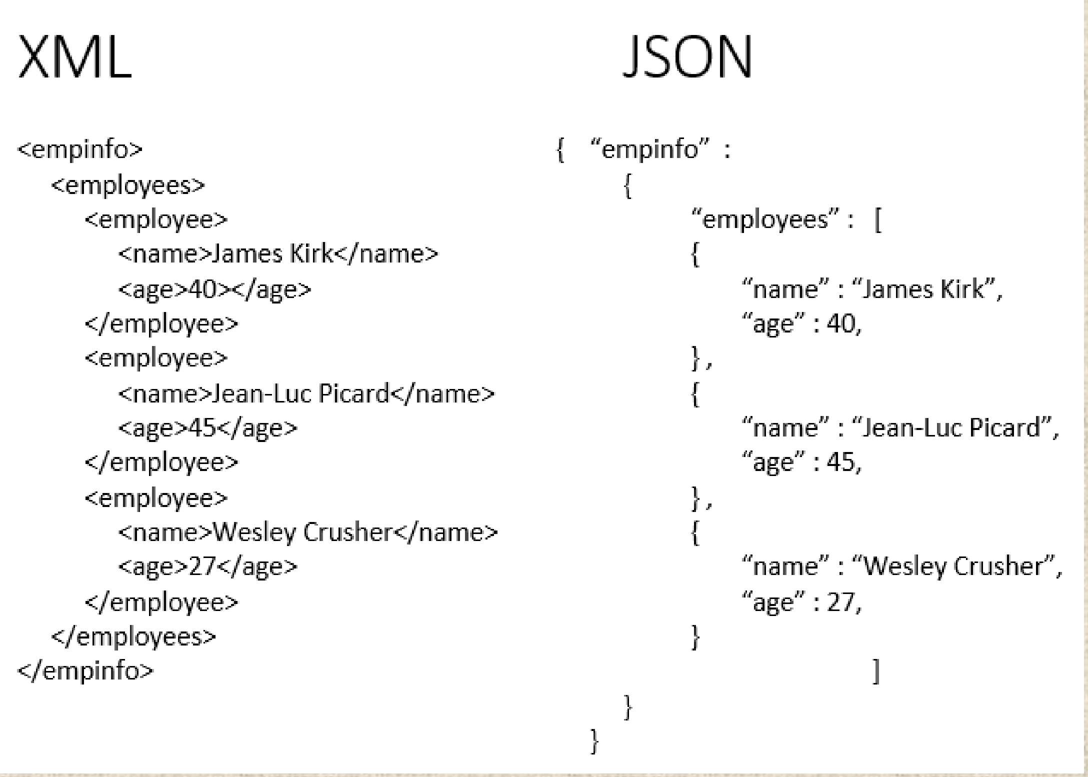
# Example of JSON:



```
{
    "Rail Booking": {
        "reservation": {
            "ref_no": 1234567,
            "time_stamp": "2016-06-24T14:26:59.125",
            "confirmed": true
        },
        "train": {
            "date": "07/04/2016",
            "time": "09:30",
            "from": "New York",
            "to": "Chicago",
            "seat": "57B"
        },
        "passenger": {
            "name": "John Smith"
        },
        "price": 1234.25,
        "comments": ["Lunch & dinner incl.", "\"Have a nice day!\""]
    }
}
```

# Why JSON and not XML?

- XML is not well suited to data-interchange. It carries a lot of baggage, and it doesn't match the data model of most programming languages.



XML

```
<empinfo>
    <employees>
        <employee>
            <name>James Kirk</name>
            <age>40></age>
        </employee>
        <employee>
            <name>Jean-Luc Picard</name>
            <age>45</age>
        </employee>
        <employee>
            <name>Wesley Crusher</name>
            <age>27</age>
        </employee>
    </employees>
</empinfo>
```

