
# The Humongous Database

Geoffrey Berard / @geofberard
geoffrey.berard@gmail.com
bit.ly/3oH4mMb - pdf

# Plan

I. MongoDB Presentation
- Schemaless
- BSon
- Document Model
- Performance

II. MongoDB Architecture
- Replica Set
- Sharding

# Plan

III. MongoDB CRUD
- CREATE
- READ
- UPDATE
- DELETE

IV. Software with MongoDB
- Architecture

V. Practical


# Presentation

# MongoDB

Technology

- Document oriented Data Base
- Non relational
- Dynamic : Schemaless
- No query lanquage
- No transactions
- Scalable : Auto Sharding
- Made in C++

# MongoDB

Functionnalities

- Text Search
- GeoSearch
- Aggregation
- Map-Reduce

# MongoDB

Supported languages

# JSON Document

```
{
  "_id": 1,
  "first_name": "Paul",
  "surname": "McCartney",
  "instruments": [
    "Guitar",
    "Bass guitar",
    "Piano"
  ],
  "address": {
    "street": "20 Forthlin Road",
    "city": "LiverPool",
    "zip": "United Kingdom"
  }
}
```

# JSON Document

Available Data Types :

- Array
- Object
- String
- Number
- Boolean
- Null

# Schemaless

Exemple RDBMS - Musiciens

| first_name | last_name | birthday |
| --- | --- | --- |
| Louis | Armstrong | 4 août 1901 |

# Schemaless

Exemple RDBMS - Alter table

| first_name | last_name | title | birthday |
|---|---|---|---|
| Louis | Armstrong | | 4 août 1901 |
| Paul | McCartney | Sir | 18 June 1942 |

# Schemaless

Exemple RDBMS - Holed Table

| first_name | last_name | title | nickname | birthday |
|---|---|---|---|---|
| Louis | Armstrong | | | 04 août 1901 |
| Paul | McCartney | Sir | | 18 June 1942 |
| Gordon Matthew Thomas | Summer | | Sting | 02/10/1951 |

# Schemaless

Exemple - MongoDB

```
[
  {
    "first_name": "Louis",
    "surname": "Armstrong",
    "birthday": "4 août 1901"
  },
  {
    "first_name": "Paul",
    "surname": "McCartney",
    "title": "Sir",
    "birthday": "18 June 1942"
  },
  {
    "first_name": "Gordon Matthew Thomas",
    "surname": "Sumner",
```

# Schemaless

Be carefull

```
[
  {
    "first_name": "Louis",
    "surname": "Armstrong",
    "birthday": "4 août 1901"
  },
  {
    "first_name": 42
  }
]
```

# Schemaless

Be carefull

# BSON

Binary Representation of JSON - 16MB Maximum

```
{
  "hello": "world"
}
```

Gives in BSON

```
\x16\x00\x00\x00\x02hello\x00\x06\x00\x00\x00world\x00\x00
```

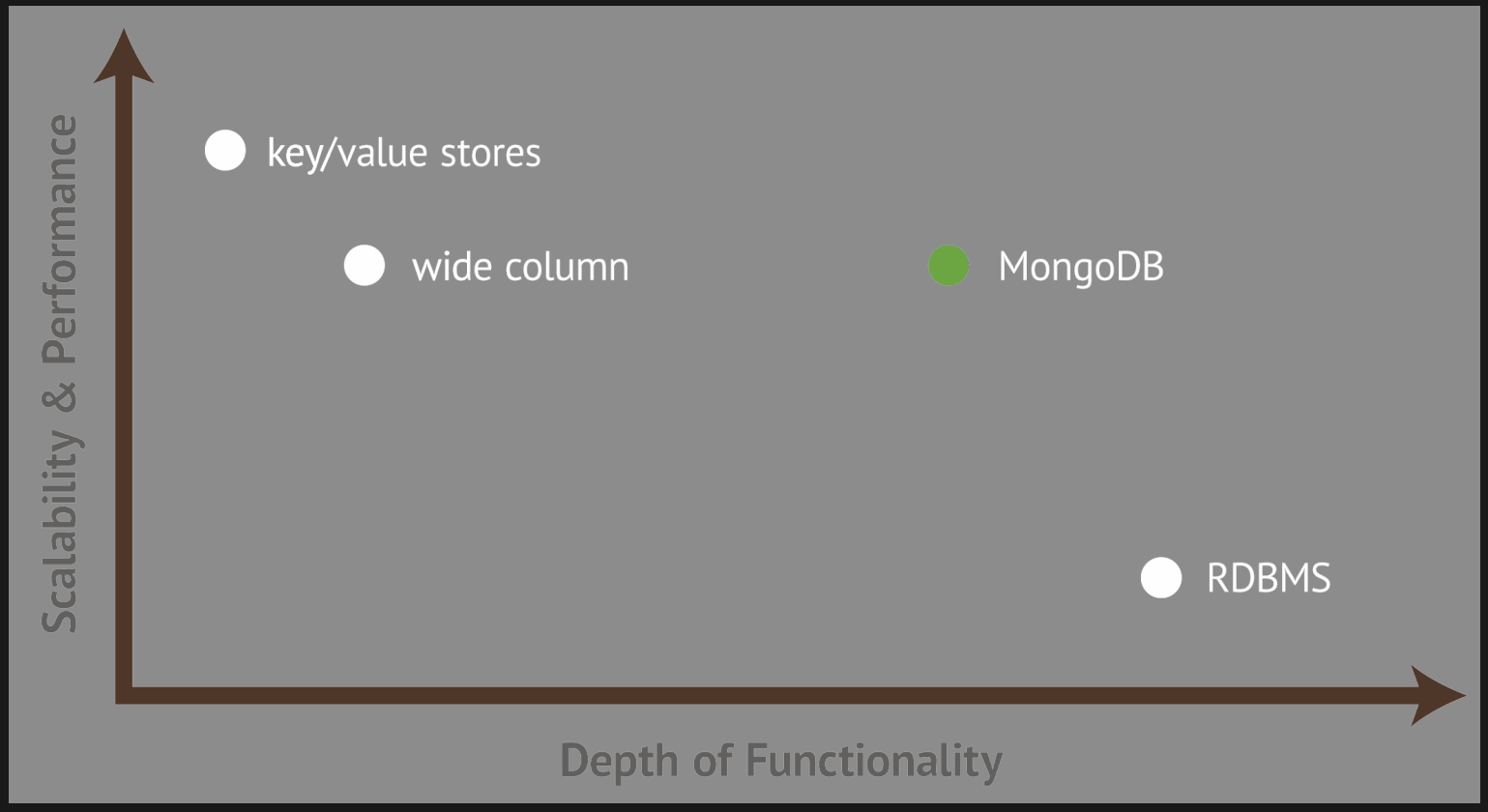
# BSON

Enriched Types

| Type | Type |
| --- | --- |
| Double | Regular expression |
| String | JavaScript |
| Object | Symbol |
| Array | 32-bit integer |
| Binary data | Timestamp |
| Object ID | 64-bit integer |
| Boolean | Min key |
| Date | Max key |
| Null | |

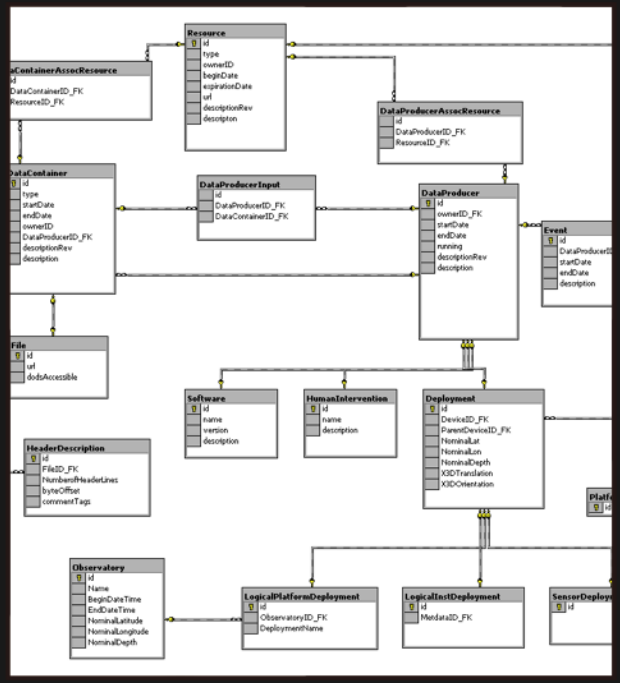
bsonspec.org

# Position


Scalability & Performance
key/value stores
wide column
MongoDB
RDBMS
Depth of Functionality

# Relational VS Document

Models Differences




```
{
    _id : ObjectId("4c4ba5e5e8aabf3"),
    employee_name: "Dunham, Justin",
    department : "Marketing",
    title : "Product Manager, Web",
    report_up: "Neray, Graham",
    pay_band: "C",
    benefits : [
            {  type :  "Health",
               plan : "PPO Plus" },
            {  type :   "Dental",
               plan : "Standard" }
                ]
}
```

# Relational VS Document

## Relational Model

**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 | Rome |

NO RELATION

**CAR**

| Car_ID | Model | Year | Value | Pers_ID |
|---|---|---|---|---|
| 101 | Bently | 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 |

# Relational VS Document

## Document Model

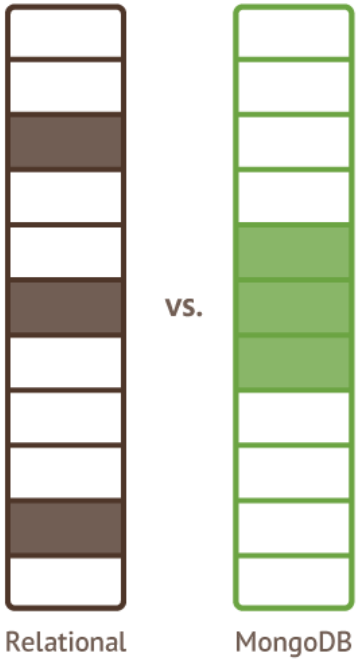
```
{
  "first_name": "Paul",
  "surname": "Miller",
  "city": "London",
  "cars": [
    {
      "model": "Bentley",
      "year": 1973,
      "value": 100000
    },
    {
      "model": "Rolls Royce",
      "year": 1965,
      "value": 330000
    }
```

# Relational VS Document

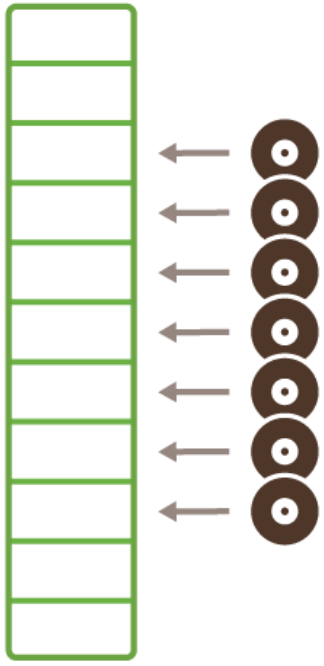
Terminology

| RDBMS | Mongo |
| --- | --- |
| Table, View | Collection |
| Row(s) | JSON Document |
| Index | Index |
| Join | Embedded Document |
| Partition | Shard |
| Partition Key | Shard Key |

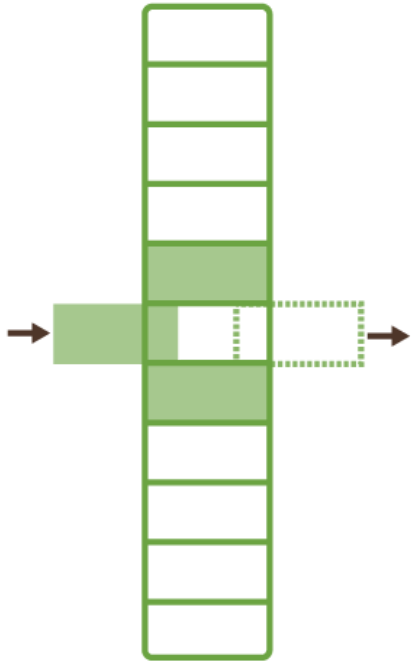
# Performances




Locality



Caching



Update

# Benefits

Efficient

- Super low latency
- Scale Easily

Agility and flexibility

- Data models can evolve easily
- Companies can adapt to changes quickly

Intuitive, natural data representation

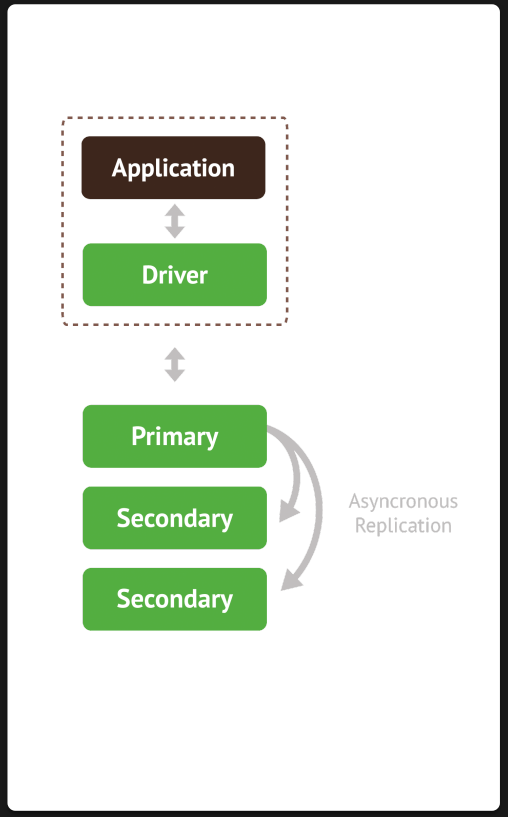
- Developers are more productive
- Many types of applications are a good fit

