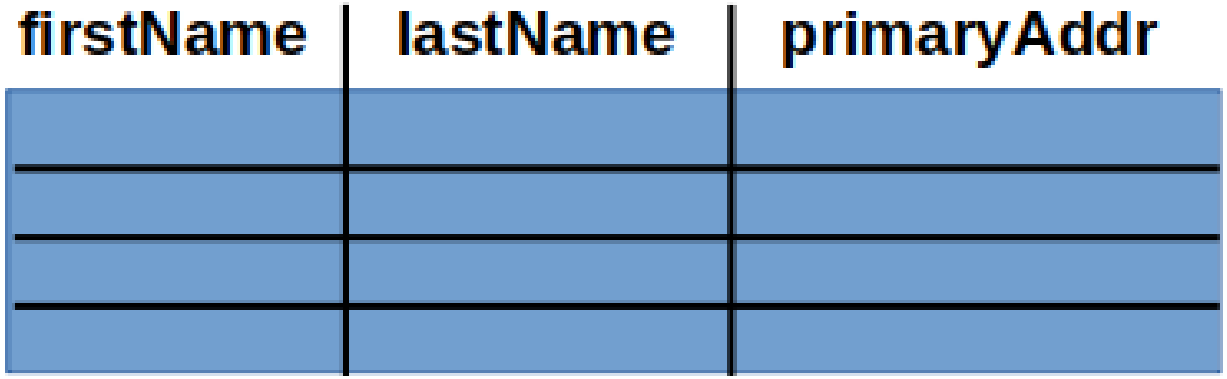
Introduction to Database Systems: CS312 MongoDB

Oliver BONHAM-CARTER

26 Oct 2020

The Problem with SQL

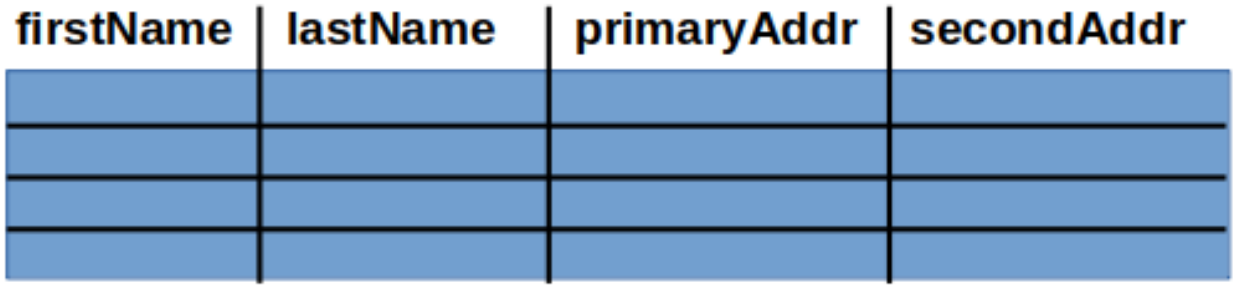
The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this



- Let's say that we have a (perfectly) working SQL table
- The schema has been designed and coded for *current data requirements*

Table Update (i)

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this



- The data we collect has changed.
- We need to update our schema for the *new data requirements*

Table Update (ii)

