



The Humongous Database

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goo.gl/lQe0pD

PLAN

- I. MongoDB Presentation
 - Schemaless
 - BSon
 - Document Model
 - Performance
- II. MongoDB Architecture
 - Replica Set
 - Sharding
- III. MongoDB CRUD
 - CREATE
 - READ
 - UPDATE
 - DELETE
- IV. Software with MongoDB
 - Architecture
- V. Practical



Presentation

MONGODB

Présentation

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

MONGODB

Functionnalities

- Text Search
- GeoSearch
- Aggregation
- Map-Reduce

MONGODB

Supported languages



DOCUMENT

JSon

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

DOCUMENT

JSon

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			04/08/1901
Paul	McCartney	Sir		18/06/1942
Gordon Matthew Thomas	Sumner		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',  
    nickname: 'Sting',  
    birthday: '2 octobre 1951',  
},
```

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

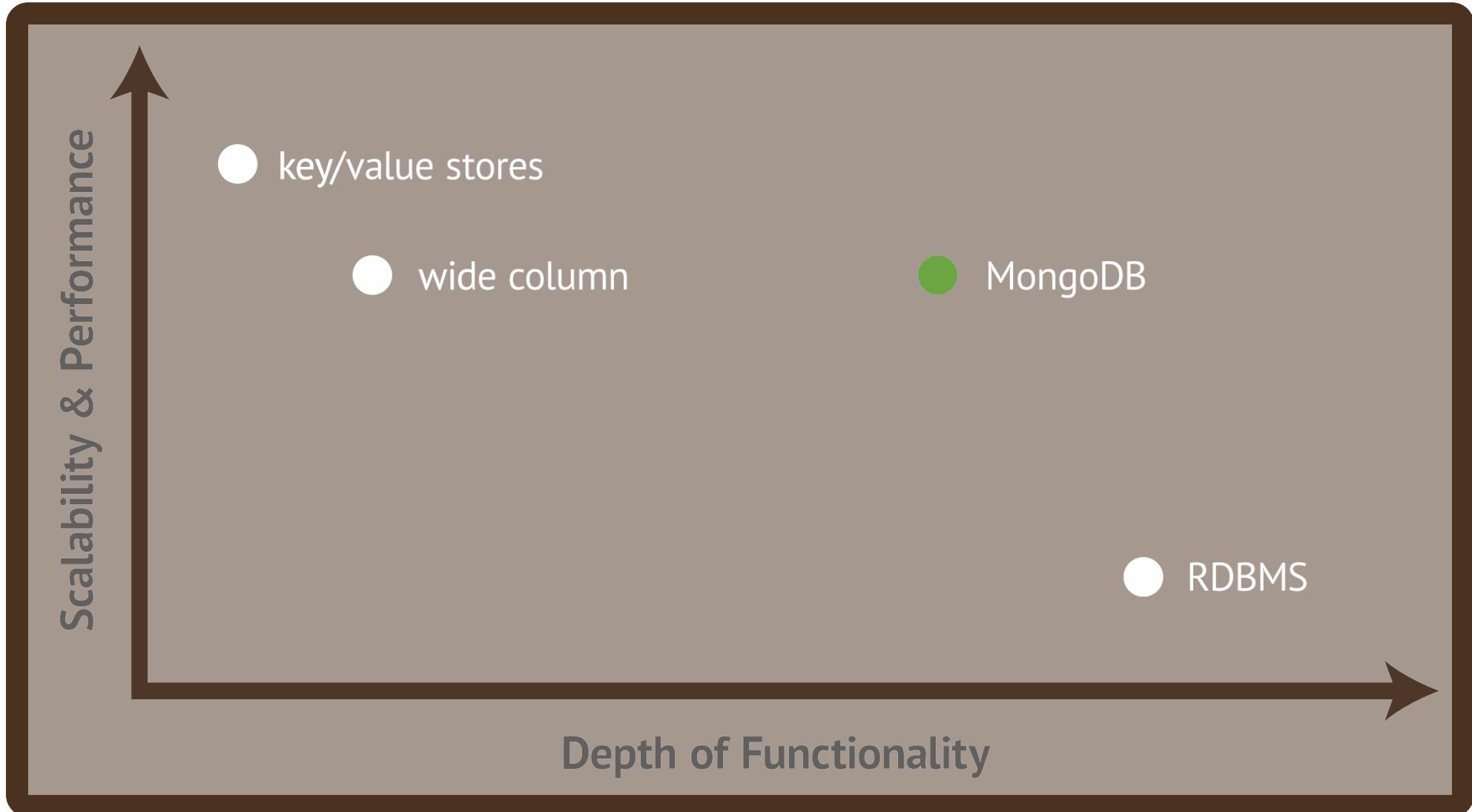
```
\x16\x00\x00\x00\x02hello\x00  
\x06\x00\x00\x00world\x00\x00
```

BSON

Enriched Types

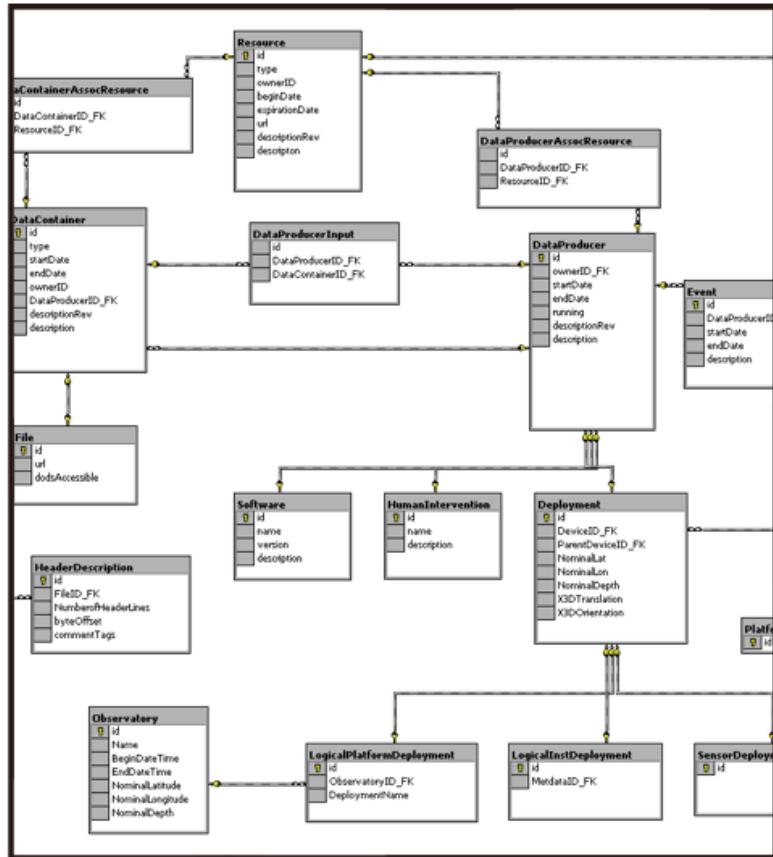
Type	Type
Double	Regular expression
String	JavaScript
Object	Symbol
Array	32-bit integer