Reduces the need for joins, disk seeks

- Programming is more simple
- Performance can be delivered at scale


# Architecture

# Replica Set

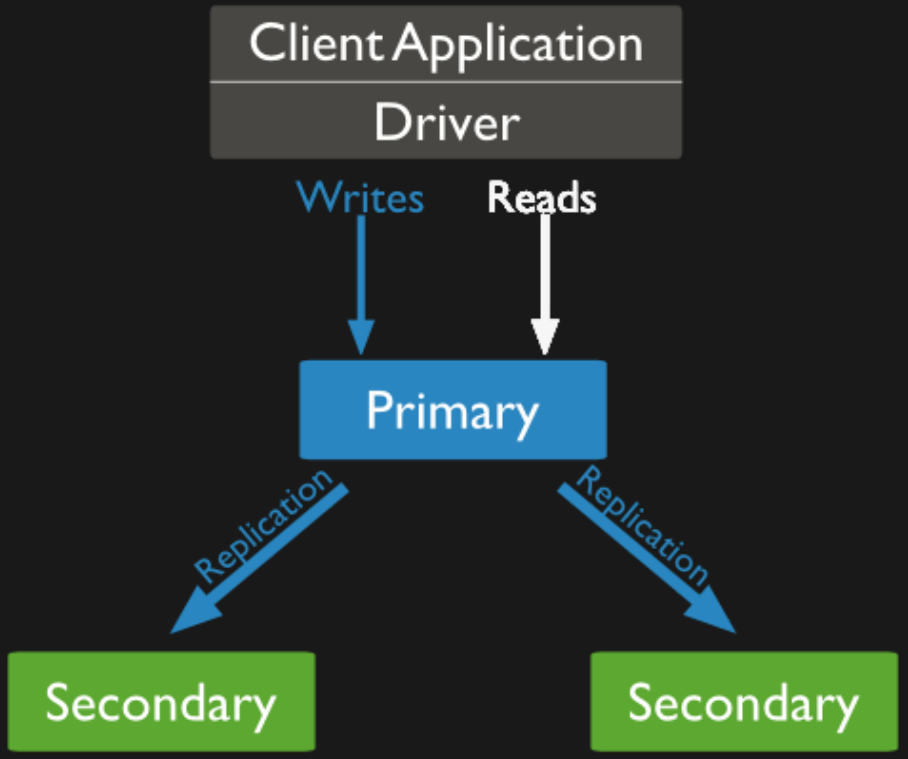



Two copies or more
Master / Slave
Automatic Failover
Purpose

- High Availability
- Data Recovery
- Maintenance

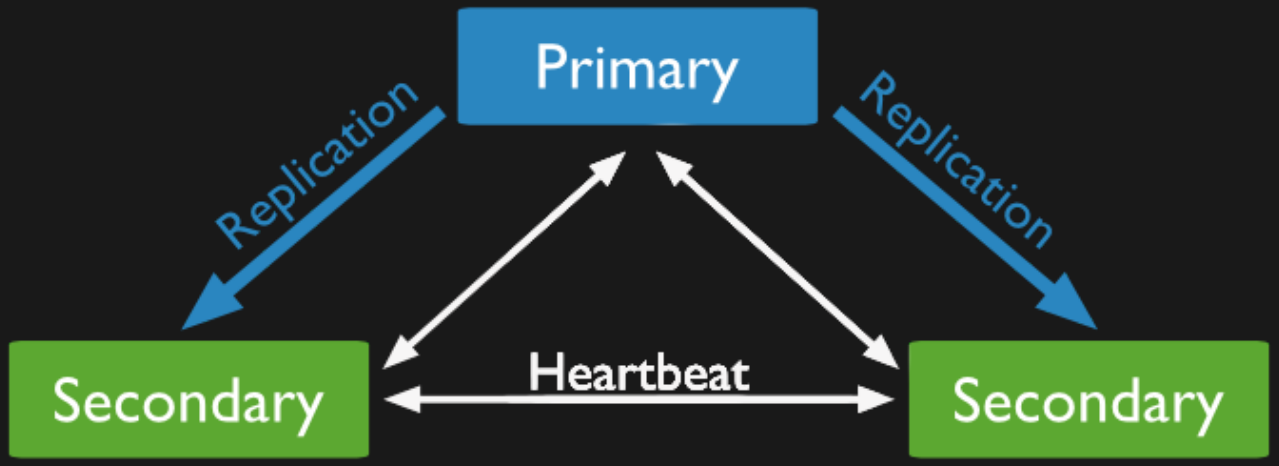
# Replica Set

Architecture



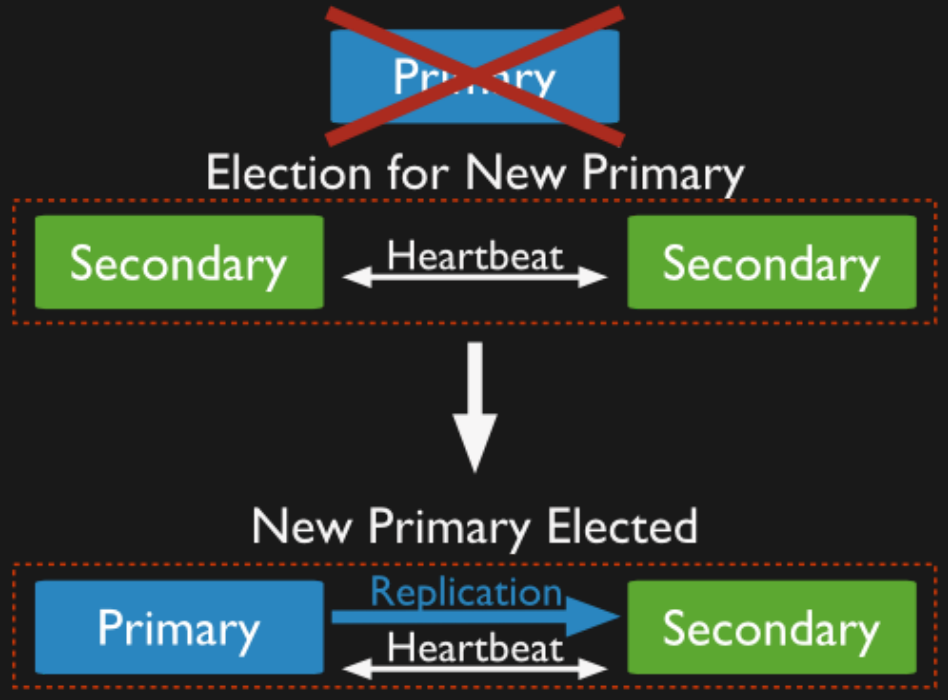
# Replica Set

Architecture



# Replica Set

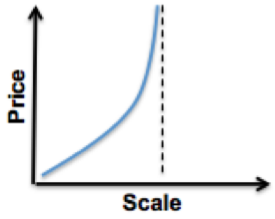
Architecture

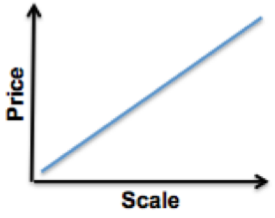


# Scalability

Vertical

Horizontal



# Sharding

## Config Server

Contains cluster metadatas

- 1 instance in dev, 3 in production
- Contains intervals definitions (chunks)
- Maintenance

# Sharding

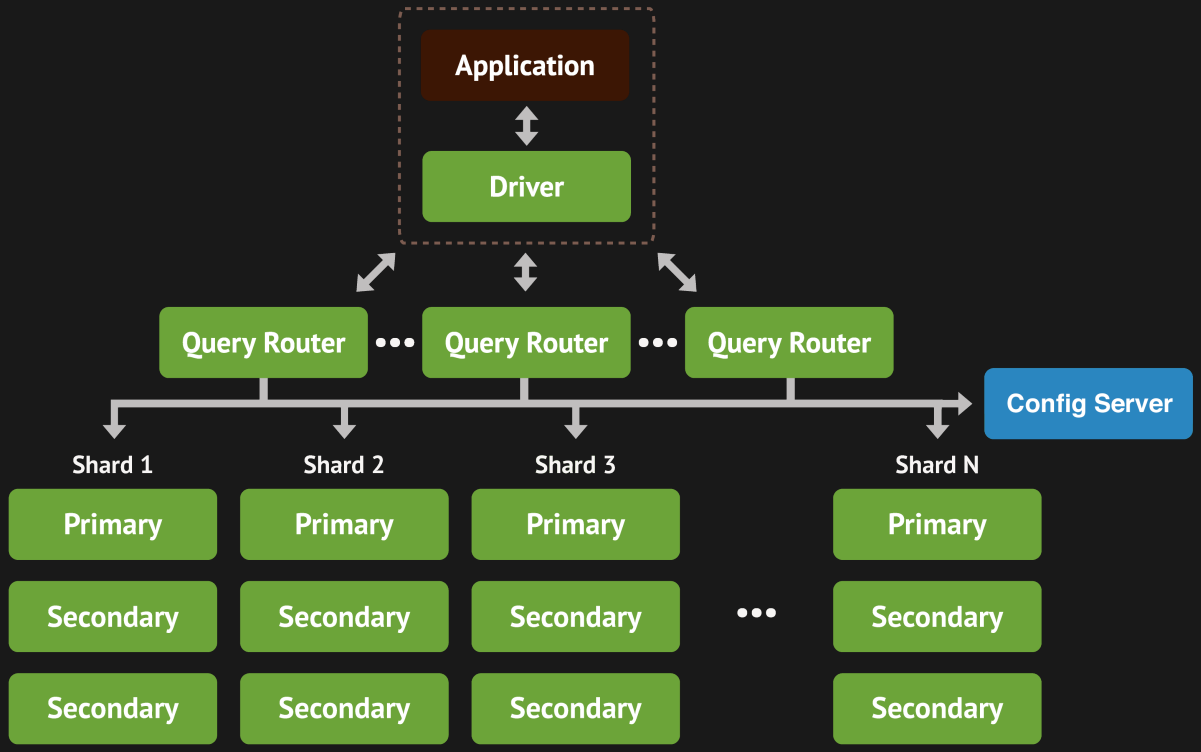
## Query Router (M ongos)

Contains cluster metadatas

- Behaves identically to mongod
- Query router
- Load Balancer
- Dedicated or shared

