Relational Databases

RDBMS databases have features like

- Persistance
- Integration
- SQL
- Transaction - Concurrency (Multiple Threads)
- Reporting

ACID (Atomicity, Consistency, Isolation, Durability)

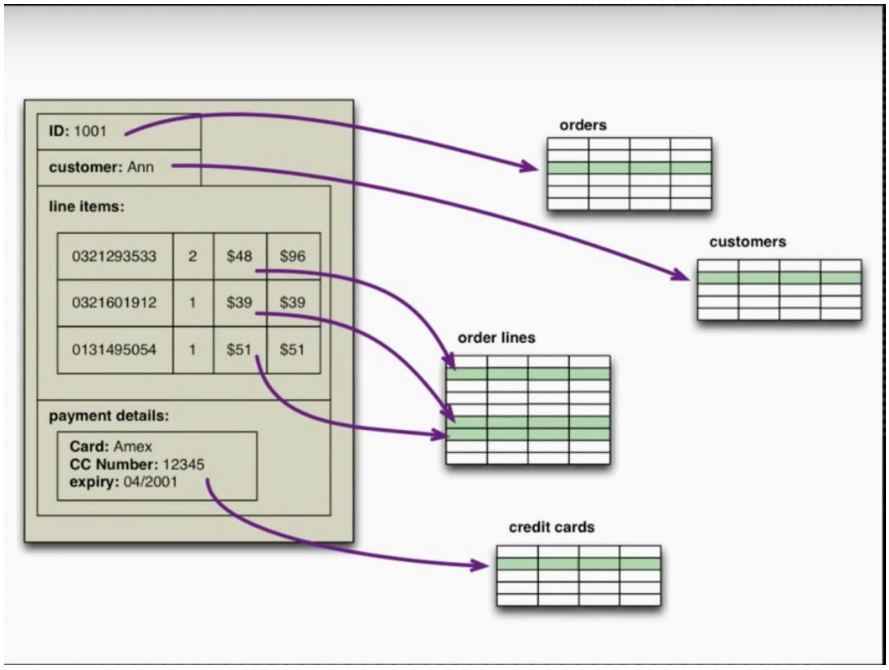
- **Atomicity** - all or nothing
- **Consistency** - The consistency property ensures that any transaction will bring the database from one valid state to another. Any data written to the database must be valid according to all defined rules, including constraints, cascades, triggers, and any combination thereof
- **Isolation** - The isolation property ensures that the concurrent execution of transactions results in a system state that would be obtained if transactions were executed sequentially, i.e., one after the other. Providing isolation is the main goal of concurrency control.
- **Durability** - The durability property ensures that once a transaction has been committed, it will remain so, even in the event of power loss, crashes, or errors.

Issues with Relational Databases

Impedance Mismatch - Data is scattered

A single application object's information is scattered in multiple tables. Because of which application has to assemble it each time when retrieving it and de-assemble it when persisting it.

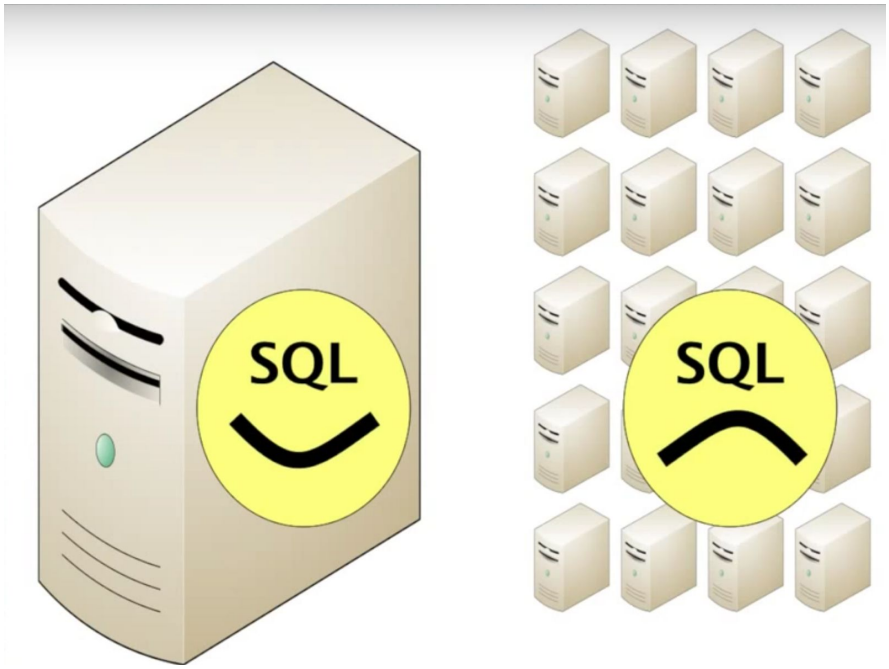
This the reason why we use ORMs



Database community tried to solve it by creating **Object Databases**. But they didn't become popular.