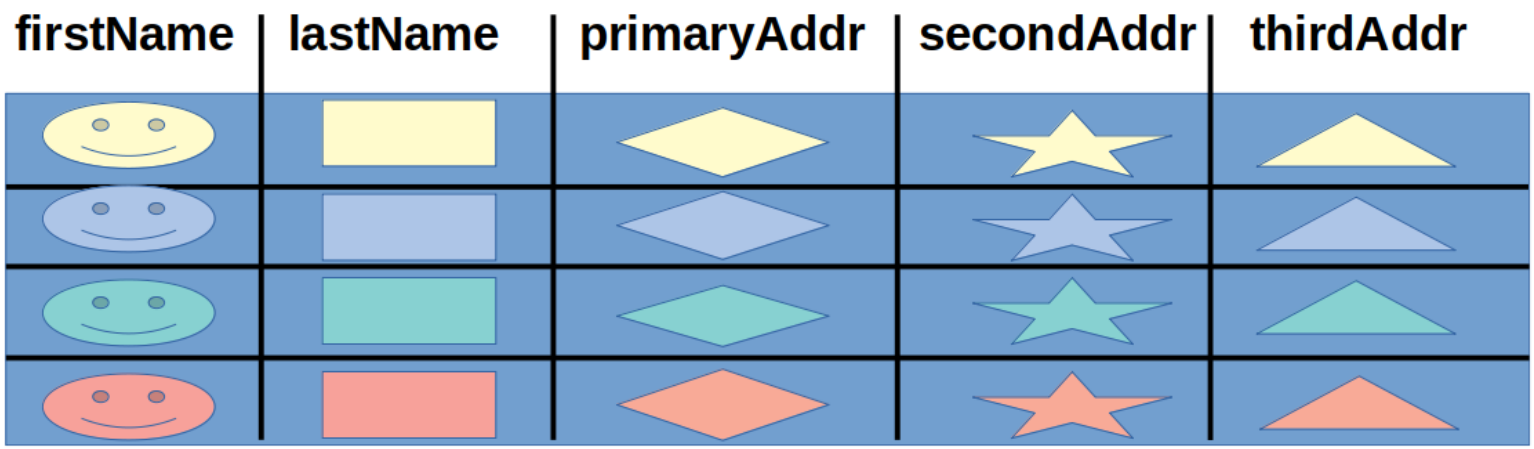
The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

firstName	lastName	primaryAddr	secondAddr	thirdAddr

- Our needs have changed again and the SQL table must be updated.
- The schema is reprogrammed

Expectations

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this



- We expect that the table will be full when in use
- Expectations are not always fulfilled...

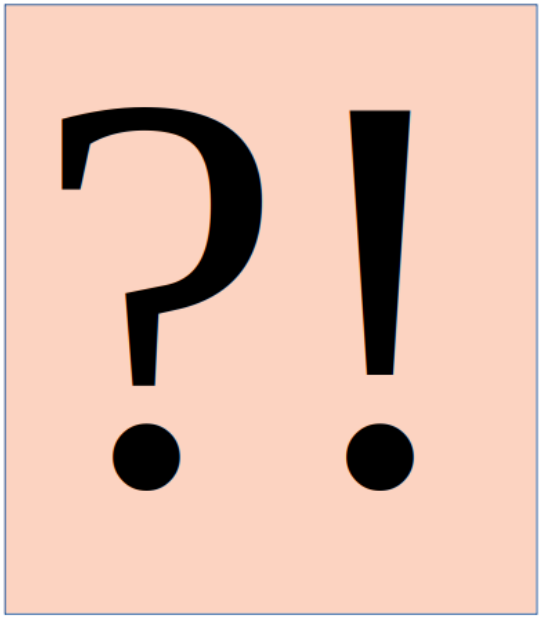
In Reality, Much Data is Missing

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

- But, in reality, much of the table is empty!
- The table can easily get huge and be hard to manage.

We Might Stop and Ask Ourselves...

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this



- What can we do to stop having to redesign our database schema with our changing data?
- Is SQL the right type of database management system for our changing data requirements?

A NoSQL Database Management System

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

- NoSQL: *Not Only SQL* database systems that support SQL-like query languages, but are used increasingly in big data applications and real-time web applications.
- The stored data is allowed to change