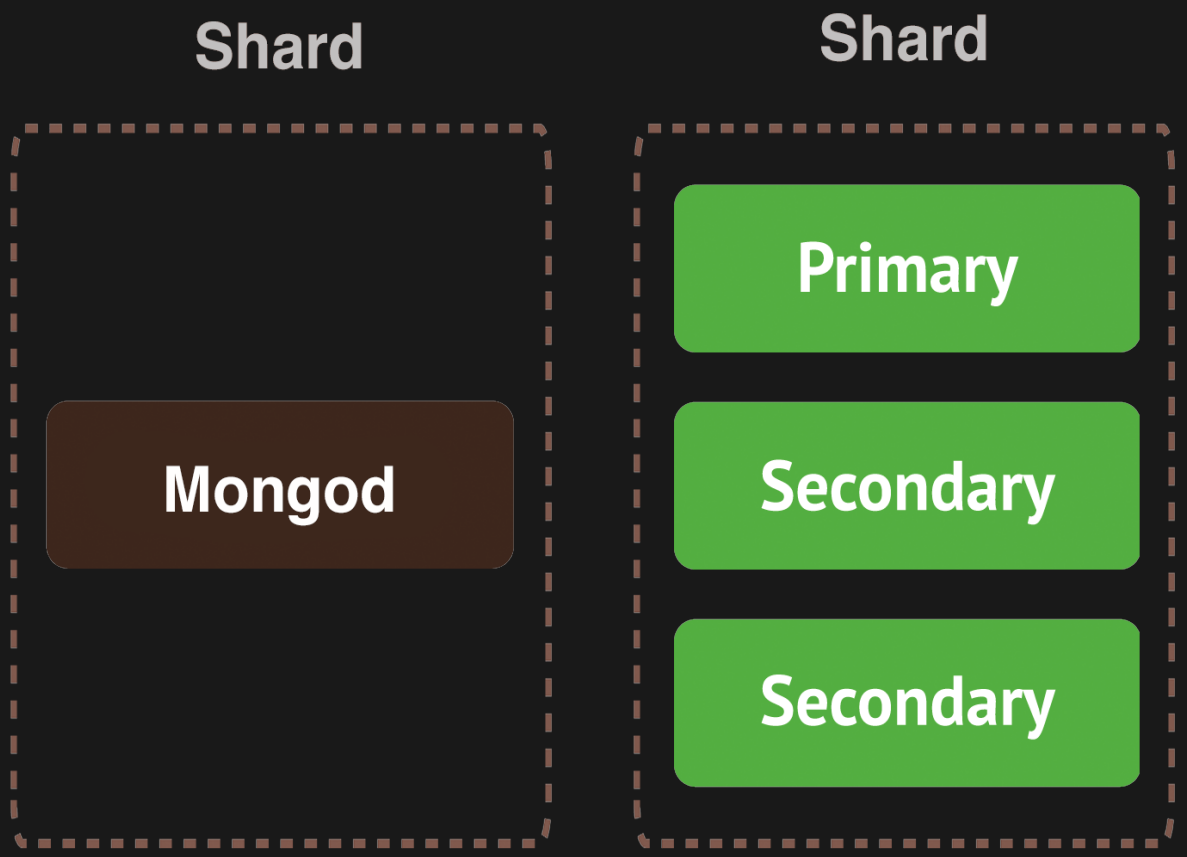
# Sharding

## Architecture



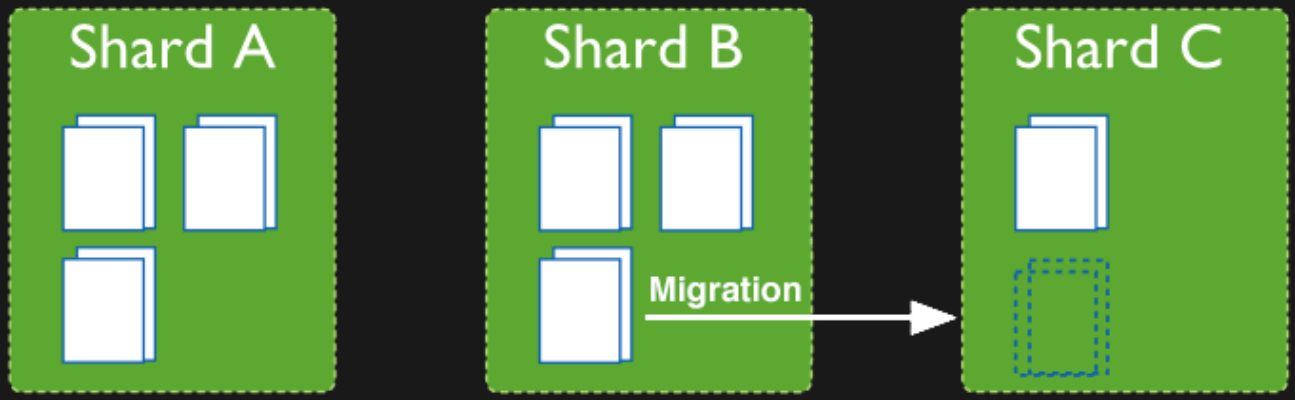
# Sharding

Shard = Cluster Node



# Sharding

Balancing



# Sharding

## Sharding Key

Requirement :

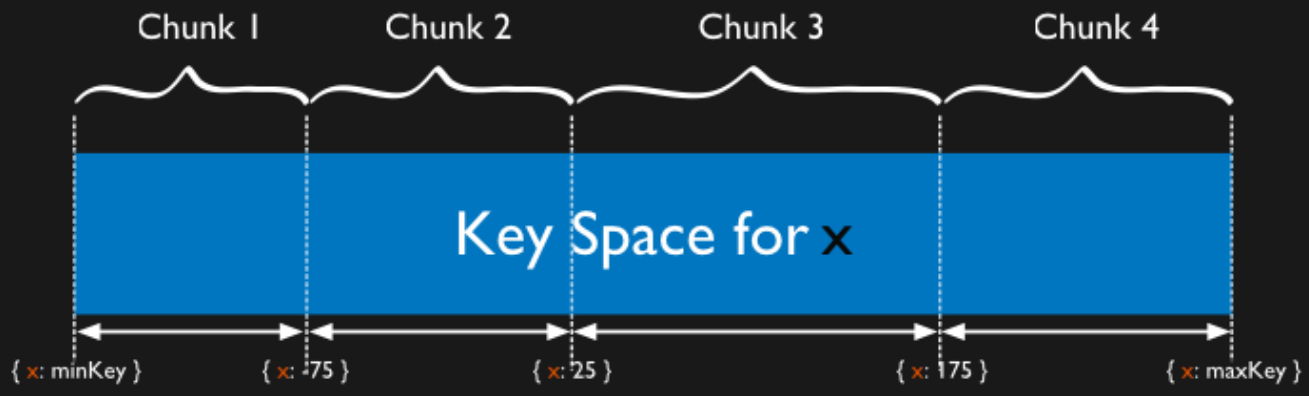
- Immutablility (key/value)
- Big cardinality
- Distributed
- Should be indexed
- Limited to 512 octets

# Sharding

## Chunk

Requirement :

- Split if bigger than 64Mo
- Split & Moved
- Split only between 2 différent values
- Moved Automatically




# CRUD

# Schemaless

Exemple RDBMS - Alter table

| | SQL | MongoDB |
|---|---|---|
| Create | Insert | Insert |
| Read | Select | Find |
| Update | Update | Update |
| Delete | Delete | Remove |

# Schemaless

~~Query language~~ => methods of objects

# Identifier

```
{
  "_id": 1,
  "first_name": "Victor",
  "surname": "Hugo",
  "groups": [
    "Writer",
    "Painter"
  ]
}
```

- Unique
- Can't be changed

# Create

## Insert

```
> db.member.insert({new_document})
```

```
WriteResult({ "nInserted" : 1 })
```

Create the collection if necessary

```
> db.member.insert({first_name: "John", last_name: "Doe"})
> db.member.insert({first_name: "Jean", last_name: "Dupont", city_of_birth: "Paris
```

# Create

## Index

Syntax (Index types)

```
createIndex( { userid: index_type } )
```

```
> db.records.createIndex( { userid: 1 } )   // Ascending index
> db.records.createIndex( { userid: -1 } )   // Descending index
```

# Create

## mongoimport

Test Only

Supported file format

- Json
- CSV
- TSV

```
$ ./mongoimport --db test --collection zips --file ../../../Downloads/zips.json
```

Download zips.json

# Read

## Find

Returning all elements of a collection:

```
> db.member.find()
```

```
{"_id":"ObjectId(\"54853dd6dd8fc0fec931fcbc\")","first_name":"John","last_name":"D
```

Returning only the first element:

```
> db.member.findOne()
```

# Read

## Find

Formating the result :

```
> db.member.find().pretty()
```

```
{
  "_id": "ObjectId(\"54853dd6dd8fc0fec931fcbc\")",
  "first_name": "John",
  "last_name": "Doe"
}
```

# Read

## Find

### Syntax

```
<collection>.find({query},{keys_filter})
```

### Example

```
> db.zips.find({state:"NY"},{city:true, _id:false})
```

```
{ city: "FISHERS ISLAND" }
{ city: "NEW YORK" }
{ city: "NEW YORK" }
{ city: "NEW YORK" }
{ city: "GOVERNORS ISLAND" }
```

# Read

## Querying

Greater than ($gt, $gte)

```
{ pop : {$gt : 100000} }
```

Lower than ($lt, $lte)

```
{ pop : {$lte : 100} }
```

Regular Expression ($regex)

```
{ city : {$regex : "^A"} }
```

# Read

## Querying

### Value Exists ($exists)

```
{ city : {$exists : true} }
```

### Value Type ($type) (Type codes)

```
{ city : {$type : type_code} }
```

# Read

## Wrong Query

Overriding query property

```
{ pop: {$gt: 10000}, pop: {$lt: 50000}}
```

is equivalent to

```
{ pop: {$lt: 50000}}
```

# Read

## Array Query

### Natural

```
{ groups : "Painter" }
```

### In ($in)

```
{ groups : { $in : ["Writer", "Sculptor", "Dancer"]}}
```

### All ($all)

```
{ groups : { $all : ["Painter", "Writer"]}}
```

## Can return

```
{
  "first_name": "Victor",
  "surname": "Hugo",
  "groups": [
    "Writer",
    "Painter"
  ],
  "address": {
    "number": 6,
    "street_name": "Place des Vosges",
    "city": "Paris",
    "zip": "75004"
  }
}
```

# Read

## Nested Document Query

```
{
  "address": {
    "number": 6,
    "street_name": "Place des Vosges",
    "city": "Paris",
    "zip": "75004"
  }
}
```

or

```
{ "address.city" : "Paris" }
```

## Can return

```
{
  "first_name": "Victor",
  "surname": "Hugo",
  "groups": [
    "Writer",
    "Painter"
  ],
  "address": {
    "number": 6,
    "street_name": "Place des Vosges",
    "city": "Paris",
    "zip": "75004"
  }
}
```

# Read

## Wrong Queries

### Incomplete object description

```
{ address : { city : "Paris" }})
```

### Document key in the wrong order

```
{
  "address": {
    "street_name": "Place des Vosges",
    "number": 6,
    "city": "Paris",
    "zip": "75004"
  }
}
```

# Read

## Combined Query

### Natural

```
{ pop : {$gt : 100000, $lt : 2000000} }
```

### Or ($or)

```
{ $or : [{state : "NY"} , {state : "NJ"}]}
```

### And ($and)

```
{ $and : [ {state : "NY"} , {pop : {$gt : 50000} } ] }
```

## Query combinaison combinaison ???

```
{$and:[{$and:[{city:{regex:"^N"}},{$or:[{state:"NY"},{state:"NJ"}]}]},
{pop:{$gt:100000,$lt:150000}}]}
```

# Read

Query combinaison combinaison ???

```
{$and:[{$and:[{city:{regex:"^N"}},{$or:[{state:"NY"},{state:"NJ"}]}]},
{pop:{$gt:100000,$lt:150000}}]}
```

```
{
  $and: [
    {
      $and: [
        { city: { regex: "^N" } },
        { $or: [{ state: "NY" }, { state: "NJ" }] },
      ],
    },
    { pop: { $gt: 100000, $lt: 150000 } },
  ],
};
```

## Query combinaison combinaison ???

```
{$and:[{$and:[{city:{regex:"^N"}},{$or:[{state:"NY"},{state:"NJ"}]}]},
{pop:{$gt:100000,$lt:150000}}]}
```

```
{
  $and: [
    {
      $and: [
        { city: { regex: "^N" } },
        { $or: [{ state: "NY" }, { state: "NJ" }] },
      ],
    },
    { pop: { $gt: 100000, $lt: 150000 } },
  ],
};
```

Cities starting with "N" in New York or New Jersey with a population between 100k and 150k inhabitants

# Read

## Count

```
> db.zips.count({find_query})
```

Example

```
> db.zips.count({state:"NY"})
```

# Read

## Cursor

```
> cursor = db.zips.find({state:"MA"},{city:true, _id:false}); null;
```

## Iterating over results :

```
> cursor.hasNext()    // > true
> cursor.next()       // > "AGAWAM"
> cursor.next()       // > "CUSHMAN"
```

# Read

## Operation on cursor

```
> cusror.sort({city : -1})   // Sort in reverse alphabetical order
> cursor.limit(5)            // Limit the nomber of results to 5
> cusror.skip(3)             // Skip 3 elements besore returning the result
```

## They can be combined

```
> cusror.sort({city : -1}).limit(5).skip(3)
```

# Update

## Syntax

```
<collection>.update( {find_query} , {update_query}, {update_params} )
```

## Example

```
update({surname : "Hugo"}, {surname : "Hugo", groups : [ "Writer", "Painter"]})
```

## On document

```
{
  "first_name": "Victor",
  "surname": "Hugo",
  "address": {
    "number": 6,
    "street_name": "Place des Vosges",
    "city": "Paris",
    "zip": "75004"
  }
}
```

## Will give

```
{
  "surname": "Hugo",
  "groups": [
    "Writer",
    "Painter"
  ]
}
```

# Update

## Ajouter/Modifier des champs ($set)

```
{$set : {groups : [ "Writer", "Painter"]}}
```

## Supprimer des champs ($unset)

```
{$unset : {groups : 1}}
```

## Modify Key ($unset)

```
{$rename : {"oldName" : "newName"}}
```

# Update

## Modify (number)

```
{$inc : {count : 1}}
```

```
{$mul : {price : NumberDecimal("0.5")}}
```

## Compare to current value (number, date)

```
{$min : {bestPrice : 150}}
```

```
{$max : {highScore : 1275000}}
```

# Update

## Array manipulation

### Change Value

```
{"groups.2" : "Poet"}
```

### Add element ($push)

```
{$push : {groups : "Poet"}}
{$pushAll : {groups : ["Poet","Politician"]}}
```

### Remove element ($pop)

```
{$pop : {groups : 1}}   // remove last element
{$pop : {groups : -1}}  // remove first element
```

# Update

## Array manipulation

### Remove specific element ($pull)

```
{$pull : {groups : "Poet"}}
{$pullAll : {groups : ["Poet","Politician"]}}
```

### Take array as a set ($addToSet)

```
{$addToSet : {groups : "Poet"}}  //  Add "Poet"
{$addToSet : {groups : "Poet"}}  //  Do nothing because exists
```

# Update

Multiple update

=>Upsert

```
{ upsert : true }     // As update third parameter
```

```
> db.member.update({surname : "Washington"},
          { $set : {groups : [ "Writer", "Painter"]}},
          { upsert : true })
```

# Update

Update or insert

```
{ multi : true }     // As update third parameter
```

```
> db.member.update({},
  { $set : {title : "Mr"}},
  { multi : true })
```

```
WriteResult({ "nMatched" : 5, "nUpserted" : 0, "nModified" : 5 })
```