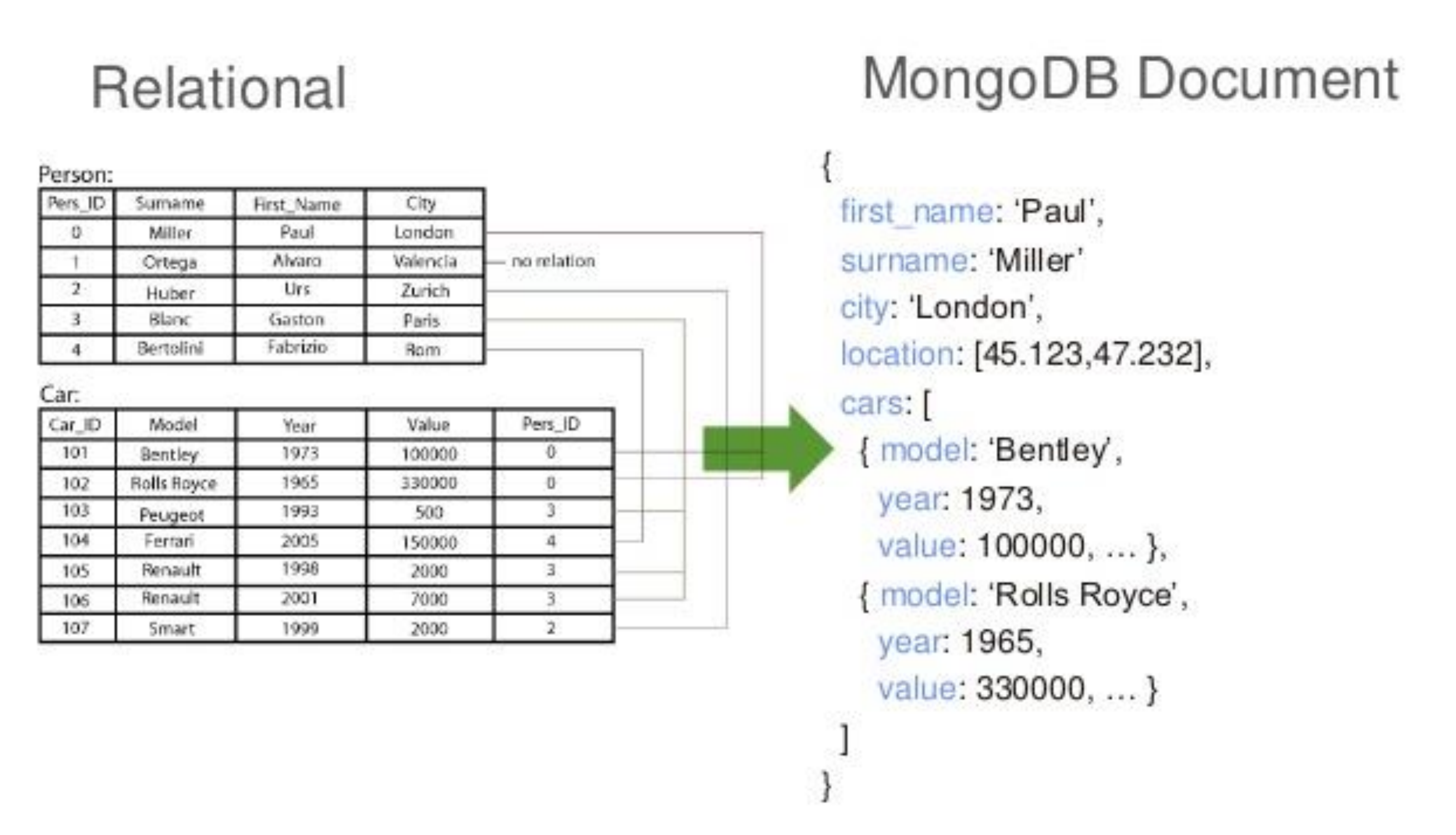
JSON

```
{   “empinfo” :
        {
                “employees” :  [
                {
                      “name” : “James Kirk”,
                      “age” : 40,
                } ,
                {
                      “name” : “Jean-Luc Picard”,
                      “age” : 45,
                } ,
                {
                      “name” : “Wesley Crusher”,
                      “age” : 27,
                }
                                   ]
        }
    }
```