Scaling

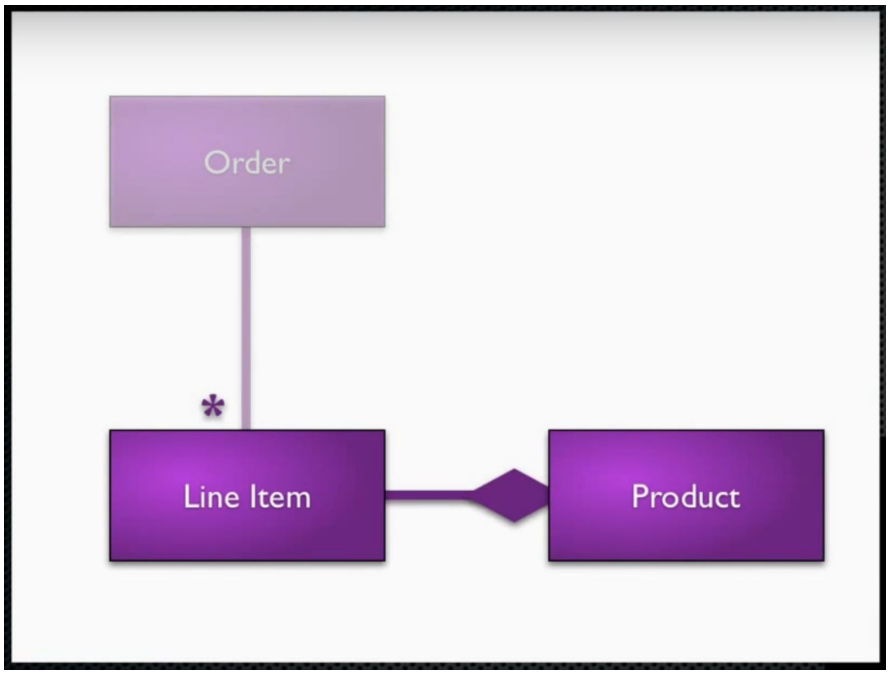
Relational databases are very difficult to run in distributed environment. For huge amount of data they need to be scale up not horizontally. SQL and transaction don't work well distributed environment.



To solve scaling issue

- Google created Bigtable
- Amazon created Dynamo

Product	revenue	prior revenue
321293533	3083	7043
321601912	5032	4782
131495054	2198	3187
...	...	...
...	...	...
...	...	...
...	...	...
...	...	...
...	...	...



In nosql this is possible using map reduce but it's hard

NoSQL Databases

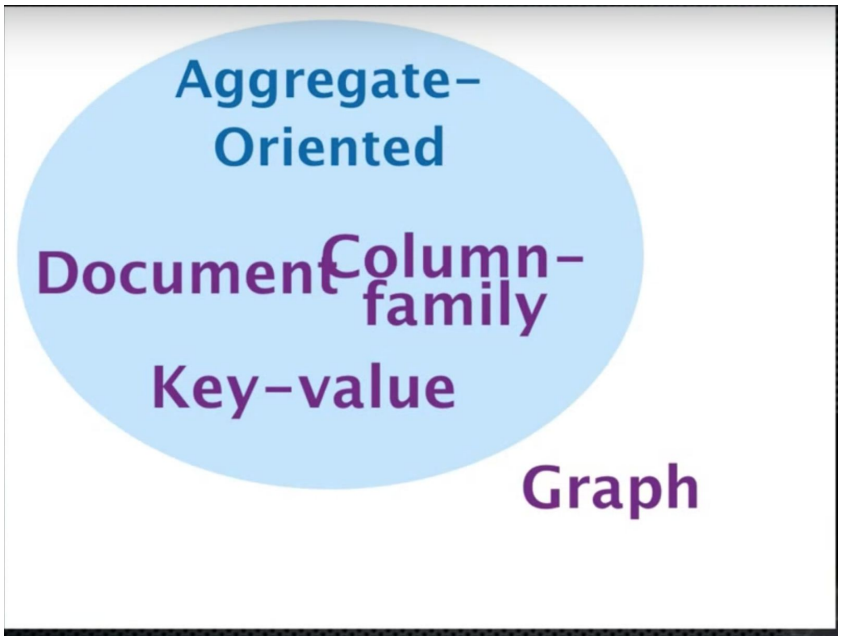
https://www.youtube.com/watch?v=qI_g07C_Q5I
To solve Relational Databases issues, Johan Oskarsson arranged a meetup and created NoSQL twitter hashtag. From there NoSQL name became popular.

BASE (Basically Available, Soft State, Eventual consistency) analysis of NoSQL

Possible Common Characteristics of NoSQL

- **Non Relational**
- **Open Source**
- **Cluster Friendly**
- **21st Century Web**
- **Schema-less**

Types of NoSQL database



Aggregate Oriented

An aggregate (Document, Object) lives on a single node (machine in a cluster) because of clustering is easy