# Delete

## Syntax

```
<collection>.remove({find_query})
```

## Drop a collection

```
<collection>.drop()
```

# Debugging

```
> db.zips.explain().find({query});
```

or

```
> cur = db.zips.find({query}); null;
> cur.explain()
```

# Debugging

Example

```
> db.zips.explain().find({state:"MA"},{city:true, _id:false}).sort({city : -1}).li
```

```
{
  "queryPlanner": {
    "plannerVersion": 1,
    "namespace": "test.zips",
    "indexFilterSet": false,
    "parsedQuery": {
      "state": {
        "$eq": "MA"
      }
    },
    "serverInfo": {
      "host": "localhost",
      "port": 27017,
      "version": "4.0.4",
      "gitVersion": "f288a3bdf201007f3693c58e140056adf8b04839"
```

# Debugging

## Execution detail

```
> cur = db.zips.explain("executionStats").find({state:"MA"},{city:true, _id:false}
```


```
{
  "queryPlanner": {
    "namespace": "test.zips"
  },
  "executionStats": {
    "executionSuccess": true,
    "nReturned": 5,
    "executionTimeMillis": 20,
    "totalKeysExamined": 0,
    "totalDocsExamined": 29353
  },
  "serverInfo": {
    "host": "it-gbe",
    "port": 27017,
    "version": "3.2.11",
```

# Advanced

Distinct (details)

```
> db.zips.distinct({field} , {search_query})
```

```
> db.zips.distinct("state" , {})
[
        "MA",
        "RI",
        "NH",
    ...
]
```

# Advanced

Geospacial (details)

```
> db.zips.createIndex( { loc : "2d" } )
> db.zips.find( { "loc": {$near : [ -112.416728, 37.781334 ] } } ).limit(5)
```

```
{ "_id" : "84759", "city" : "PANGUITCH", "loc" : [ -112.436886, 37.80777 ], "pop"
{ "_id" : "84710", "city" : "ALTON", "loc" : [ -112.548389, 37.469905 ], "pop" : 1
{ "_id" : "84760", "city" : "PARAGONAH", "loc" : [ -112.773972, 37.89172 ], "pop"
{ "_id" : "84717", "city" : "BRYCE CANYON", "loc" : [ -112.074311, 37.608427 ], "p
{ "_id" : "84761", "city" : "PAROWAN", "loc" : [ -112.832251, 37.844861 ], "pop" :
```

# Advanced

Aggregate (details)

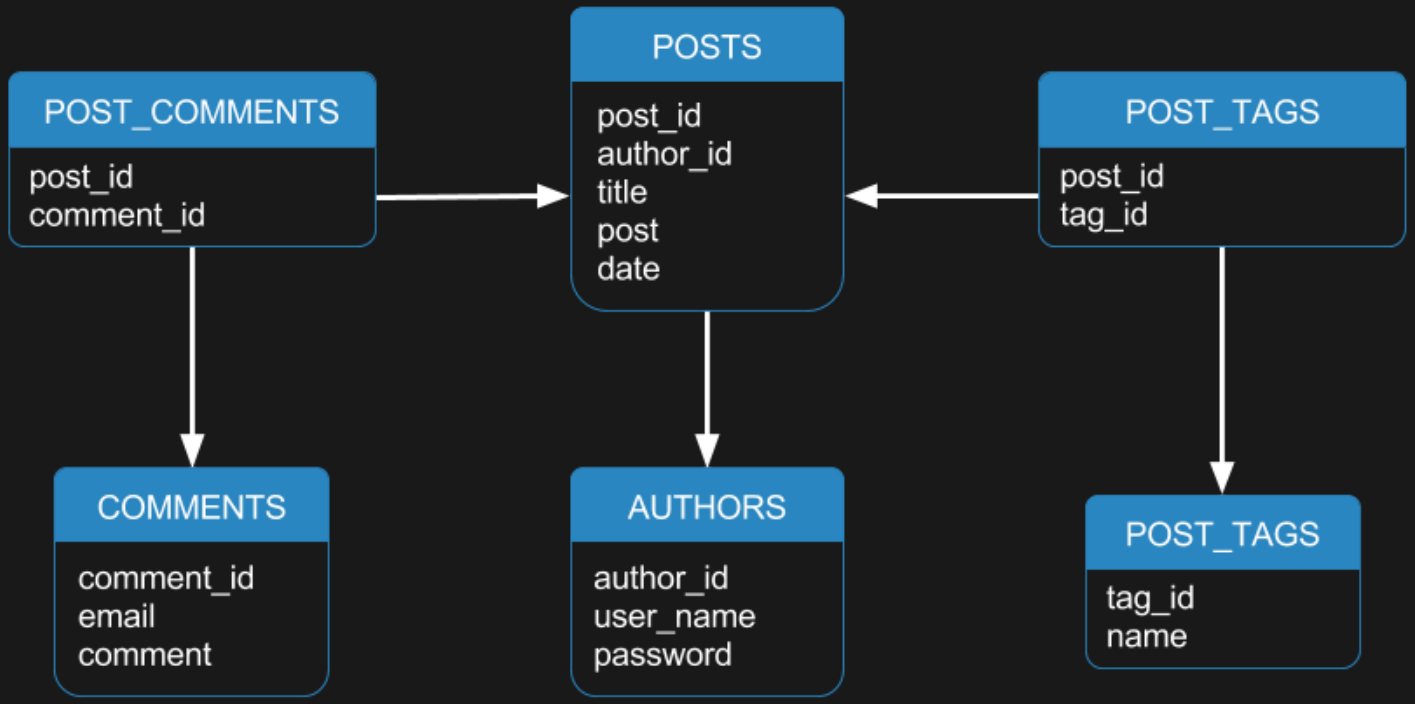
```
> db.zips.aggregate([{ $group: {group} } , { $match: {group} }])
> db.zips.aggregate([{ $group: { _id: "$city", totalPop: { $sum: "$pop" } } }])
```

```
{ "_id" : "WRANGELL", "totalPop" : 2573 }
{ "_id" : "SKAGWAY", "totalPop" : 692 }
{ "_id" : "THORNE BAY", "totalPop" : 744 }
...
```


# Case Study

# Blog

Relational



# Blog

## Document

### Post

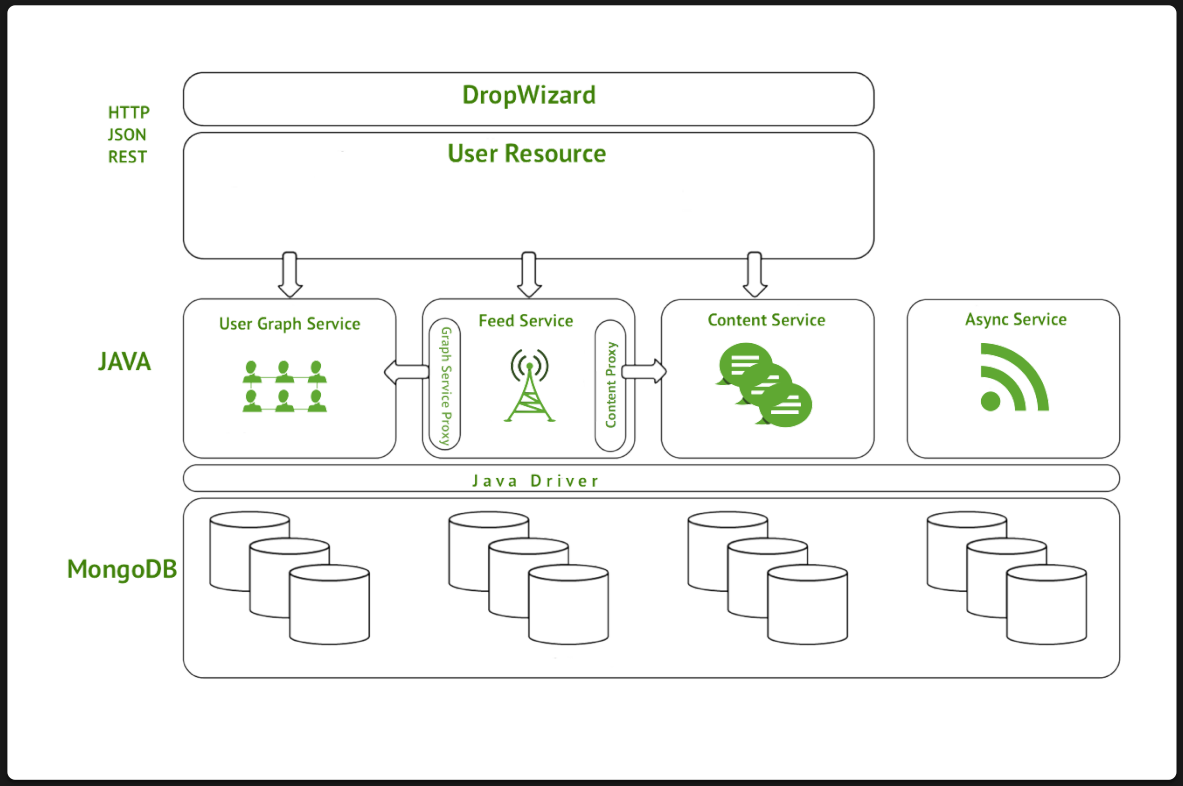
```
{
  _id: ObjectId("54853dd6dd8fc0fec931fcbc"),
  title: "Title",
  body: "...",
  author: "Author",
  date: "Date",
  comments: [
    { name: "Observer", comment: "Comment",}
  ],
  tags: ["Course", "MongoDB"],
};
```

### Author

```
{ _id: "UserName", email: "UserEmail" }
```

# Socialite

## Architecture



# Socialite

## Design 1

```
...
{ _id : "vHugo", email : "victor.hugo@gmail.com", follower:["gWashington"]}
{ _id : "gWashington", email : "george.washington@gmail.com"}
...
```

# Socialite

## Design 1


VS

# Socialite

## Design 2

### User collection

```
{ _id : "vHugo", email : "victor.hugo@gmail.com"}
{ _id : "gWashington", email : "george.washington@gmail.com"}
```

### Follower collection

```
{ _id : 1, _from : "gWashington", _to : "vHugo"}
```

# Socialite

## Design 3

### User collection

```
{ _id : "vHugo", email : "victor.hugo@gmail.com"}
{ _id : "gWashington", email : "george.washington@gmail.com"}
```

### Follower collection

```
{ _id : 1, _from : "gWashington", _to : "vHugo"}
```

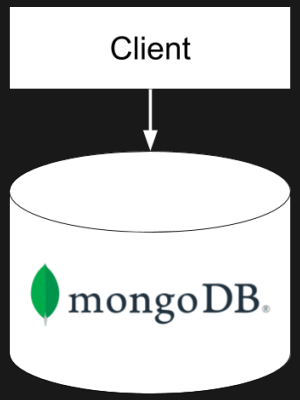
### Following collection

```
{ _id : 1, _from : "vHugo", _to : "gWashington"}
```

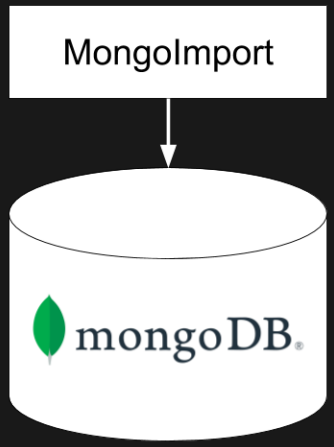

# Practicals


# Part 1

# Architecture



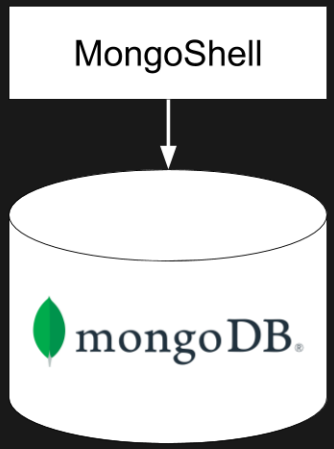
# Architecture




```
→  bin ./mongoimport --db test --collection zips --file ../../lectures/public/data-set/zips.json
2020-12-17T00:17:26.968+0100    connected to: mongodb://localhost/
2020-12-17T00:17:27.422+0100    29353 document(s) imported successfully. 0 document(s) failed to import.
```

```
→  bin ./mongod --dbpath /usr/local/var/mongodb
{"t":{"$date":"2020-12-17T00:17:09.256+01:00"},"s":"I",  "c":"CONTROL",  "id":23285,   "ctx":"main","msg":"Automatically
{"t":{"$date":"2020-12-17T00:17:09.262+01:00"},"s":"W",  "c":"ASIO",     "id":22601,   "ctx":"main","msg":"No TransportL
{"t":{"$date":"2020-12-17T00:17:09.263+01:00"},"s":"I",  "c":"NETWORK",  "id":4648602, "ctx":"main","msg":"Implicit TCP
{"t":{"$date":"2020-12-17T00:17:09.263+01:00"},"s":"I",  "c":"STORAGE",  "id":4615611, "ctx":"initandlisten","msg":"Mong
chitecture":"64-bit","host":"MacBook-Pro.local"}}
{"t":{"$date":"2020-12-17T00:17:09.263+01:00"},"s":"I",  "c":"CONTROL",  "id":23403,   "ctx":"initandlisten","msg":"Buil
29aee605fe4279b0e","modules":[],"allocator":"system","environment":{"distarch":"x86_64","target_arch":"x86_64"}}}
{"t":{"$date":"2020-12-17T00:17:09.263+01:00"},"s":"I",  "c":"CONTROL",  "id":51765,   "ctx":"initandlisten","msg":"Oper
{"t":{"$date":"2020-12-17T00:17:09.263+01:00"},"s":"I",  "c":"CONTROL",  "id":21951,   "ctx":"initandlisten","msg":"Opti
odb"}}}}
{"t":{"$date":"2020-12-17T00:17:09.265+01:00"},"s":"W",  "c":"STORAGE",  "id":22271,   "ctx":"initandlisten","msg":"Dete
ongodb/mongod.lock"}}
{"t":{"$date":"2020-12-17T00:17:09.265+01:00"},"s":"I",  "c":"STORAGE",  "id":22270,   "ctx":"initandlisten","msg":"Stor
"storageEngine":"wiredTiger"}}
{"t":{"$date":"2020-12-17T00:17:09.265+01:00"},"s":"W",  "c":"STORAGE",  "id":22302,   "ctx":"initandlisten","msg":"Reco
{"t":{"$date":"2020-12-17T00:17:09.265+01:00"},"s":"I",  "c":"STORAGE",  "id":22315,   "ctx":"initandlisten","msg":"Open
```