# MongoDB VS RDBMS

| MongoDB | RDBMS |
|---|---|
| Database | Database |
| Collection | Table |
| Document | Tuple/Row |
| Field | Column |
| Embedded Documents | Table Join |

# From RDBMS to MongoDB



## Relational

Person:

| Pers_ID | Surname | First_Name | City |
|---|---|---|---|
| 0 | Miller | Paul | London |
| 1 | Ortega | Alvaro | Valencia |
| 2 | Huber | Urs | Zurich |
| 3 | Blanc | Gaston | Paris |
| 4 | Bertolini | Fabrizio | Rom |

Car:

| Car_ID | Model | Year | Value | Pers_ID |
|---|---|---|---|---|
| 101 | Bentley | 1973 | 100000 | 0 |
| 102 | Rolls Royce | 1965 | 330000 | 0 |
| 103 | Peugeot | 1993 | 500 | 3 |
| 104 | Ferrari | 2005 | 150000 | 4 |
| 105 | Renault | 1998 | 2000 | 3 |
| 106 | Renault | 2001 | 7000 | 3 |
| 107 | Smart | 1999 | 2000 | 2 |

## MongoDB Document

```
{
 first_name: ‘Paul’,
 surname: ‘Miller’
 city: ‘London’,
 location: [45.123,47.232],
 cars: [
  { model: ‘Bentley’,
    year: 1973,
    value: 100000, … },
  { model: ‘Rolls Royce’,
    year: 1965,
    value: 330000, … }
 ]
}
```

# Benefits of using JSON (document model)

- Document maps nicely to programming languages data type
- Embedded documents and arrays reduces the need for joins

# MongoDB vs HBase

| MongoDB | HBase |
|---|---|
| In MongoDB data is stored in JSON format. We have to insert/update/fetch the document as a whole | In HBase we can work on partial data. |
| MongoDB relies on the OS to buffer its data and maps the whole data to memory with mmap. | HBase use the log-structured merge tree, which probably is more efficient for heavy load and big data. |
| MongoDB supports secondary index and the index should be keep in memory. | HBase requires a third party module to support secondary index. |
| MongoDB has good feature of searching a document data using find/findOne by its inner attribute. The attribute can be indexed to search faster. | HBase do not have this feature. |
| Examples: Product/catalog data, geospatial data, Aadhar biometric database, ebay search suggestion | Examples: storing genome sequences, sports match histories, time-series data, log files |

Source: https://www.oodlestechnologies.com/blogs/Comparison-Between-MongoDB-and-Hbase

# Introduction

- Download MongoDB in https://www.mongodb.org/downloads#production
    - If you're using Mac, you can use Homebrew
    - For Windows:
        - This lab assumes that you install it to C:\Program Files\MongoDB. Add the bin directory to your System Environment Variables
    - If you're using any other operating systems, please refer to this https://docs.mongodb.org/manual/installation/ for more info
- During installation, you'll be required to install it to a PATH. Remember the path that you installed MongoDB to.

# Running MongoDB Server

- Before you proceed, you will need to create a directory which stores your MongoDB data. It is always /data/db by default. (For Windows, it's C://data/db/.) Create that data directory.
  - If you can't create the directory in Mac or Linux, use "sudo" privileges
- Finally, head to your terminal and type