Key-Value

E.g. Project Voldemort, riak, redis,

Document

E.g. MongoDB, Ravendb, CouchDB relax

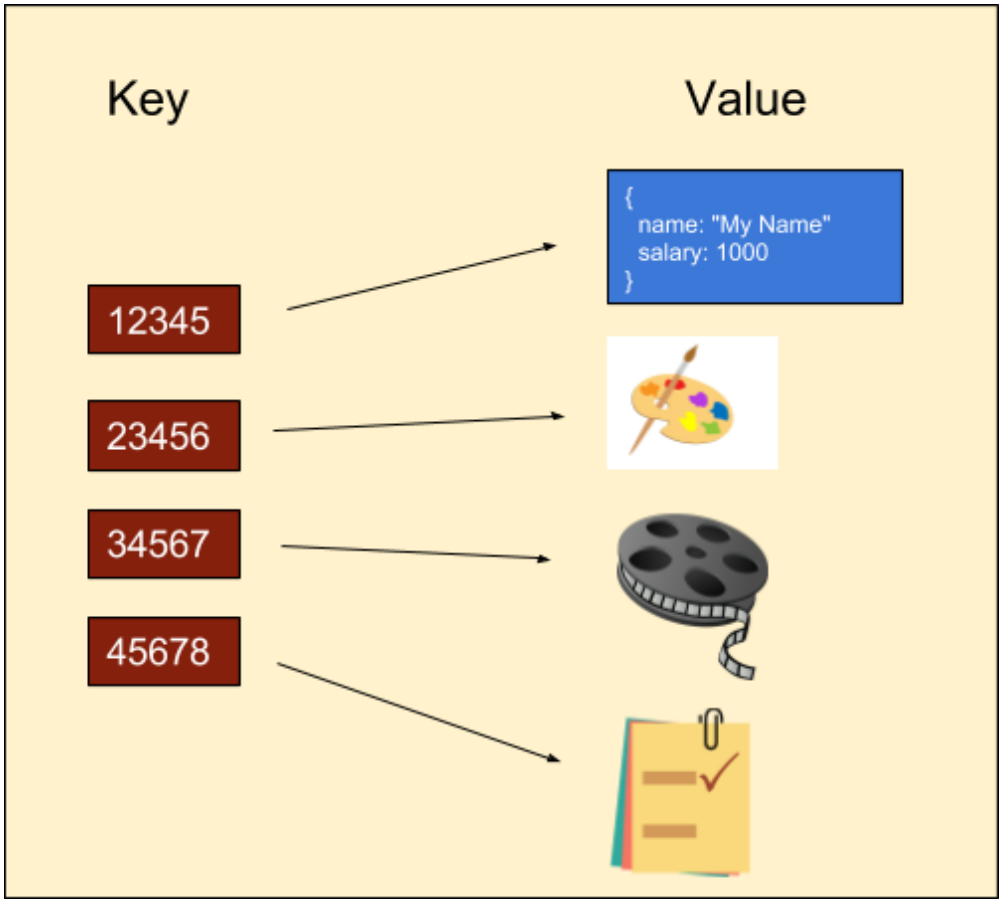
Column Family

E.g. Cassandra, Apache HBASE

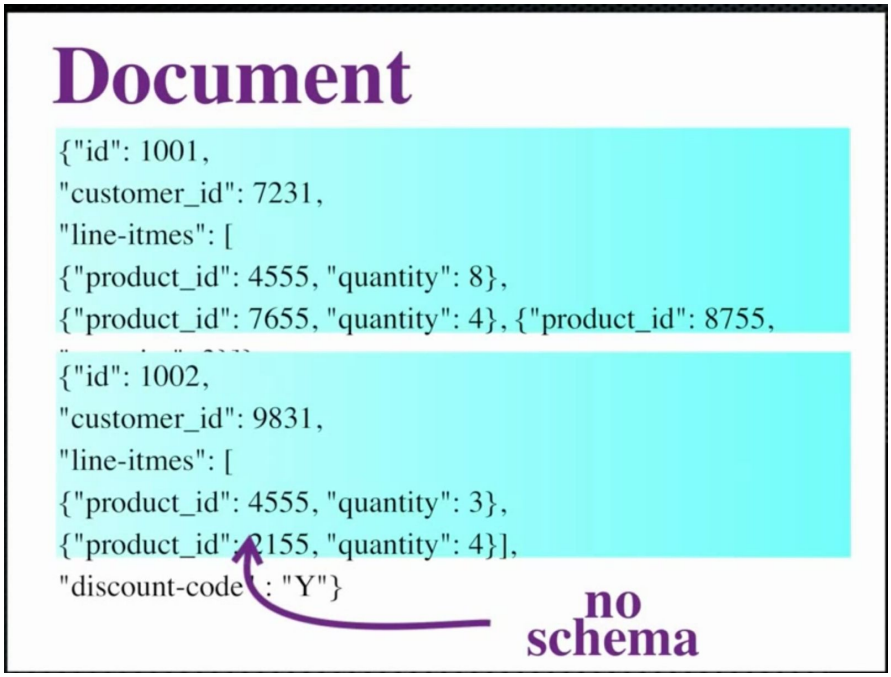
Graph

E.g. Neo4j

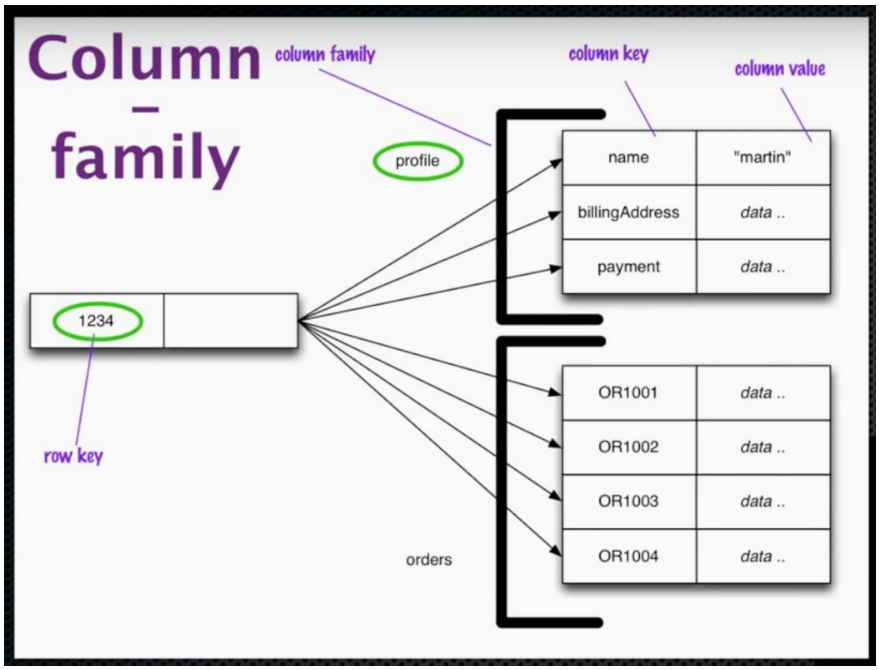
Key Value - NoSQL database



Document - NoSQL database

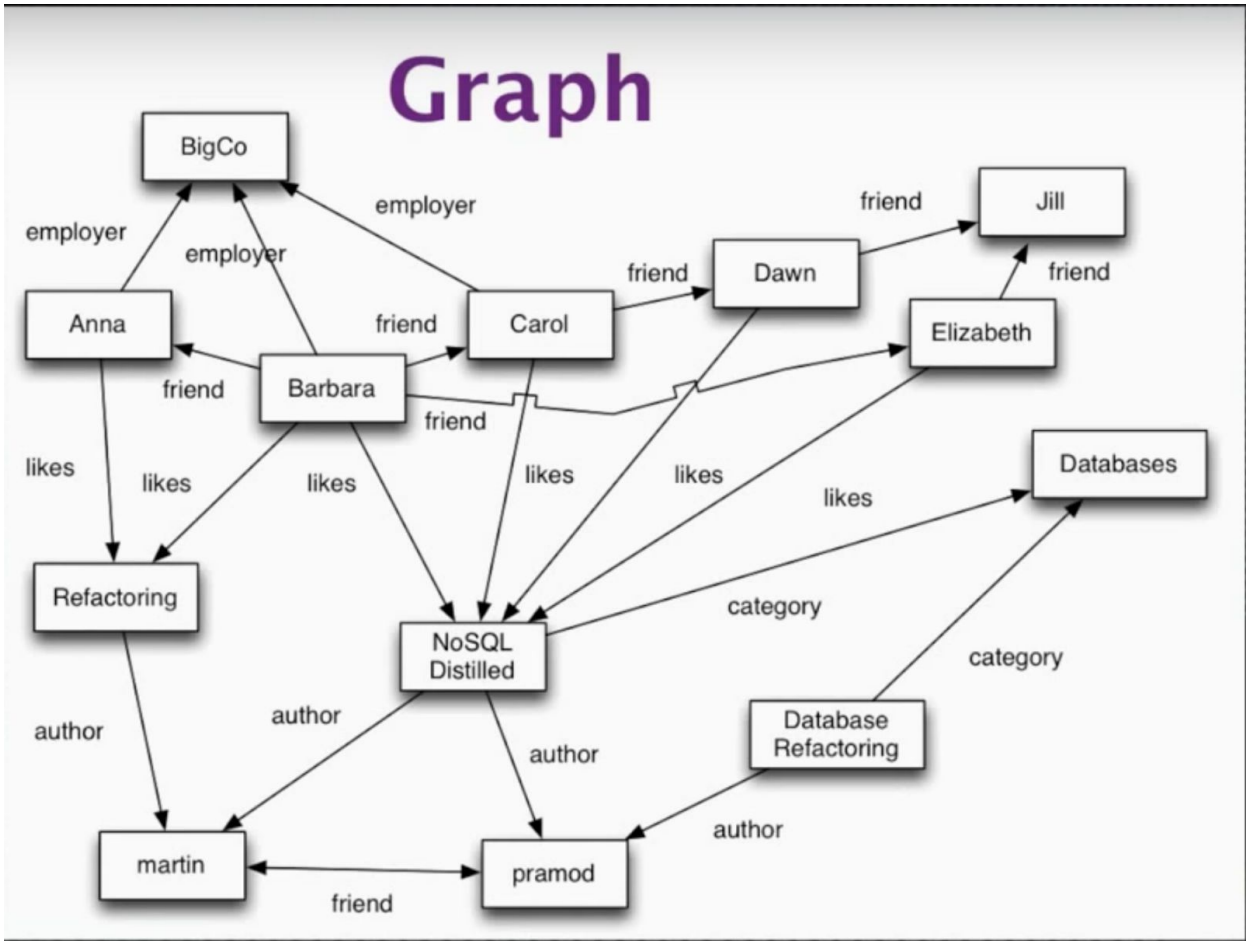


Column Family - NoSQL database

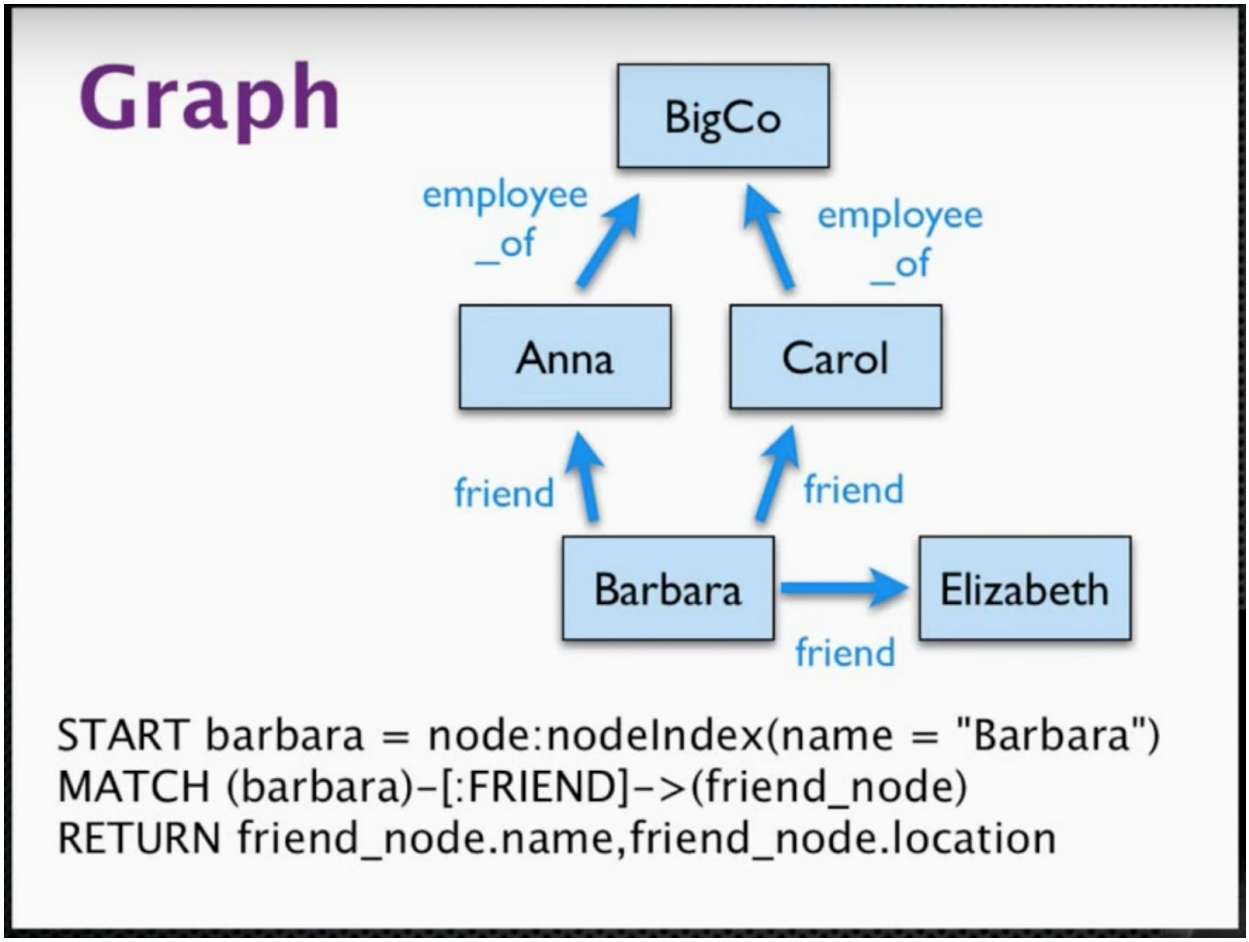


Graph - NoSQL database

Based on relationship between nodes of data. Relational databases don't perform well when joining a lot of tables.



Query language for Graph databases