# Architecture




```
➜  bin ./mongo
MongoDB shell version v4.4.2
connecting to: mongodb://127.0.0.1:27017/?compressors=disabled&gssapiServiceName=mongodb
Implicit session: session { "id" : UUID("ce5e267e-1769-438c-8c67-6b68ad878346") }
MongoDB server version: 4.4.2
---
The server generated these startup warnings when booting:
        2020-12-17T00:17:10.403+01:00: Access control is not enabled for the database. Read and write access to data and
        2020-12-17T00:17:10.403+01:00: This server is bound to localhost. Remote systems will be unable to connect to th
t should serve responses from, or with --bind_ip_all to bind to all interfaces. If this behavior is desired, start the s
        2020-12-17T00:17:10.403+01:00: Soft rlimits too low
        2020-12-17T00:17:10.403+01:00:         currentValue: 256
        2020-12-17T00:17:10.403+01:00:         recommendedMinimum: 64000
---
---
        Enable MongoDB's free cloud-based monitoring service, which will then receive and display
        metrics about your deployment (disk utilization, CPU, operation statistics, etc).

        The monitoring data will be available on a MongoDB website with a unique URL accessible to you
        and anyone you share the URL with. MongoDB may use this information to make product
        improvements and to suggest MongoDB products and deployment options to you.
```

```
➜  bin ./mongod --dbpath /usr/local/var/mongodb
{"t":{"$date":"2020-12-17T00:17:09.256+01:00"},"s":"I",  "c":"CONTROL",  "id":23285,   "ctx":"main","msg":"Automatically
{"t":{"$date":"2020-12-17T00:17:09.262+01:00"},"s":"W",  "c":"ASIO",     "id":22601,   "ctx":"main","msg":"No TransportL
{"t":{"$date":"2020-12-17T00:17:09.263+01:00"},"s":"I",  "c":"NETWORK",  "id":4648602, "ctx":"main","msg":"Implicit TCP
{"t":{"$date":"2020-12-17T00:17:09.263+01:00"},"s":"I",  "c":"STORAGE",  "id":4615611, "ctx":"initandlisten","msg":"Mong
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{"t":{"$date":"2020-12-17T00:17:09.263+01:00"},"s":"I",  "c":"CONTROL",  "id":51765,   "ctx":"initandlisten","msg":"Oper
{"t":{"$date":"2020-12-17T00:17:09.263+01:00"},"s":"I",  "c":"CONTROL",  "id":21951,   "ctx":"initandlisten","msg":"Opti
odb"}}}}
{"t":{"$date":"2020-12-17T00:17:09.265+01:00"},"s":"W",  "c":"STORAGE",  "id":22271,   "ctx":"initandlisten","msg":"Dete
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{"t":{"$date":"2020-12-17T00:17:09.265+01:00"},"s":"I",  "c":"STORAGE",  "id":22270,   "ctx":"initandlisten","msg":"Stor
"storageEngine":"wiredTiger"}}
{"t":{"$date":"2020-12-17T00:17:09.265+01:00"},"s":"W",  "c":"STORAGE",  "id":22302,   "ctx":"initandlisten","msg":"Reco
{"t":{"$date":"2020-12-17T00:17:09.265+01:00"},"s":"I",  "c":"STORAGE",  "id":22315,   "ctx":"initandlisten","msg":"Open
```
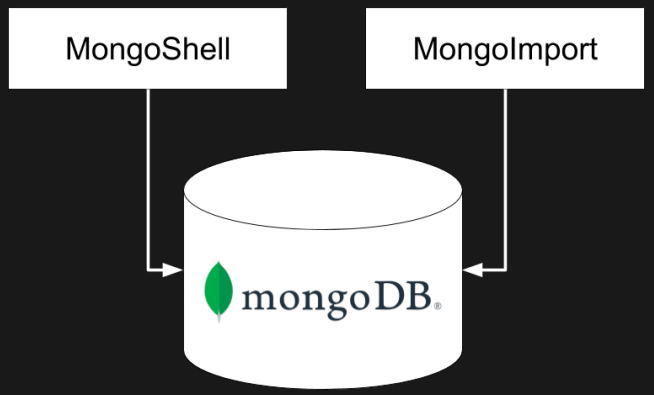

# Architecture



# Install MongoDB

## Run with Docker

Create container and start MongoDB Server

```
$ docker run --name mongo-server mongo
```

Restart server

```
$ docker start -i mongo-server
```

# Install MongoDB

In another shell, run MongoShell (client)

```
$ docker exec -it mongo-server mongo
```

## Run with Docker

Import a json file in the container

```
$ docker cp <path>/file.json mongo-server:/tmp/<file>.json
```

Load it into the database

```
$ docker exec mongo-server mongoimport --db test --collection emails --file /tmp/<
```

# Install MongoDB

## Linux & MacOS

Documentation here
Download mongodb zip here
Unzip and go in the file

```
$ cd path_to_downloaded_file
$ tar xvf mongodb-macos-x86_64-4.4.2.tgz
```

Create the storage directory

```
$ sudo mkdir -p /usr/local/var/mongodb
$ sudo chmod 777 /usr/local/var/mongodb
```

# Install MongoDB

## Linux & MacOS

Go to the directory

```
$ cd mongodb-macos-x86_64-4.4.2/bin
```

Run MongoDB Daemon (server)

```
$ ./mongod --dbpath /usr/local/var/mongodb
```

Run MongoShell (client) in an other shell

```
$ ./mongo
```

# Install MongoDB Tools

## Linux & MacOS

Documentation here
Download zip and unzip it

```
$ unzip mongodb-database-tools-*.zip
```

Go to the bin directory

```
$ cd mongodb-macos-x86_64-4.4.2/bin
```

run mongoimport

```
$ ./mongoimport <your params>
```

# Install MongoDB

## Windows

Installation procedure is detailed here
Download mongodb zip here
Install it
Create the storage directory

```
$ cd C:\
$ md "\data\db"
```

# Install MongoDB

## Windows

Go to the directory

```
$ cd "C:\Program Files\MongoDB\Server\4.2\bin\"
```

Run MongoDB Daemon (server)

```
$ mongod.exe --dbpath="c:\data\db"
```

Run MongoShell (client) in an other cmd

```
$ mongo.exe
```

# Install MongoDB Tools

Windows

Installation procedure is detailed here

# Mongo Shell

## Emails

I.1. Import the enron.json in the collection "emails" [Shell command]
I.2. What is the total amount of emails ? [Query + Result]
I.3. What is the amount of emails in inbox ? [Query + Result]
I.4. List the emails sent from domain yahoo.com [Query]
I.5. How long took the last request [Request + Time]

# Mongo Shell

## Emails

I.6. Add an index the right field to make the last request run faster [Index Query]
I.7. How long took the last request with the index [Time]
I.8. Find only dates and subjects of all messages sent by mike.mcconnell@enron.com [Query]
I.9. Remove rosalee.fleming@enron.com from all the email recipient [Query]
I.10. Add rob.bradley@enron.com as recipient
to all emails sent by rosalee.fleming@enron.com [Query]

# Mongo Shell

## ZIP Codes

Import the zips.json in the collection "zips" [Shell command]

II.1. List the 10 most populated zones in California and Louisiana [Query]

II.2. Then most populated zones in California and Louisiana ranked 10 to 20 [Query]

II.3. Add a field country with the value USA to all the zips [Query]

II.4. List all zones with more than 100 000 inhabitants located on the east of meridian -110. [Query]

II.5. What is the closest zones to coordonates -73.996705, 40.74838 [Query + Answer]

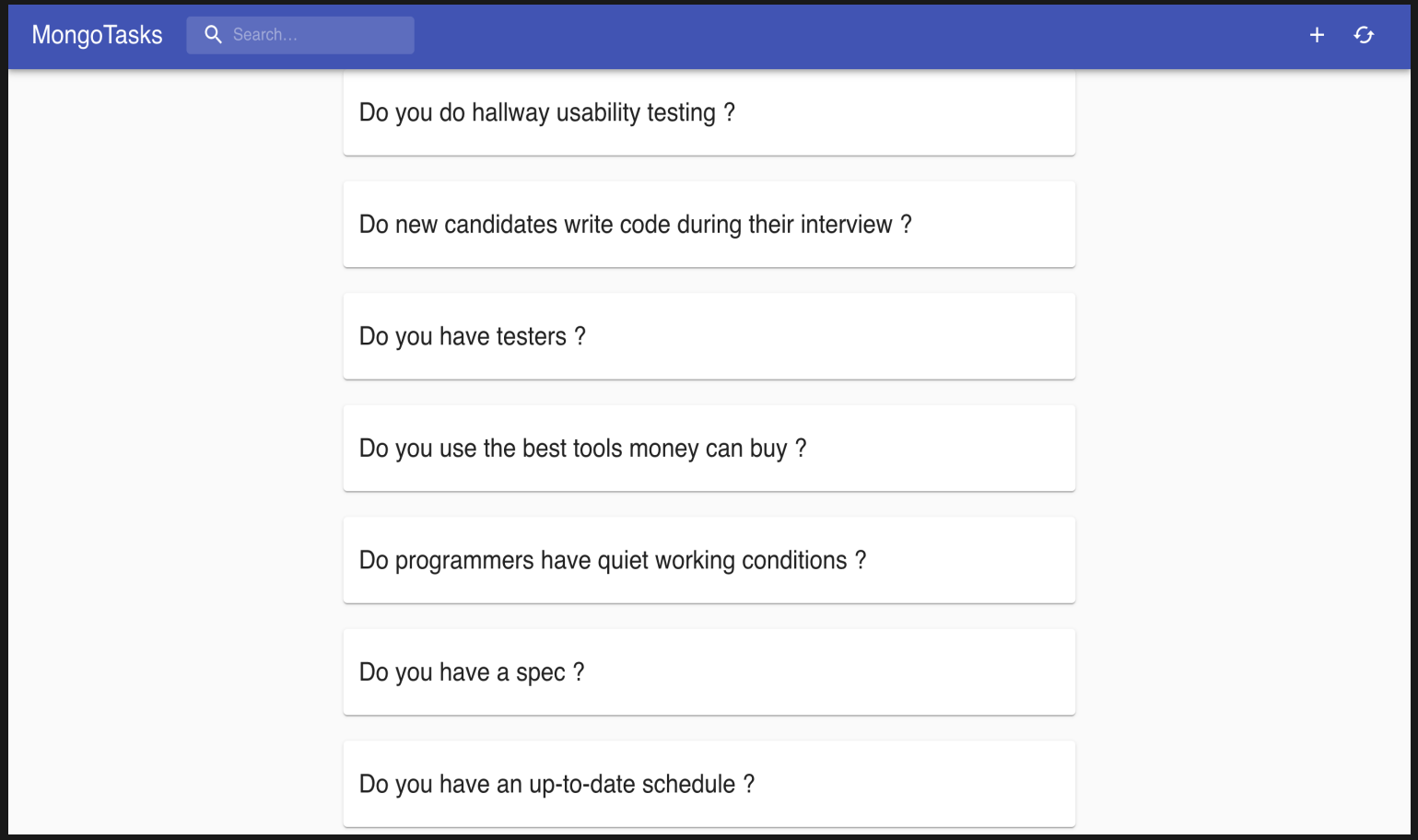
II.6. The cities that are less than 5km away from -73.996705, 40.74838: [Query + Answer]

II.7. The cities that have more than 500 000 inhabitants. [Query + Answer]