- `https://www.mongodb.com/`

Database Language Guide

SQL systems versus NoSQL

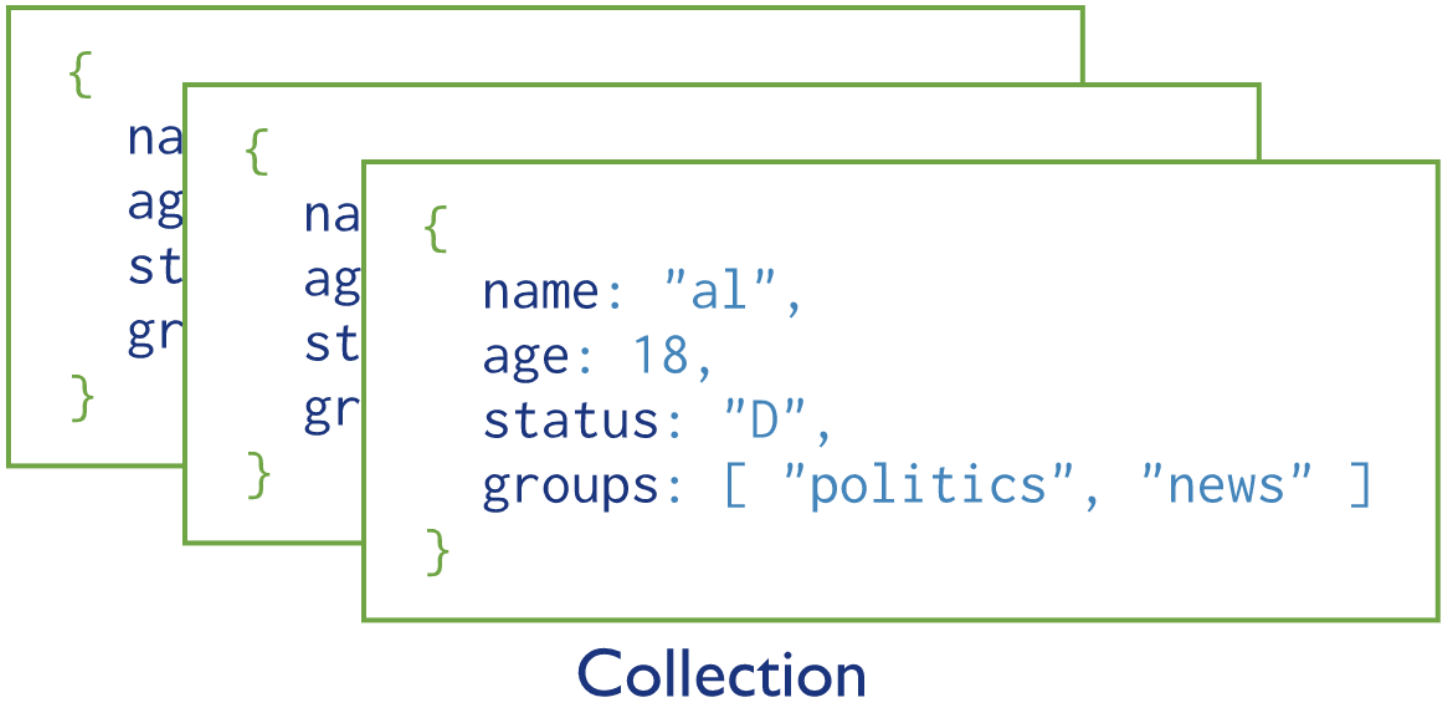
The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

RDBMS		MongoDB
Database	⇨	Database
Table, View	⇨	Collection
Row	⇨	Document (BSON)
Column	⇨	Field
Index	⇨	Index
Join	⇨	Embedded Document
Foreign Key	⇨	Reference
Partition	⇨	Shard

- The terms are different but their meanings are similar
- *Schema*-less, collections (like tables) are populated by any data
- *Documents* are similar to the *tuples* of Sqlite3 programming