MongoDB

https://docs.mongodb.com/manual/

Installation

Download Community version

Mac & Linux
https://www.mongodb.com/download-center#community
Unzip the downloaded file. Rename the folder to "mongodb"

Move mongodb folder to any location where you keep your development installations
E.g. I moved it to

/Users/sheraz/dev/mongodb
Tip: create environment variable for mongodb and use it for all other configuration

```
export MONGO_HOME=/Users/sheraz/dev/mongodb
```

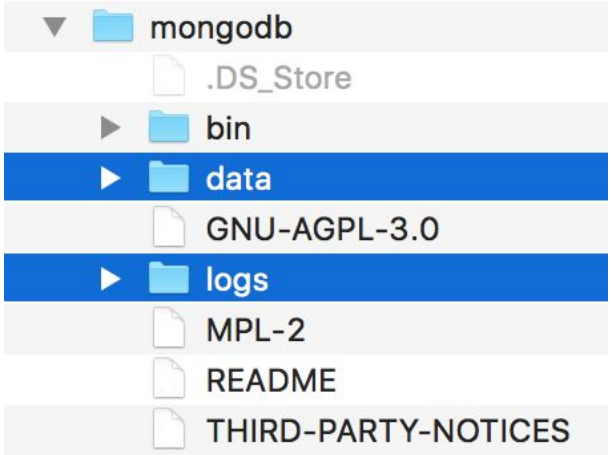
Add bin folder to PATH

```
export PATH=$MONGO_HOME/bin:$PATH
```

Setup Database

Data and logs folder

Make **data** and **logs** folder in **mongodb** folder



Startup script

Create a mongodb startup script e.g. start-mongodb for easy start/restarting mongodb.
Add commands below in the script

```
pkill -9 mongod

mongod --dbpath $MONGO_HOME/data  --directoryperdb --rest --logpath
$MONGO_HOME/logs/mongo.log --logappend
```

start-mongodb

```
pkill -9 mongod

mongod --dbpath $MONGO_HOME/data  --directoryperdb --rest --logpath $MONGO_HOME/logs/mongo.log --logappend
```

Start mongoDB

$ start-mongodb

Using mongodb shell

If mongodb/bin is in path and mongodb process is running then we can use mongodb shell