Binary data	Timestamp
Object ID	64-bit integer
Boolean	Min key
Date	Max key
Null	

POSITION



RELATIONAL VS DOCUMENT

Models Differences



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

MongoDB Model

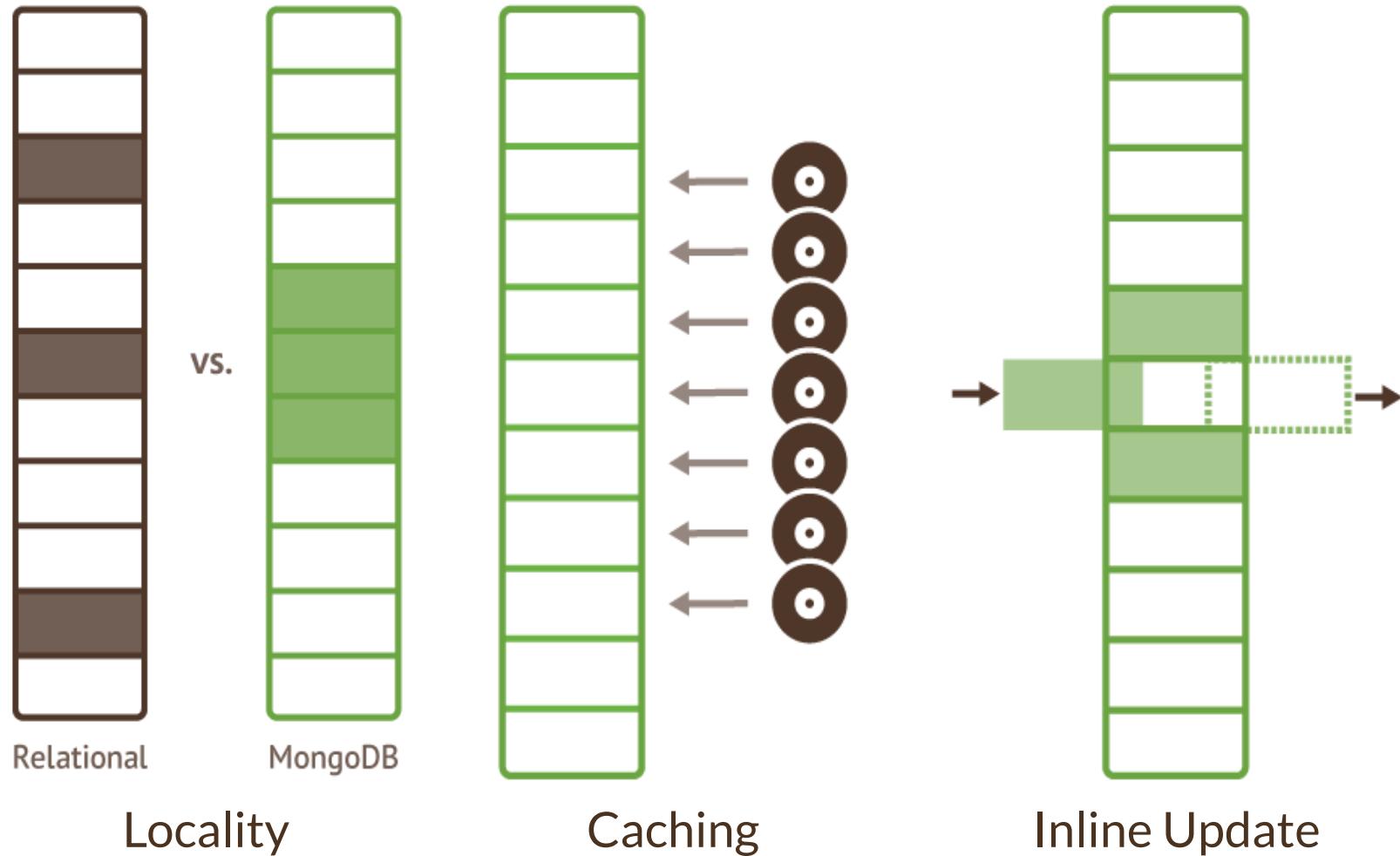
```
{  
  first_name: 'Paul',  
  surname: 'Miller',  
  city: 'London',  
  cars: [  
    {  
      model: 'Bentley',  
      year: 1973,  
      value: 100000  
    },  
    {  
      model: 'Rolls Royce',  
      year: 1965,  
      value: 330000  
    }  
  ]  
}
```

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



DOCUMENT MODEL

Benefits