# Part 2

# MongoTasks

## MongoDB based App

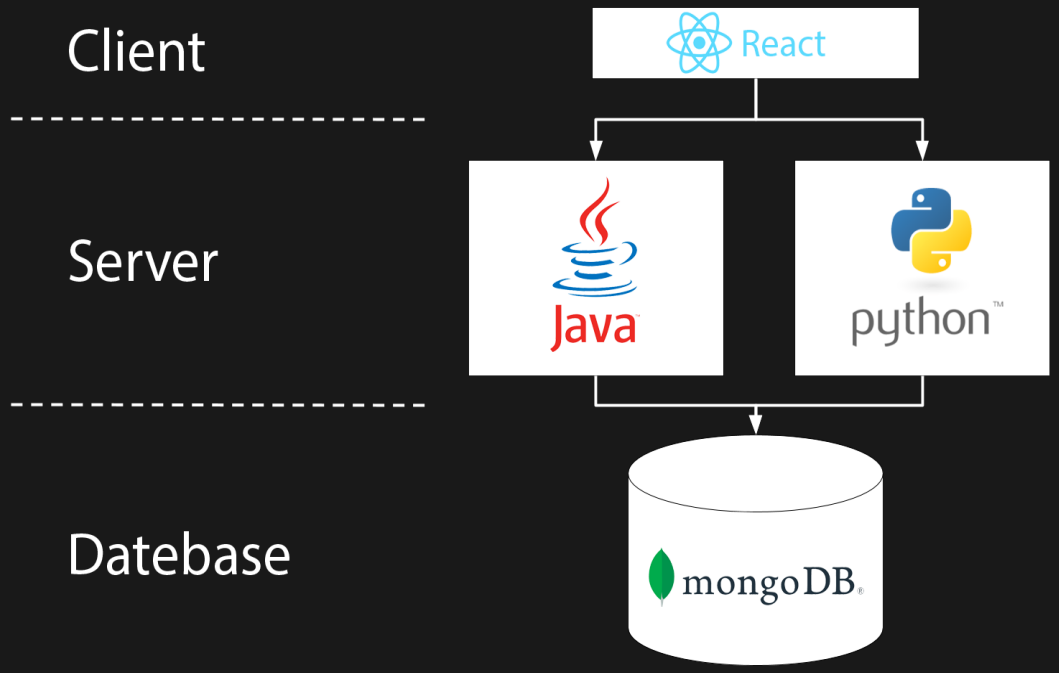


# MongoTasks


https://github.com/geofberard/MongoTasks

# MongoTasks

Architecture



# MongoTasks

## Python

Install Python (documentation)
Install Git (documentation)
Get source code

```
$ git clone https://github.com/geofberard/MongoTasks.git
$ cd MongoTasks
```

Install python dependencie

```
$  pip3 install Django
$  pip3 install pymongo
```

# MongoTasks

## Python

### Start the server

```
$  cd src/main/python
$  $ python3 src/main/python/manage.py runserver
```

```
→  MongoTasks git:(main) ✗ cd src/main/python
→  python git:(main) ✗ python3 manage.py runserver
Watching for file changes with StatReloader
Performing system checks...

System check identified no issues (0 silenced).

You have 18 unapplied migration(s). Your project may not work properly until you apply the migrations for app(s): admin, auth, contenttypes, sessions.
Run 'python manage.py migrate' to apply them.
December 17, 2020 - 02:11:18
Django version 3.1.4, using settings 'mongotasks.settings'
Starting development server at http://127.0.0.1:8000/
Quit the server with CONTROL-C.
```

Then you can access the app on: http://localhost:8000

# MongoTasks

## Python

All changes need to be done in the file :

```
src/main/python/api/tasks_service.py
```

# MongoTasks

## Python

### CheatSheet

Each step of the practical is saved in a specific branch.
If you get stuck, you might jump to the next step (replace X) with :

```
$ git reset HEAD --hard
$ git checkout step-X
```

All your changes will be lost but you will see a working implementation and you will be able to keep going.

# MongoTasks

## Python

### Create

You need to add a new document in the tasks collection

```
$ git checkout step-1
```

# MongoTasks

## Python

### Read

You need to return all the notes from the tasks collection

```
$ git checkout step-2
```

# MongoTasks

## Python

### Update

You need to update a document 'done' field in the tasks collection

```
$ git checkout step-3
```

# MongoTasks

## Python

### Delete

You need to remove a document from the tasks collection

```
$ git checkout step-4
```

# MongoTasks

## Python

### Full Implementation

```
$ git checkout complete
```

# MongoTasks

## Java

Install Java (documentation)
Install Maven (documentation)
Install Git (documentation)
Get source code

```
$ git clone https://github.com/geofberard/MongoTasks.git
$ cd MongoTasks
```

Install java dependencie

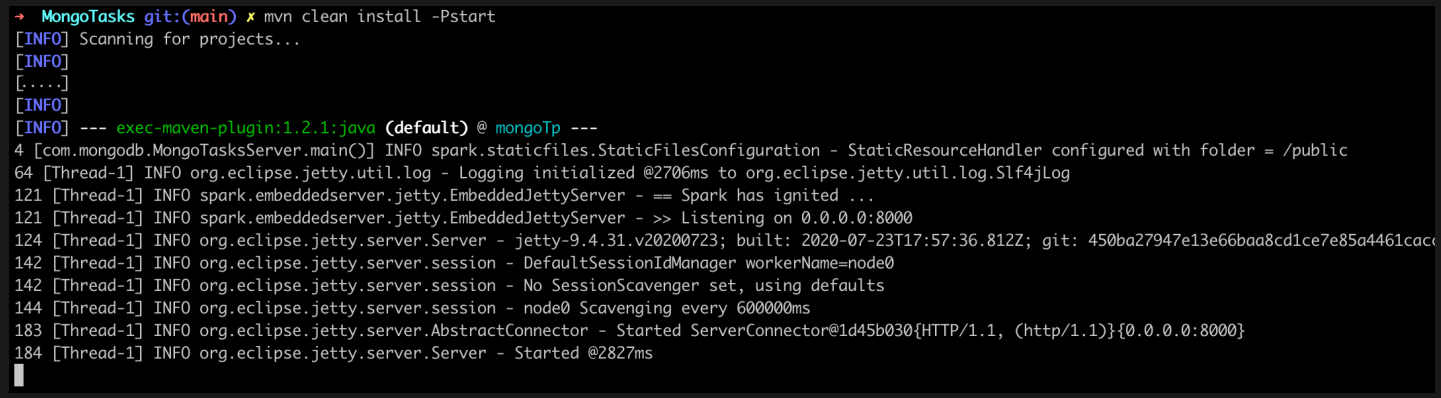
```
$ mvn clean install
```

# MongoTasks

## Java

### Start the server

```
$ mvn clean install -Pstart
```




Then you can access the app on: http://localhost:8000

# MongoTasks

## Java

All changes need to be done in the file :

```
src/main/java/com/mongodb/TasksService.java
```

# MongoTasks

## Java

### CheatSheet

Each step of the practical is saved in a specific branch.
If you get stuck, you might jump to the next step (replace X) with :

```
$ git reset HEAD --hard
$ git checkout step-X
```

All your changes will be lost but you will see a working implementation and you will be able to keep going.

# MongoTasks

## Java

### Create

You need to add a new document in the tasks collection

```
$ git checkout step-1
```

# MongoTasks

## Java

### Read

You need to return all the notes from the tasks collection

```
$ git checkout step-2
```

# MongoTasks

## Java

### Update

You need to update a document 'done' field in the tasks collection

```
$ git checkout step-3
```

# MongoTasks

## Java

### Delete

You need to remove a document from the tasks collection

```
$ git checkout step-4
```

# MongoTasks

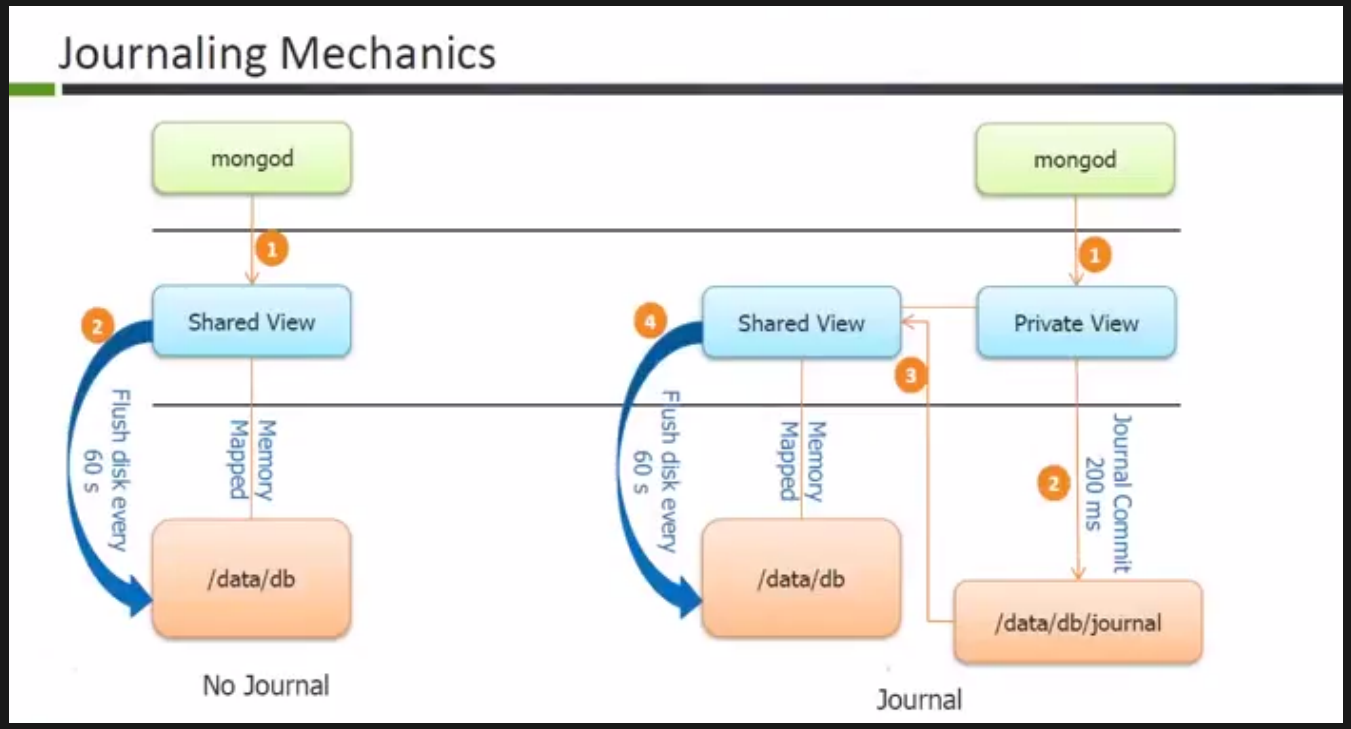
## Java

### Full Implementation

```
$ git checkout complete
```


# Replication

# MongoDB write path



# MongoDB

## Journal vs Oplog

Journal

- low level log of an operation for crash recovery (can be turned off)

Oplog (similar to RDBMS binlog)

- stores (idemopotent) high-level transactions that modify the database
- kept on the master and used for replication

https://docs.mongodb.org/manual/core/read-isolation-consistency-recency/

# Replica set

A group of mongod processes that provide redundancy and high availability

# Replica set

## Members

Primary

- acceptes all writes and reads
- 1 primary per replica set

Secondaries

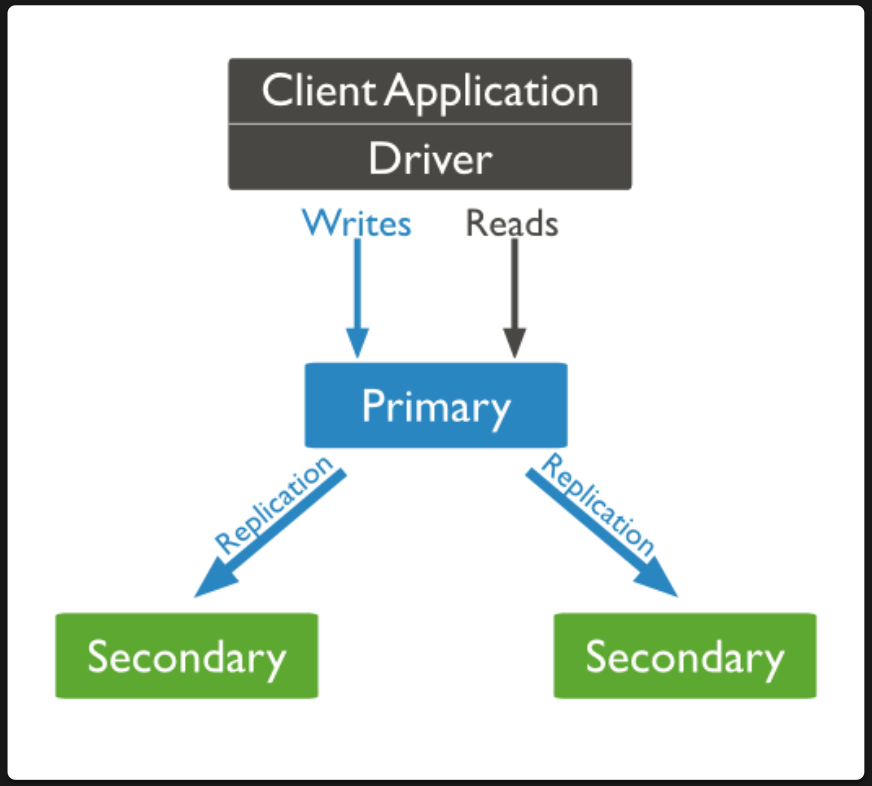
- replicates data
- can serve reads
- can be hidden (priority 0)