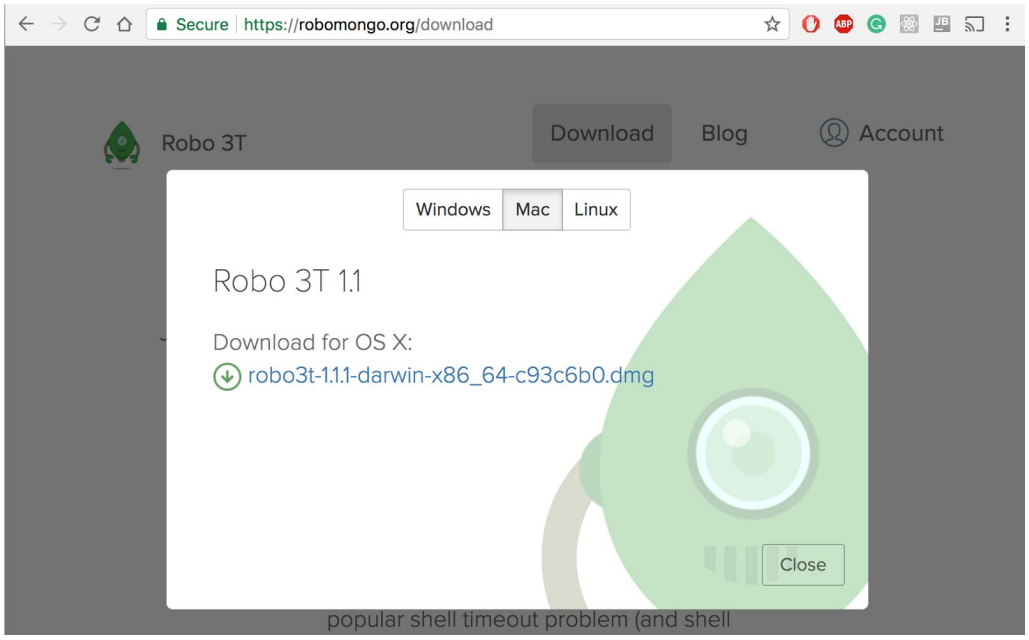
$ mongo

```
sheraz — mongo — 74×32
~/dev/bin — mongod ◂ -bash        ~ — mong  This line does not end wit
Sherazs-MBP:~ sheraz$ mongo
MongoDB shell version v3.4.7
connecting to: mongodb://127.0.0.1:27017
MongoDB server version: 3.4.7
Server has startup warnings:
2017-09-07T20:35:25.061-0400 I CONTROL  [main] ** WARNING: --rest is speci
fied without --httpinterface,
2017-09-07T20:35:25.061-0400 I CONTROL  [main] **          enabling http i
nterface
2017-09-07T20:35:25.555-0400 I CONTROL  [initandlisten]
2017-09-07T20:35:25.556-0400 I CONTROL  [initandlisten] ** WARNING: Access
 control is not enabled for the database.
2017-09-07T20:35:25.556-0400 I CONTROL  [initandlisten] **          Read a
nd write access to data and configuration is unrestricted.
2017-09-07T20:35:25.556-0400 I CONTROL  [initandlisten]
2017-09-07T20:35:25.556-0400 I CONTROL  [initandlisten]
2017-09-07T20:35:25.556-0400 I CONTROL  [initandlisten] ** WARNING: soft r
limits too low. Number of files is 256, should be at least 1000
> show dbs
admin  0.000GB
local  0.000GB
> use mydb
switched to db mydb
> db
mydb
> help
        db.help()                    help on db methods
        db.mycoll.help()             help on collection methods
        sh.help()                    sharding helpers
        rs.help()                    replica set helpers
        help admin                   administrative help
        help connect                 connecting to a db help
```

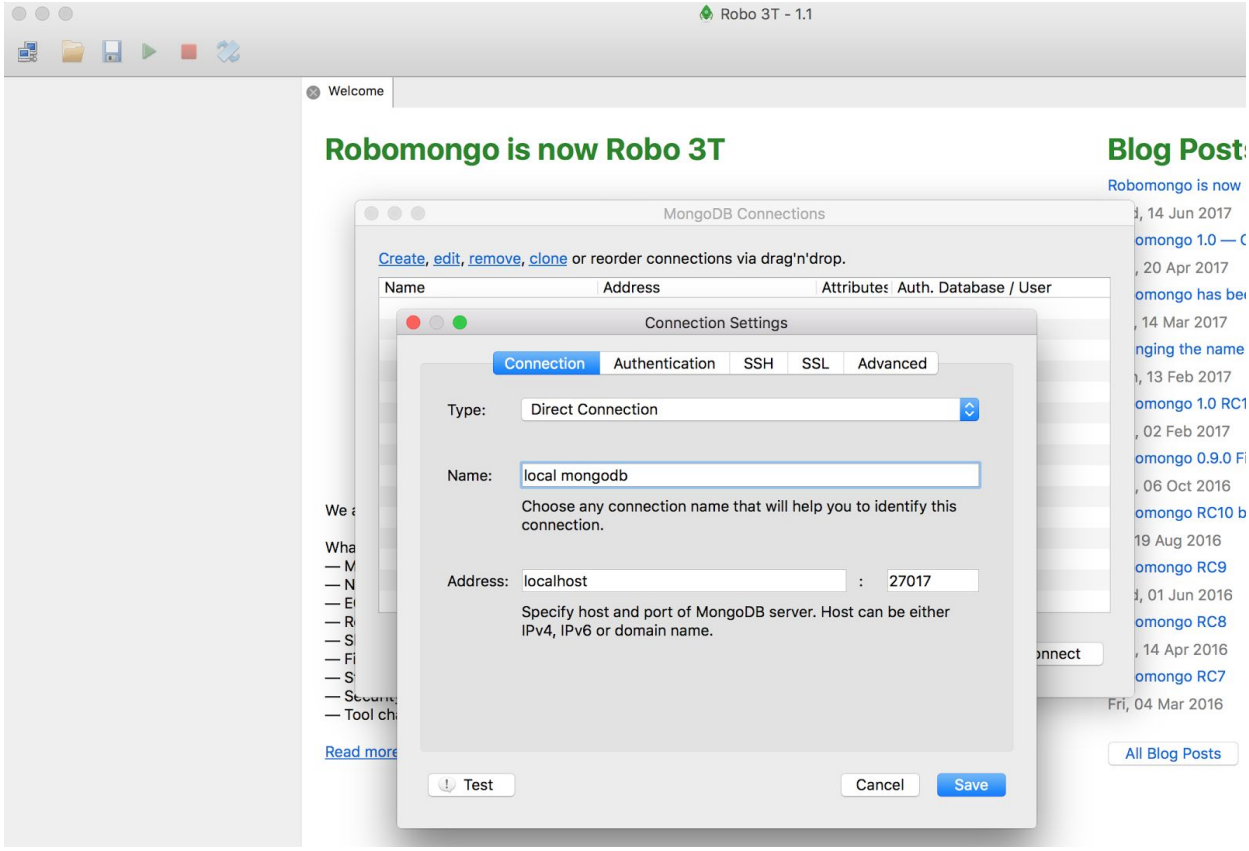
MongoDB IDE/Explorer - Robomongo

Download and install robomongo

https://robomongo.org/download



Create new localhost connection, save it and connect it.