Schema Free

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

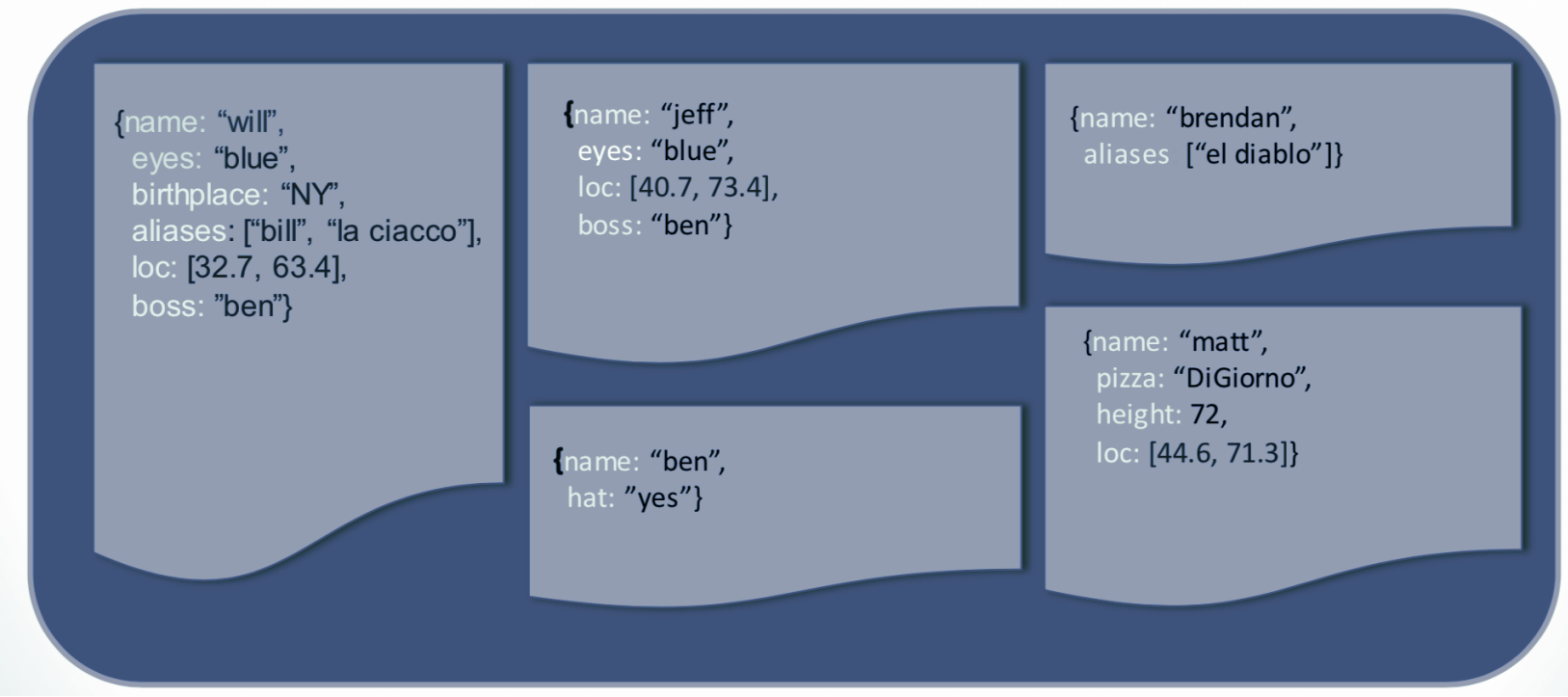


- No pre-defined data schema
  - Data may be entered in absence of a defined schema
- **Documents** (*rows*) of **collections** (*DB*'s) may have different types of data

Schema Free

Mostly similar documents

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this



- Sometimes not all the data is available to create a document.
- The query *interprets* missing data as NULL entries

JSON and MongoDB Code

The Problem With SQL
About Mongo
Schema
Language
JSON
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

- **Data is in name / value pairs**
- A name/value pair consists of a field name followed by a colon, followed by a value:
  - Example: `{ "name": "R2-D2 "}`
- **Data is separated by commas**
  - Example: `{ "name": "R2-D2", race : "Droid"}`
- **Curly braces hold objects**
  - Example: `{"name": "R2-D2", race : "Droid", affiliation: "rebels"}`
- **An array is stored in brackets** `[]`
  - Example `[ { "name": "R2-D2", race : "Droid", affiliation: "rebels"}, { "name": "Yoda", affiliation: "rebels"} ]`

CRUD Operations

Create, Read, Update and Delete

The Problem With SQL
About Mongo
Schema
Language
JSON
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

We will see more of these commands later!