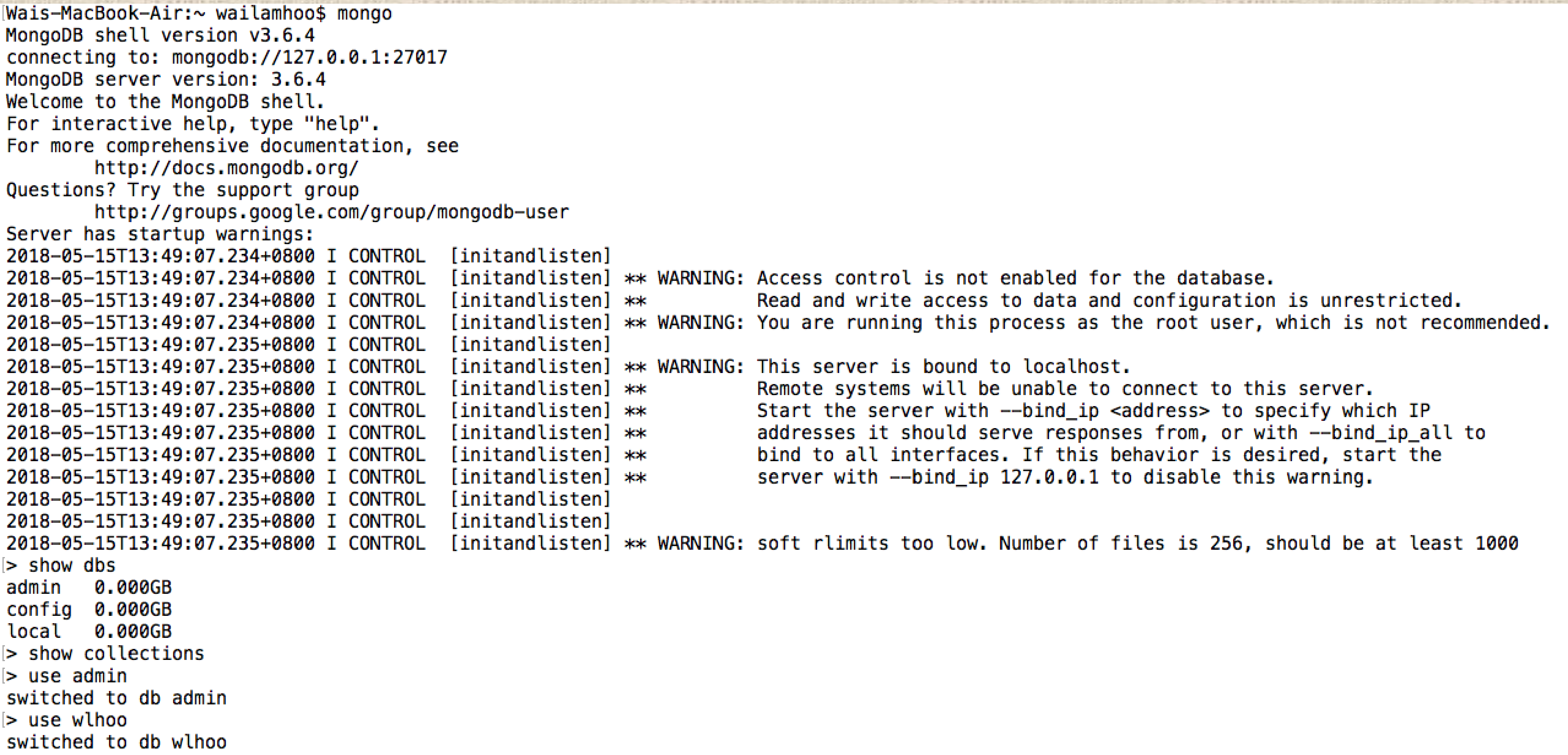
  ```
  mongod --smallfiles --noprealloc
  ```

  to start your MongoDB Server.
  - If it states "no such command is recognized", that means you have not added the bin directory into your PATH
  - If you use "sudo" privileges to create path, please use "sudo" privileges for this command too

# Run MongoDB

- open a new terminal (or a tab), and type mongo.
- Basic commands:
  - **show dbs**: Show the names of all databases
  - **show collections**: Show the names of all collections in the database
  - **use dbname**: Change to the database named dbname
  - **db**: Returns the name of the current database that you are connected to