Arbiters

- at most 1
- break ties

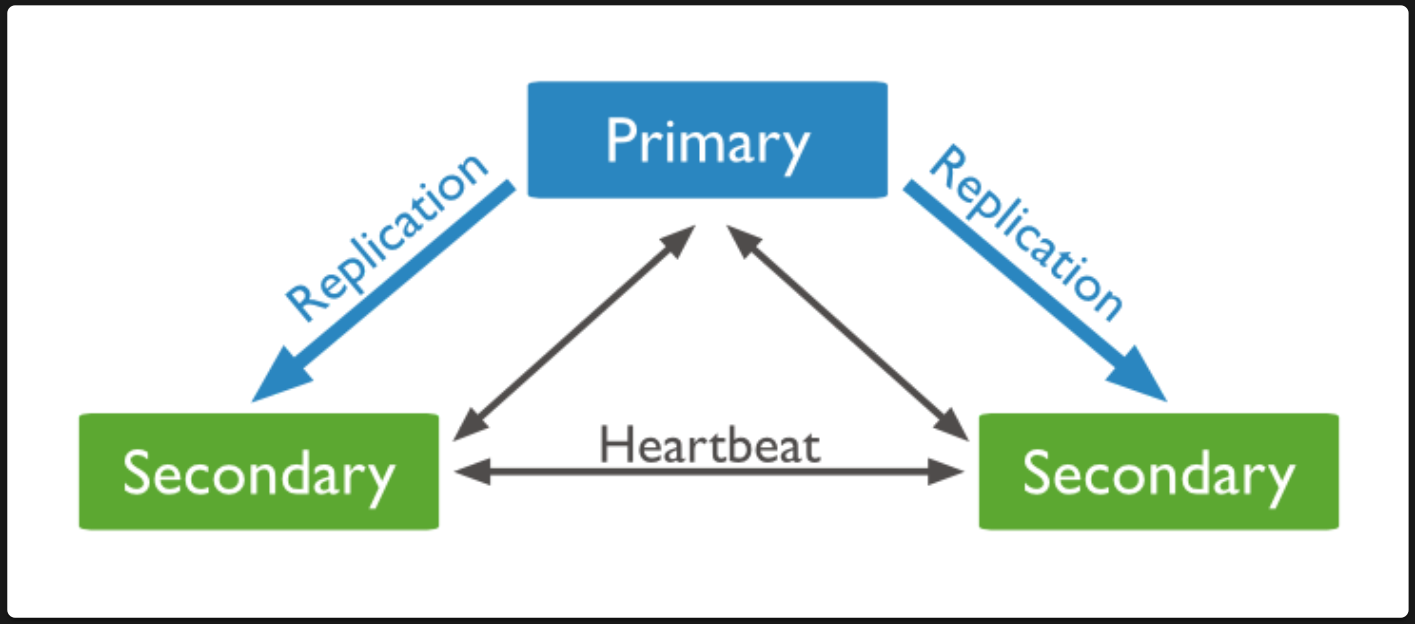
# Replica set

Read & Write



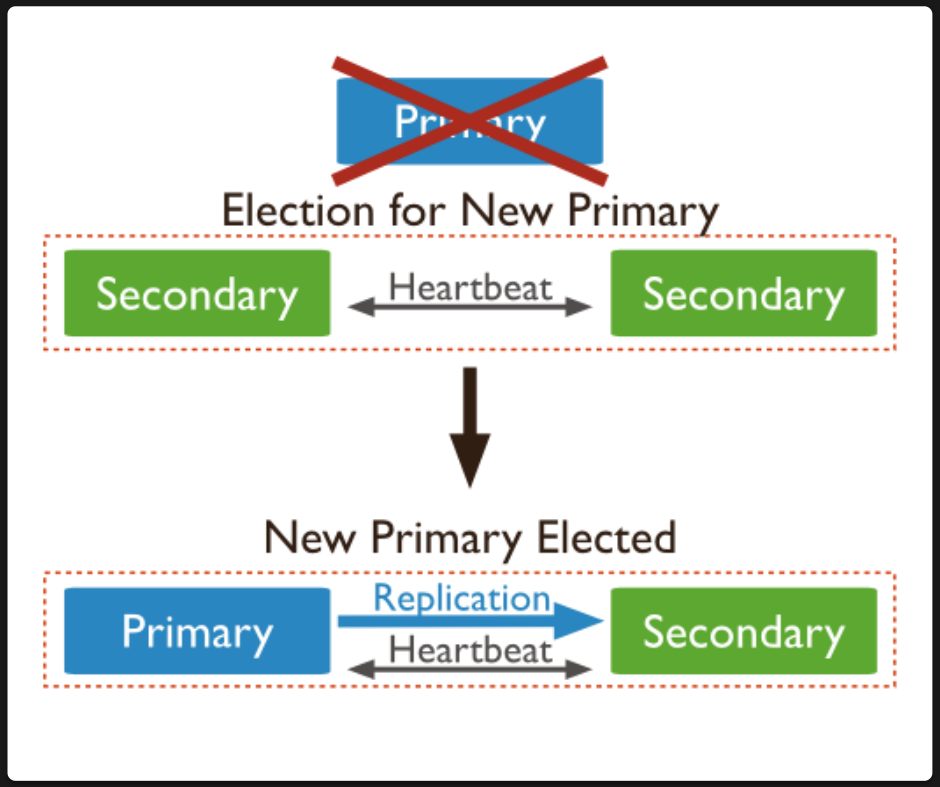
# Replica set

Replication Flow



# Replica set

Automatic Failover



# Replica set

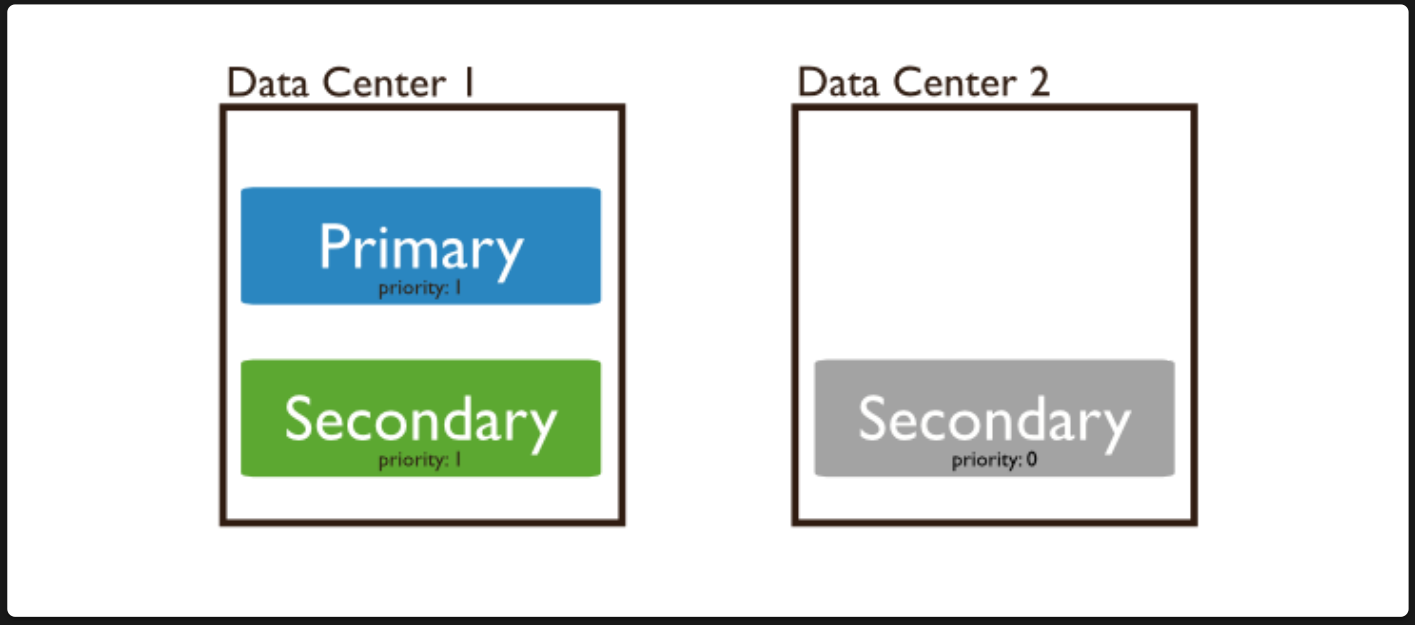
Election strategy

- member’s priority
- latest optime in the oplog
- uptime
- break the tie rules

# Replica set

Priority 0

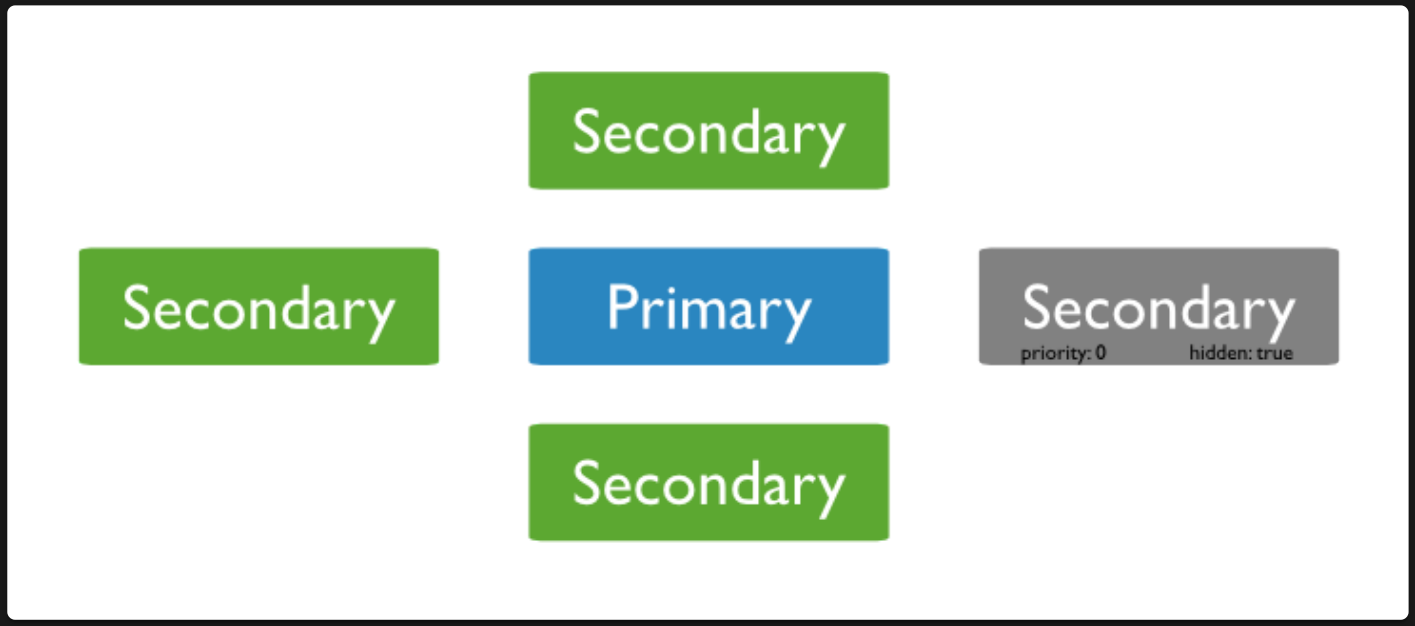
- cannot become primary
- cannot trigger elections
- can vote in elections
- copy of data + accepts reads



# Replica set

Hidden

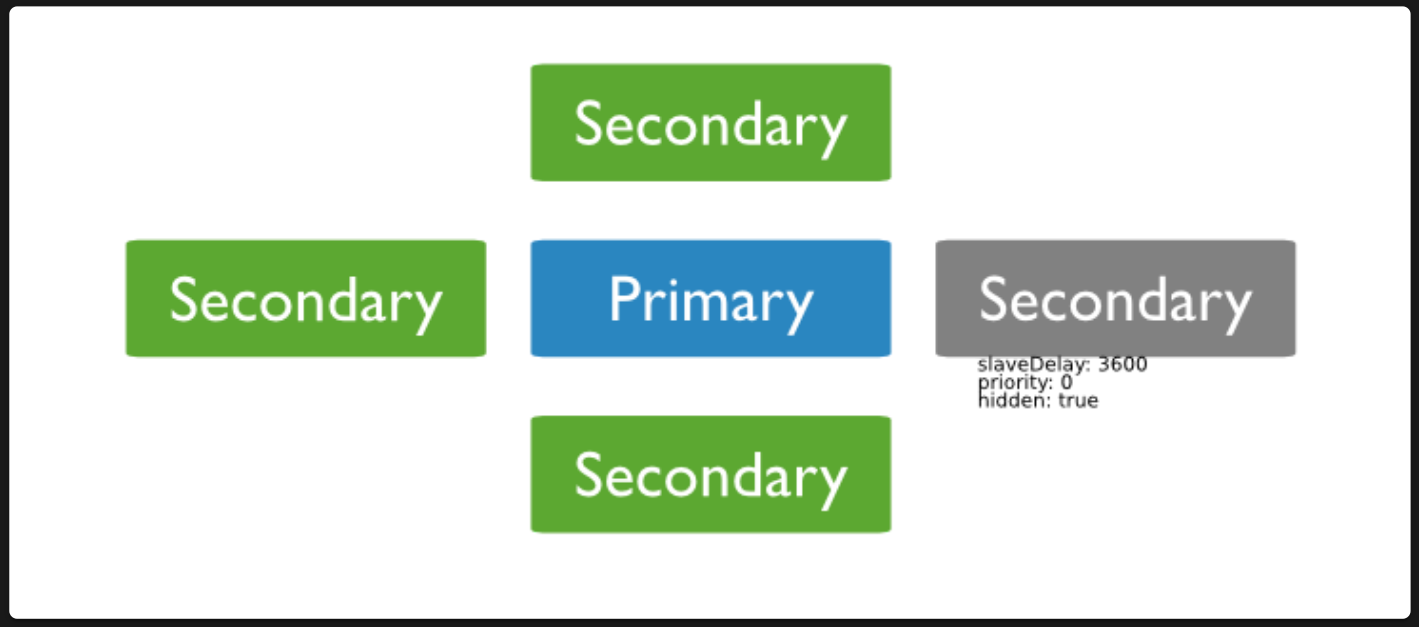
- Priority 0 members that don’t accept reads