- **Db.collection** specifies the collection or the *table* in which to store the document (*tuple*)
- **Create**
  - `db.collection.insert()`
  - `db.collection.save()`
  - `db.collection.update()`
- **Read**
  - `db.collection.find()`
  - `db.collection.findOne()`
- **Update**
  - `db.collection.update()`
- **Delete**
  - `db.collection.remove()`

Getting started with Mongo in Docker

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Windows
MacOS and Linux
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

Create a Docker container from DockerHub for Mongo: Windows.

```
docker pull mongo
```

Create a Docker container from DockerHub for Mongo: MacOS and Linux.

```
sudo docker pull mongo
```

Setup Mongo in Docker Container

Windows, Powershell

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Windows
MacOS and Linux
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

Create a volume for data to persist

```
docker volume create --name=mongodata
```

Start a Docker container running the Mongo DB server

```
docker run -it -v mongodata:/data/db --name mongodb -d mongo
```

Check log to see that the server is operational

```
docker logs mongodb
docker ps
```

Run instance of MongoDB, goes into root of container.

```
docker exec -it mongodb bash
```

Setup Mongo in Docker Container

Windows, Powershell

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Windows
MacOS and Linux
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

Start the MongoDB client

```
mongo
```

You are now able to run MongoDB commands here.
Note: `exit` to quit.

Setup Mongo in Docker Container

Windows, Powershell

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Windows
MacOS and Linux
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

Leave the container

```
exit
```

Stop Mongo container

```
docker stop mongodb
```

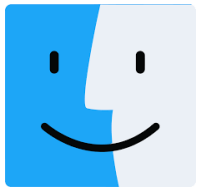
Removing all stopped containers, if necessary due to errors in launching container

```
docker rm $(docker ps -a -q)
```

Setup Mongo in Docker Container

MacOS and Linux, Terminal

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Windows
MacOS and Linux
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this



Create a directory for data to persist.

```
mkdir -p ~/mongodata
```

Start a Docker container running the Mongo DB server

```
sudo docker run -it -v ~/mongodata:/data/db --name mongodb -d mongo
```

Check log to see that the server is operational

```
sudo docker logs mongodb
sudo docker ps
```

Run instance of MongoDB, goes into `root` of container.

```
docker exec -it mongodb bash
```

Setup Mongo in Docker Container

MacOS and Linux, Terminal

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Windows
MacOS and Linux
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

Start the MongoDB client

```
mongo
```

You are now able to run MongoDB commands here.
Note: `exit` to quit.

Setup Mongo in Docker Container

MacOS and Linux, Terminal

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Windows
MacOS and Linux
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

Leave the container

```
exit
```

Stop Mongo container

```
docker stop mongodb
```

Removing all stopped containers, if necessary due to errors in launching container

```
docker rm $(docker ps -a -q)
```

Run MongoDB Commands

Working in MongoDB

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Windows
MacOS and Linux
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

Find databases or collections, from Mongo's client

```
show dbs
show collections
```

Begin a new database, from Mongo's client

```
use myDB
```

Simple Collections
Simple Example of Queries

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

Simple Insert into the *Greetings* collection

```
db.Greetings.drop()

db.Greetings.insert({"Hello":"English greeting"})
db.Greetings.insert({"Goodbye":"English farewell "})

db.Greetings.insert({"Bonjour":"French greeting"})
db.Greetings.insert({"Au revoir":"French farewell"})

db.Greetings.insert({"Buongiorno":"Italian greeting"})
db.Greetings.insert({"Arrivederci":"Italian farewell"})
```

Find contents of *Greetings* collection: select * from Greetings;

```
db.Greetings.find({},{})
db.Greetings.find({},{}).pretty();
db.Greetings.find({},{_id:0}).pretty();
```

General Finds

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

- The `find()` method with no parameters returns all documents from a collection and returns all fields for the documents.