# Run MongoDB



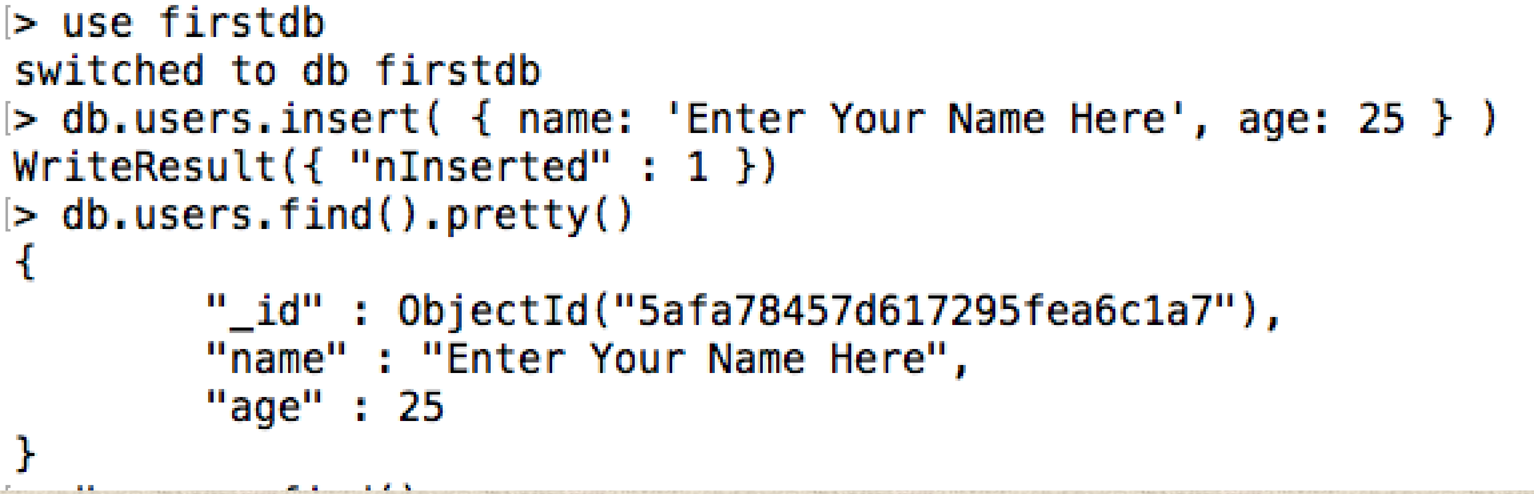
```
Wais-MacBook-Air:~ wailamhoo$ mongo
MongoDB shell version v3.6.4
connecting to: mongodb://127.0.0.1:27017
MongoDB server version: 3.6.4
Welcome to the MongoDB shell.
For interactive help, type "help".
For more comprehensive documentation, see
        http://docs.mongodb.org/
Questions? Try the support group
        http://groups.google.com/group/mongodb-user
Server has startup warnings:
2018-05-15T13:49:07.234+0800 I CONTROL  [initandlisten]
2018-05-15T13:49:07.234+0800 I CONTROL  [initandlisten] ** WARNING: Access control is not enabled for the database.
2018-05-15T13:49:07.234+0800 I CONTROL  [initandlisten] **          Read and write access to data and configuration is unrestricted.
2018-05-15T13:49:07.234+0800 I CONTROL  [initandlisten] ** WARNING: You are running this process as the root user, which is not recommended.
2018-05-15T13:49:07.235+0800 I CONTROL  [initandlisten]
2018-05-15T13:49:07.235+0800 I CONTROL  [initandlisten] ** WARNING: This server is bound to localhost.
2018-05-15T13:49:07.235+0800 I CONTROL  [initandlisten] **          Remote systems will be unable to connect to this server.
2018-05-15T13:49:07.235+0800 I CONTROL  [initandlisten] **          Start the server with --bind_ip <address> to specify which IP
2018-05-15T13:49:07.235+0800 I CONTROL  [initandlisten] **          addresses it should serve responses from, or with --bind_ip_all to
2018-05-15T13:49:07.235+0800 I CONTROL  [initandlisten] **          bind to all interfaces. If this behavior is desired, start the
2018-05-15T13:49:07.235+0800 I CONTROL  [initandlisten] **          server with --bind_ip 127.0.0.1 to disable this warning.
2018-05-15T13:49:07.235+0800 I CONTROL  [initandlisten]
2018-05-15T13:49:07.235+0800 I CONTROL  [initandlisten]
2018-05-15T13:49:07.235+0800 I CONTROL  [initandlisten] ** WARNING: soft rlimits too low. Number of files is 256, should be at least 1000
> show dbs
admin   0.000GB
config  0.000GB
local   0.000GB
> show collections
> use admin
switched to db admin
> use wlhoo
switched to db wlhoo
```

# Run MongoDB

- There will not be any commands to **create a database**. If the database does not exist, say when you do **use random1234**, Mongo will **create a database called random1234** for you. So, be careful in your syntax!
- Mongo by default connects you to the **test database** upon opening a connection.