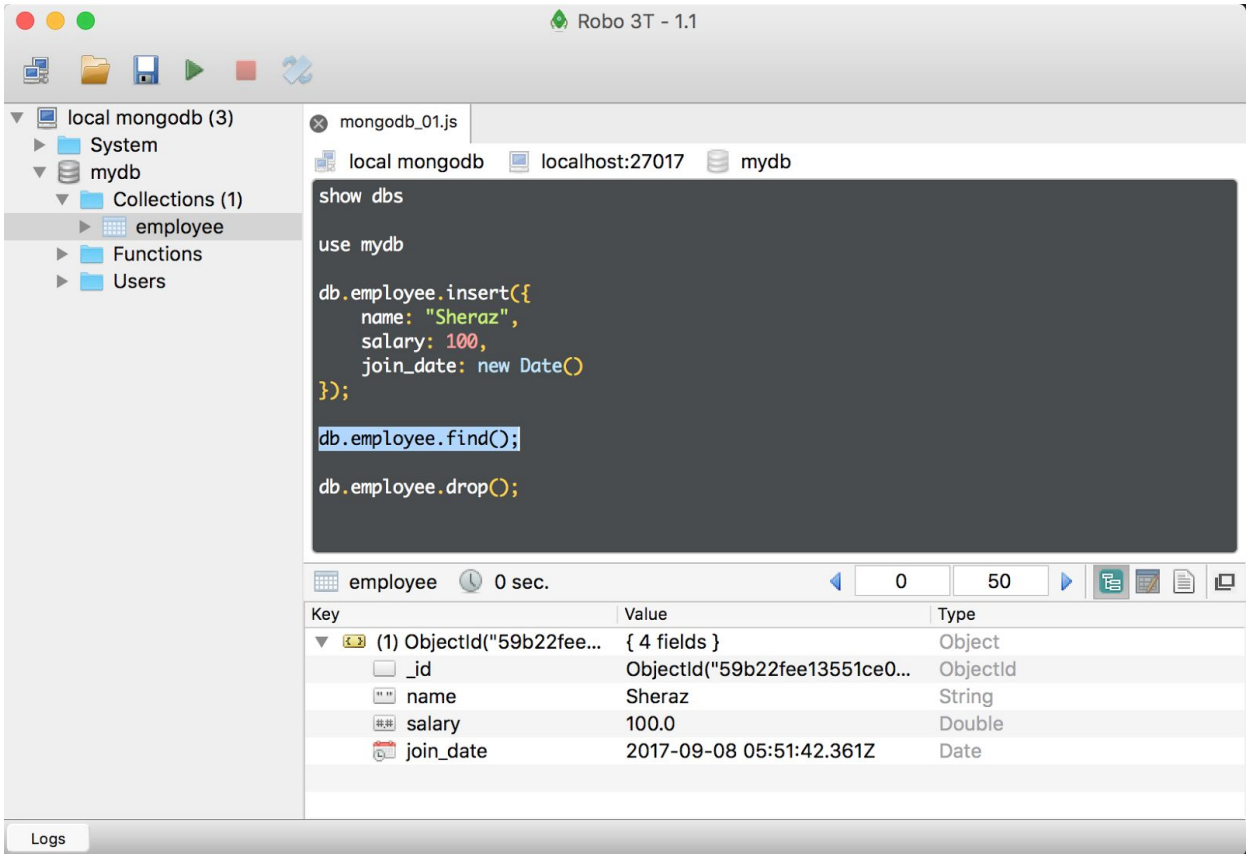


Using robomongo

Create or Use existing script

Right click connection name -> click "Open Shell"

If you have existing script then
Click open button -> browse and open your script



Running script or Command

To run entire script do not select anything in the script and hit command + enter
To run single command select a command and hit command + enter
DB admin commands do not end with semicolon but javascript commands can.

RDBMS vs NoSQL - MongoDB Terminologies

https://docs.mongodb.com/manual/reference/sql-comparison/#terminology-and-concepts
https://docs.mongodb.com/manual/reference/glossary/

SQL Terms/Concepts	MongoDB Terms/Concepts
database	database
table	collection
row	document or BSON document
column	field
index	index
table joins	$lookup, embedded documents
primary key Specify any unique column or column combination as primary key.	primary key In MongoDB, the primary key is automatically set to the _id field.
aggregation (e.g. group by)	aggregation pipeline

Mongo Shell - Javascript

https://docs.mongodb.com/manual/tutorial/write-scripts-for-the-mongo-shell/#differences-between-interactive-and-scripted-mongo
By default mongo shell uses Javascript to interact with mongodb.