The following operation returns all documents in the `music` collection

```
db.music.find({},{})
```

Returns all bandName in the `music` collection matching "Beatles"

```
db.music.find({ }, {"bandName":"Beatles"})
```

General Finds

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

```
db.collection.find({ What to search },{ What to filter in results })
```

- The `find()` method can also be used to specify particular fields to show from a collection-wide search.

The following operation returns all records with no filtration

```
db.music.find({},{})
```

The following operation filters-out only the bandName from the `music` collection

```
db.music.find({ },{"bandName":true})
```

Returns all `bandName` and `songs` in the `music` collection

```
db.music.find({ },{"bandName":true, "songs":true})
```

Insert into the *Country* collection

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

```
db.Country.drop()
db.Country.insert({
   language_en: "English",
   language_fr: "anglais",
   country_en: "England",
   country_fr :"l'angleterre"
   })
```

Adding to the Collection

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

```
db.Country.insert({
    language_en: "French",
    language_fr: "francais",
    country_en: "France",
    country_fr :"la France"
})

db.Country.insert({
    language_en: "Italian",
    language_fr: "italien",
    country_en: "Italy",
    country_fr :"l'Italie"
})
```

Simple Queries

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

Find contents of *Country* collection:
select * from Country;

```
db.Country.find()
db.Country.find().pretty()
```

```
> db.Country.find().pretty()
{
        "_id" : ObjectId("5c89c87211455eb94061b2f1"),
        "language_en" : "English",
        "language_fr" : "anglais",
        "country_en" : "England",
        "country_fr" : "l'angleterre"
}
{
        "_id" : ObjectId("5c89c87211455eb94061b2f2"),
        "language_en" : "French",
        "language_fr" : "francais",
        "country_en" : "France",
        "country_fr" : "la France"
}
{
        "_id" : ObjectId("5c89c87311455eb94061b2f3"),
        "language_en" : "Italian",
        "language_fr" : "italien",
        "country_en" : "Italy",
        "country_fr" : "l'Italie"
}
```

Simple Queries

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

Find specific contents of *Country* collection
select * from Country where country_en == "France";

```
db.Country.find({country_en : "France"}).pretty()
```

Find specific contents of *Country* collection
select * from Country where language_en == "English";

```
db.Country.find({language_en : "English"}).pretty()
```

Find specific contents of *Country* collection
select language_fr, language_en from Country where language_en == "English";

```
db.Country.find({language_en : "English"},
  {_id:0}).pretty()

db.Country.find({language_en:"English"},
{language_fr : 1, language_en : 1}).pretty()
```

How to shut down a session

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

Drop the collection (Greetings): Destroy the data, remove collection

```
db.Greetings.drop()
```

Drop the collection (Country): Destroy the data, remove collection

```
db.Country.drop()
```

Closing down

- Type `exit` in the client terminal

Advanced Data and Queries

Let's horse around with data and code ...

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

Locate your data file, open it in Atom and copy and past the contents (all at once) into the MondoDB client

`syntheticData_small.json`

Synthetic data available from:
`https://next.json-generator.com/`

Investigating Queries

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

```
db.collection.find({searchSpace},{showAttrib:1})
```

What do the following queries do?

```
db.employee.find({},{"name.last":1, "name.first":1})
db.employee.find({},{company:1})
db.employee.find({},{"name.last":1,address:1})
db.employee.find({},{company:1,registered:1,_id:0})
db.employee.find({},{company:1,"friends.name":1,_id:0})
db.employee.find({company:"RADIANTIX"},
   {"friends.name":1,_id:0})
```

Rewriting Queries

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

```
db.collection.find({searchSpace},{showAttrib:1})
```

Rewrite the queries to get...

- The last name, first name and balance information of each document
- The company name, latitude and longitude of each document
- The list of friends of record associated with the company PROSURE
- The phone number for the PROSURE company

Consider this...

The Problem With SQL
About Mongo
Schema
Language
Start MongoDB
Collections
Finding Information
A Simple Base
Queries
Shutting Down
Queries
Consider this

- Can you create and populate a new Mongo database?
- Can you write sophisticated queries in your database?