# Create database and Insert Data

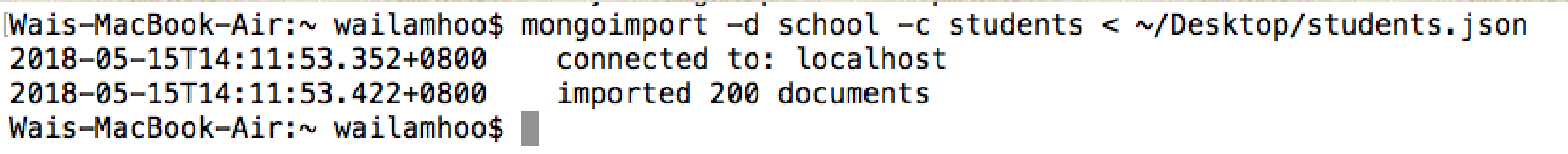
- We’ll now be using a new database called **firstdb** , and we’ll be inserting some entries into the collection named **users**.
- **use firstdb**
- **db.users.insert( { name: 'Enter Your Name Here', age: 25 } )**
- **db.users.find().pretty())**



```
> use firstdb
switched to db firstdb
> db.users.insert( { name: 'Enter Your Name Here', age: 25 } )
WriteResult({ "nInserted" : 1 })
> db.users.find().pretty()
{
        "_id" : ObjectId("5afa78457d617295fea6c1a7"),
        "name" : "Enter Your Name Here",
        "age" : 25
}
```

# Import JSON file

- Assume you download the JSON data, stored it in Desktop and wish to import to MongoDB:
- **mongoimport –d school –c students < ~/Desktop/student.json**



```
Wais-MacBook-Air:~ wailamhoo$ mongoimport -d school -c students < ~/Desktop/students.json
2018-05-15T14:11:53.352+0800    connected to: localhost
2018-05-15T14:11:53.422+0800    imported 200 documents
Wais-MacBook-Air:~ wailamhoo$
```

- Enter mongoDB by typing **mongo**. Then, switch to *school* database by typing **use school**