Here are some of the shell helper commands and its JavaScript equivalents

Shell Helpers	JavaScript Equivalents
show dbs, show databases	db.adminCommand('listDatabases')
use <db>	db = db.getSiblingDB('<db>')
show collections	db.getCollectionNames()

show users	db.getUsers()
show roles	db.getRoles({showBuiltinRoles: true})
show log <logname>	db.adminCommand({ 'getLog' : '<logname>' })
show logs	db.adminCommand({ 'getLog' : '*' })

it	cursor = db.collection.find()
	if (cursor.hasNext()){
	  cursor.next();
	}

> show dbs
> show databases
Show all the databases

> show roles
Show all mongodb built-in roles

> show users
Show all users

> use <db>
Switch database

Printing results

Mongo shell do not have console.log().
To print result we can:

- Just write variable name
  > myVar
- Use the print() function
  > print(myVar);

This is same behavior as browser and node console.

Help

Shell help commands

> help

> help admin
> help connect
> help keys
> help misc
> help mr

JavaScript help commands

help("");
help("connect");
help("mr");
help("keys");
help("admin");
help("misc");

NOTE: Go over all help();

Database

To use or to switch to an existing or non existing database we can use **use** command
> use mydb
After this command a global variable **db** is created.
In all subsequent commands when we have to use current selected database then we use it through **db** variable.

> print(db);
> db.stats();
> db.help();
> db.listCommands();

NOTE: Go over all the commands mentioned in db.help(); and db.listCommands();

Collection

Collections are just like RDBMS table.

Create Collection

```
db.createCollection("person");
```

List all Collections

```
show collections
```

Drop Collection

```
db.person.drop();
```

Basic CRUD

https://docs.mongodb.com/manual/crud/
First object in find(), update(), and remove() is **Filter** Object. You will find more details on Filters in following sections.

```
db.person.insert({
   name: "Sheraz",
   salary: 100
});

db.person.find({});

db.person.update({}, {
   name: "Sheraz",
   salary: 200
});

db.person.remove({});
```

Data Types and Values

All JSON/BSON data types are valid in mongodb
ObjectID, null, String, Number base 64 bit floating points, boolean, Date, Arrays, Regular Expression (given between //), Complex JSON objects

Retrieve selected fields

https://docs.mongodb.com/manual/tutorial/project-fields-from-query-results/
find() will always return all the fields in a document. To retrieve selected field we have to set field name to 1.

```
db.person.find({}, {name: 1});
```

Even if we retrieve selected fields, still find() will return _id. To turn off _id we use 0.

```
db.person.find({}, {name: 1, _id: 0});
```

Update selected fields

https://docs.mongodb.com/manual/reference/operator/update-field/
update() expects the entire object (with all the fields) even if we want to update some of the fields. To overcome it we can use **$set** Update Operator. **$set** operator update given field's value.
https://docs.mongodb.com/manual/reference/operator/update/set/

```
db.person.update({}, {$set: {name: "Chaudhry"}});
```

First argument object is filter/criteria and second object is what to update;

Below command update all employee, sets salary=1500 where salary < 1500

```
db.employee.update({salary: {$lt: 1500}}, {$set: {salary:
1500}}, {multi: true});
```

Lookup other update operator
https://docs.mongodb.com/manual/reference/operator/update/

Filter

https://docs.mongodb.com/manual/tutorial/query-documents/
First object in find(), update(), and remove() is **Filter** Object. Just like in SQL we write WHERE clause in SELECT, UPDATE and DELETE.

Exact match (Just like = in SQL)

```
// Exact match
db.person.find({name: "Sheraz", salary: 100});
```

Comparison

https://docs.mongodb.com/manual/reference/operator/query-comparison/

```
// Comparison < ($lt), > ($gt), <= ($lte), >= ($gte),
db.person.find({salary: {$lt: 200}});
```

In

```
// In ($in), Not In ($nin)
db.person.find({name: {$in: ["Sheraz", "Chaudhry"]}});
```

Logical

https://docs.mongodb.com/manual/reference/operator/query-logical/

```
// And ($and), Or ($or)
db.person.find({$or: [
   {name: "Sheraz"},
   {salary: {$gt: 50}}
]});
```

Loading external Script in Console

Create a script in your computer
E.g.
~/dev/mogo
oad("/path/my-script-name.js");
Run the function inside the script MAY BE

Files

~/.dbshell - History of mongo shell commands
~/.mongorc.js - startup script
/etc/mongorc.js - Global startup script

Commands

$set, $mul, $pop -1 1, $push, $slice, $pull, $gt, $lt, $gte, $lte

Aggregation

https://docs.mongodb.com/manual/aggregation/
https://docs.mongodb.com/manual/reference/operator/aggregation-group/
There are 3 types of Aggregation.

- Aggregation Pipeline,
- Map-Reduce,
- Single Purpose Aggregation Operations

Aggregation Pipeline

https://docs.mongodb.com/manual/core/aggregation-pipeline/

Map-Reduce

https://docs.mongodb.com/manual/core/map-reduce/

Single Purpose Aggregation Operations

https://docs.mongodb.com/manual/reference/aggregation/

SQL and Mongodb Aggregation Comparison

https://docs.mongodb.com/manual/reference/sql-aggregation-comparison/

Privilege Action

https://docs.mongodb.com/manual/reference/privilege-actions

Roles

Built-in Roles

https://docs.mongodb.com/manual/core/security-built-in-roles/

User defined Roles

https://docs.mongodb.com/manual/core/security-user-defined-roles/

User

https://docs.mongodb.com/manual/core/security-users/
https://docs.mongodb.com/manual/tutorial/create-users/

Create user

```
db.createUser(
    {
```

```
        user: "myuser",
        pwd: "password123",
        roles: [
            { role: "readWrite", db: "mydb" }
        ]
    }
);
```

Drop User

```
db.dropUser("myuser");
```

Enable Authentication

https://docs.mongodb.com/manual/tutorial/enable-authentication/