# Replica set

Delayed

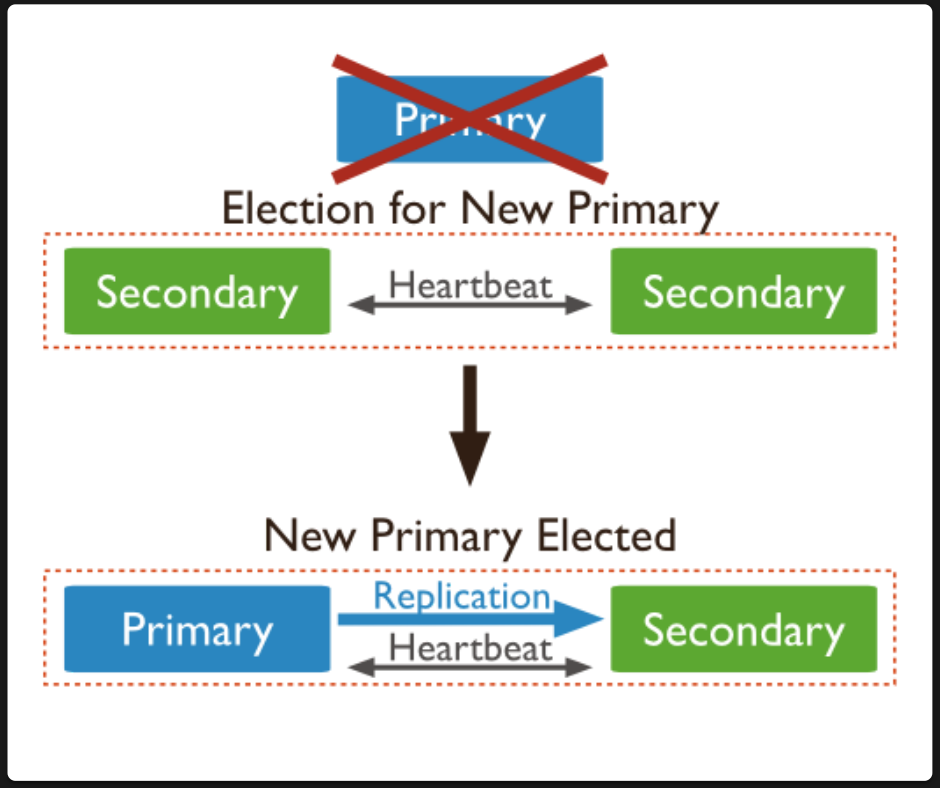
- must be priority 0
- must hidden



# Replica set

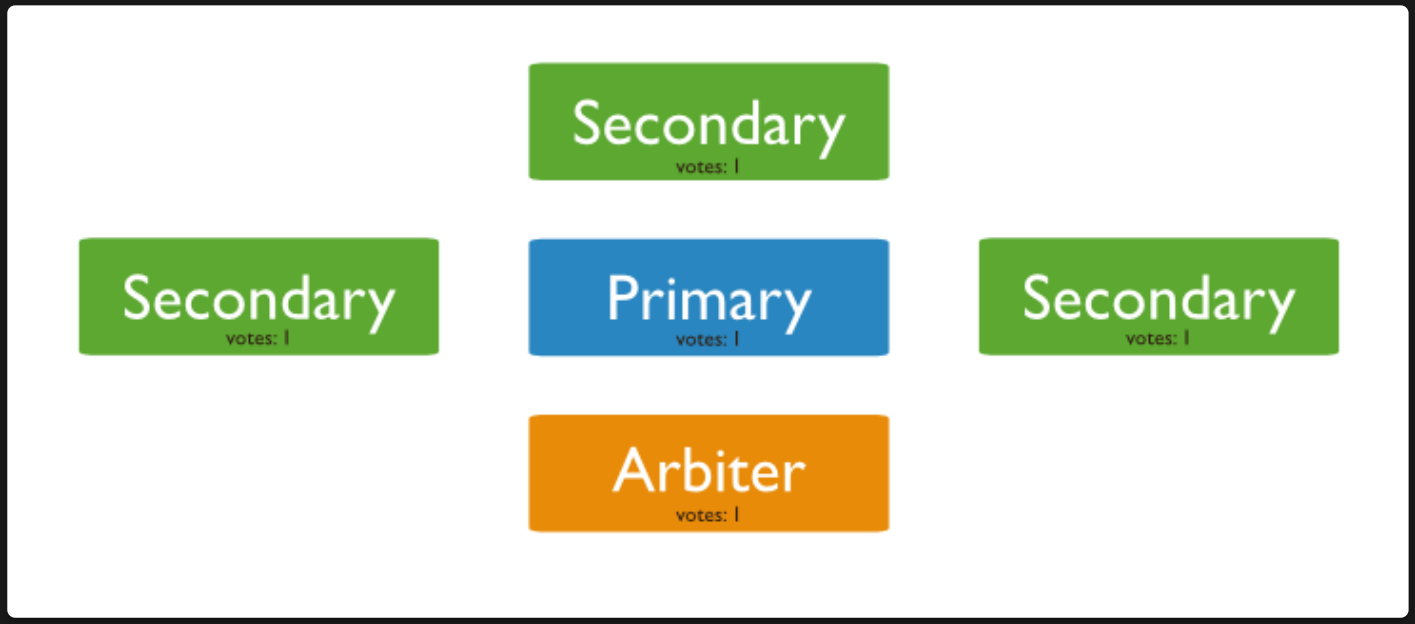
Election

- Odd number of node
- Cannot be elected with one vote



# Replica set

## Arbiters



# Replica set

No primary:

- writes no longer possible
- reads still accepted

Fault tolerance:

Number of members that can become unavailable and still be able to elect a primary

| Nb of members | Majority required | Fault tolerance |
|---|---|---|
| 3 | 2 | 1 |
| 4 | 3 | 1 |
| 5 | 3 | 2 |
| 6 | 4 | 2 |

https://docs.mongodb.org/manual/core/replica-set-architectures/

# Replica set

## Rollback

What if the primary is lost right after accepting write operation ?
Some omerations may have not been replicatated on secondaries
Issues

- some entries will be lost
- some client could have read those data before they where lost

Solution

- manually apply rollbacks
- change write configuration (semantics)

https://docs.mongodb.com/manual/core/replica-set-rollbacks/

# Write semantics

w:1

- Acknowledging the write after the local write

w:N

- Waitings for N members to write before acknowledging

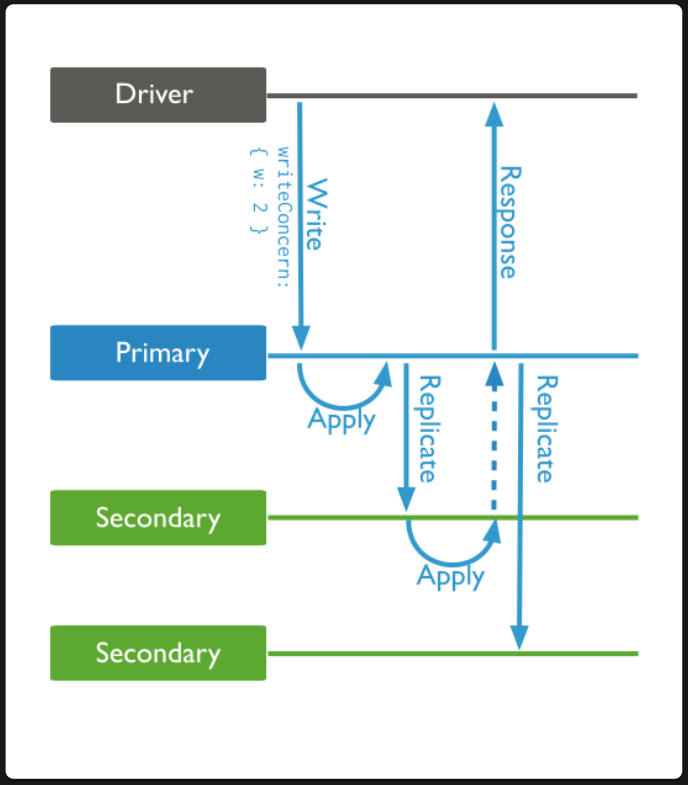
w:majority

- Waiting for the majority of members to write before acknowledging

wtimeout (optional)

- Prevent blocking if write concern cannot be reached

# Write semantics



# Changing write semantics

At the query level

```
> db.products.insert(
  { item: "envelopes", qty : 100, type: "Clasp" },
  { writeConcern: { w: 2, wtimeout: 5000 } }
)
```

Default value

```
> cfg = rs.conf()
> cfg.settings = {}
> cfg.settings.getLastErrorDefaults = { w: "majority", wtimeout: 5000 }
> rs.reconfig(cfg)
```

# Read preference

primary (default)

- read from the current replica set primary.

primaryPreferred

- read from primary (or secondary iff no primary)

secondary

- read from secondary members

secondaryPreferred

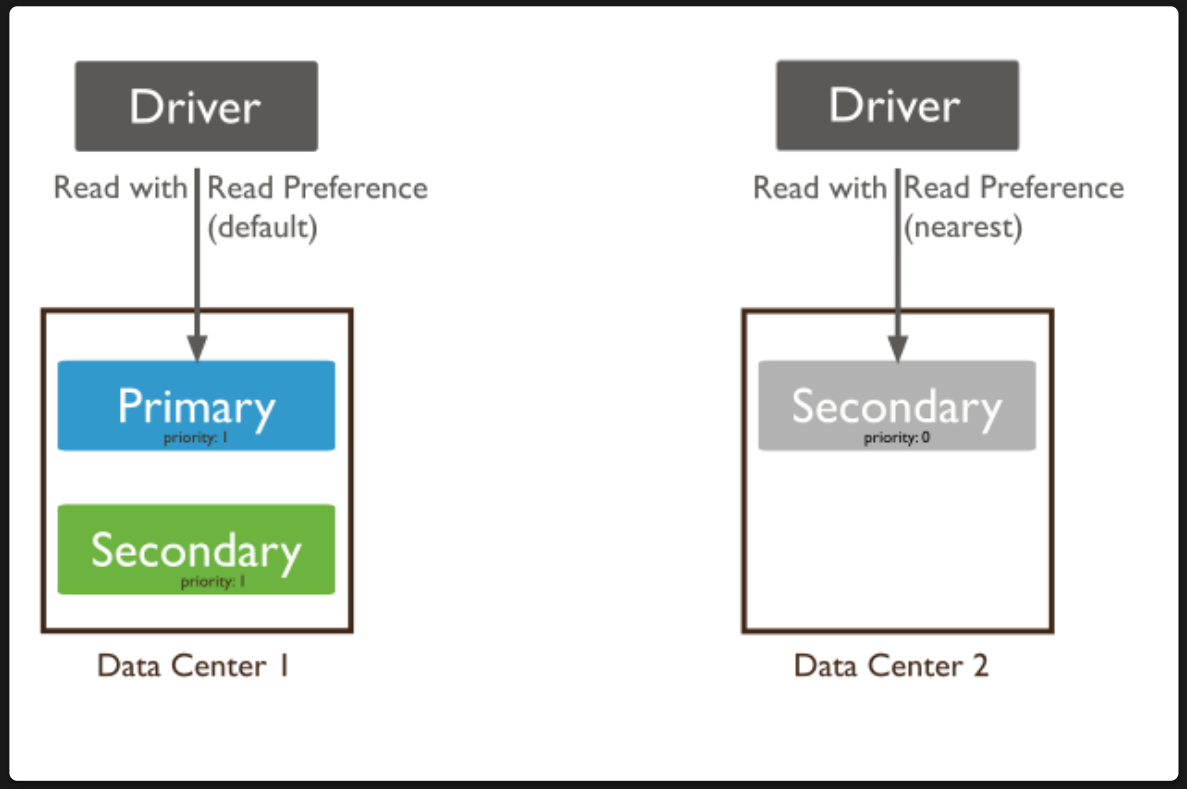
- read from secondary(or primary iff no primary)

nearest

- read from the member with the least network latency

# Read preference

Example



# Read preference

## Usecase

Maximize Consistency

- primary

Maximize Availability

- primaryPreferred

Minimize Latency

- nearest


# Practical

# Replication

MongoDB consistency in real world

> Read the documentation for the systems you depend on thoroughly–then verify their claims for yourself. You may discover surprising results!

— Kyle Kingsbury(Aphyr)
https://aphyr.com/posts/322-jepsen-mongodb-stale-reads

# Replication

MongoDB proposes a replica set tutorial in the documentation
The full documentation is here

# Bibliography


MongoDB Manual

MongoDB University

JSon Specification

BSon Specification

Socialite