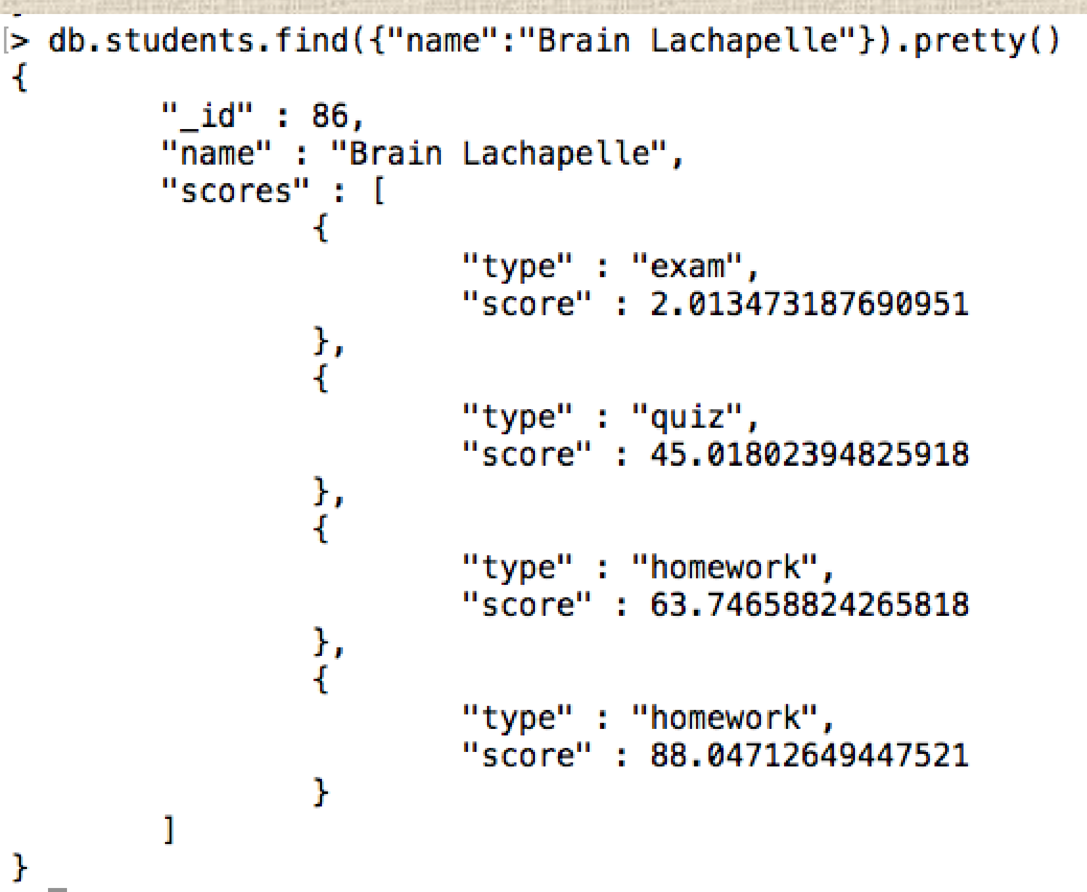
# Inserting data

Try insert these documents!

| Id | Name | Scores |
|---|---|---|
| 200 | Drake | [] |
| 201 | Logic | [{“type”: “homework”, ”score”: 89},<br>{“type”: “quiz”, ”score”: 56}] |
| 202 | Kraimir | [{“type”: ”homework”, “score”: 11}] |

# Finding documents

Example: Display the details of the student named "Brain Lachapelle"



```
> db.students.find({"name":"Brain Lachapelle"}).pretty()
{
        "_id" : 86,
        "name" : "Brain Lachapelle",
        "scores" : [
                {
                        "type" : "exam",
                        "score" : 2.013473187690951
                },
                {
                        "type" : "quiz",
                        "score" : 45.01802394825918
                },
                {
                        "type" : "homework",
                        "score" : 63.74658824265818
                },
                {
                        "type" : "homework",
                        "score" : 88.04712649447521
                }
        ]
}
```

# Finding documents

1. Obtain the number of students who achieved a a score greater than 95 of any type.
   - Hint: find(), $gt, dot notation, count()
2. Display the student who achieved the highest score on any type in the whole school
   - Hint: find(), sort(), limit()
3. Display the _id and name of the first 10 students (arranged in alphabetical order by name) who achieved a score between 10 and 35 of any type
   - Hint: find(), dot notation, $lt, $gt, projection (second parameter of find()), sort(), limit()
4. What is the number of students whose names are between C and E lexically? Also, display only the name of 10 of these students, in descending order
   - Hint: find(), $gt, $lt, projection, sort(), limit(), count()

# Updating and removing documents

- Update from one value to another
  - **db.users.update({“username”:”admin123”}, {$set: {“password”: “secret”}})**
- Removes “profile ID” attribute
  - **db.users.update({“username”:”admin123”}, {$unset: {“profile_id”: 1}})**
- Increments “login_count” value by 1
  - **db.users.update({“username”:”admin123”}, {$inc: {“login_count”: 1}})**
- Insert a new permission in **“permission” array**
  - **db.users.update({“username”:”admin123”}, {$push: {“permissions”: “add_blog”}})**

# Updating and removing documents

- Removes the first element from “permission” array:
  - **db.users.update({“username”:”admin123”}, {$pop: {“permissions”: -1}})**
- Removes the specified element from “permission” array
  - **db.users.update({“username”:”admin123”}, {$pull: {“permissions”: “edit_bg”}})**
- Insert the specified element to “permission” array
  - **db.users.update({“username”:”admin123”}, {$addToSet: {“permissions”: “edit_blog”}})**
- Remove user
  - **db.users.remove({“username”:”admin123”})**