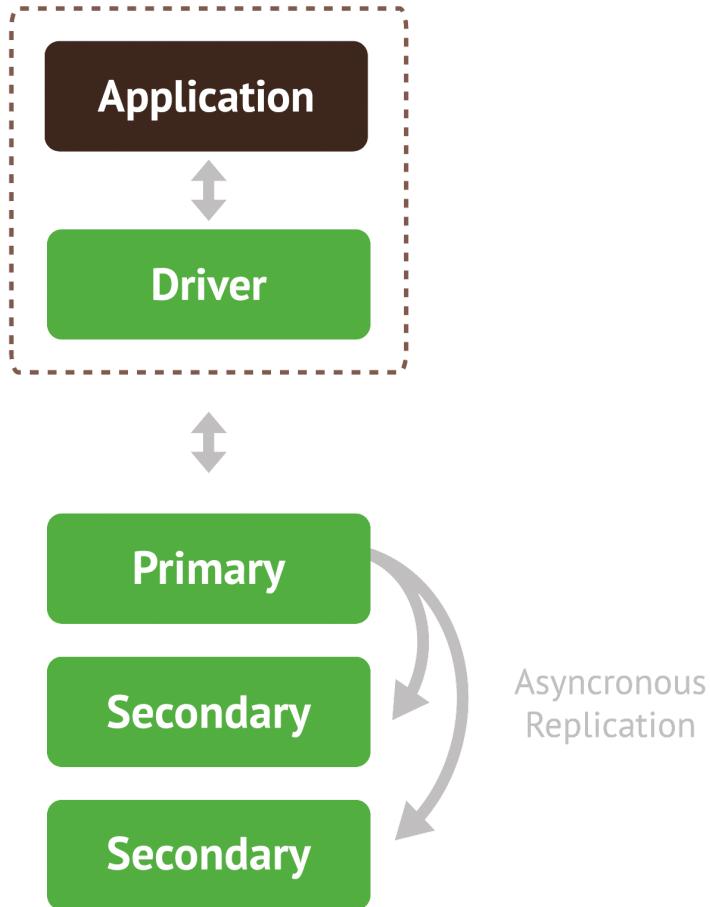
- Efficient
 - Super low latency
 - Scale Easily
- Agility and flexibility
 - Data models can evolve easily
 - Companies can adapt to changes quickly
- Intuitive, natural data representation
 - Developers are more productive
 - Many types of applications are a good fit
- Reduces the need for joins, disk seeks
 - Programming is more simple
 - Performance can be delivered at scale



Architecture

REPLICA SET

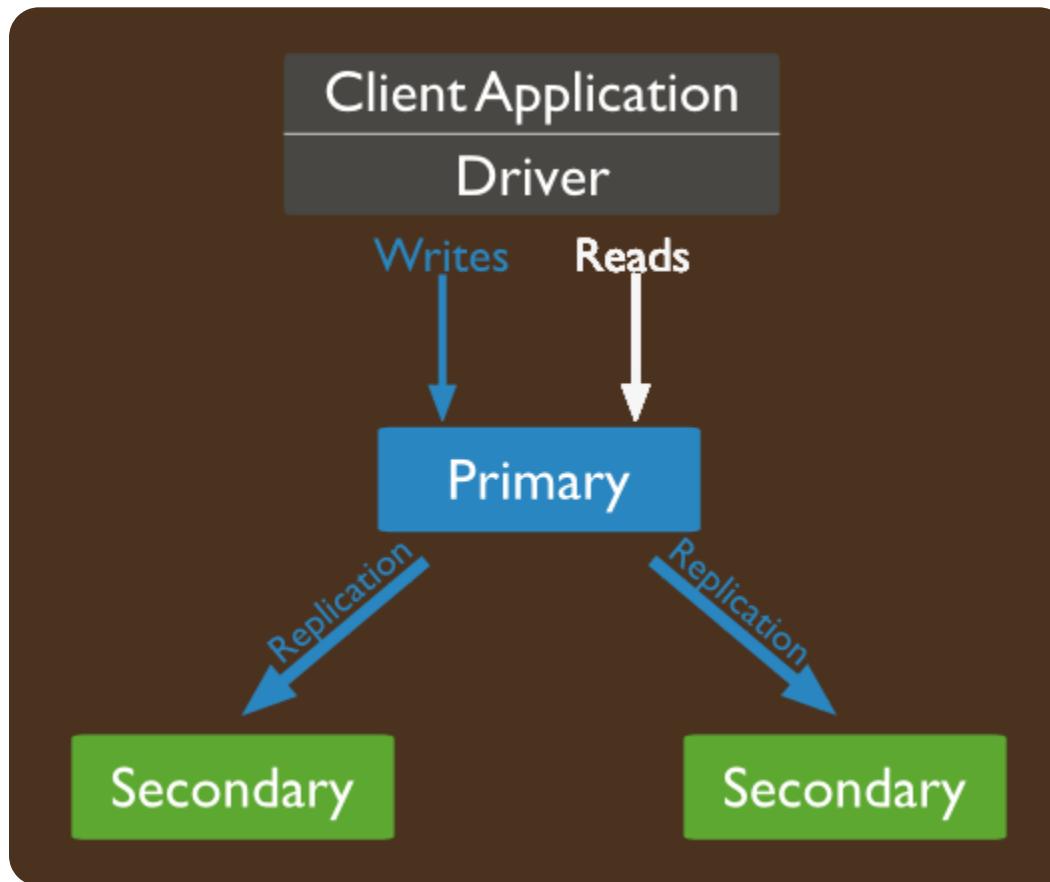
Presentation



- Two copies or more
- Master / Slave
- Automatic Failover
- Purpose :
 - High Availability
 - Data Recovery
 - Maintenance

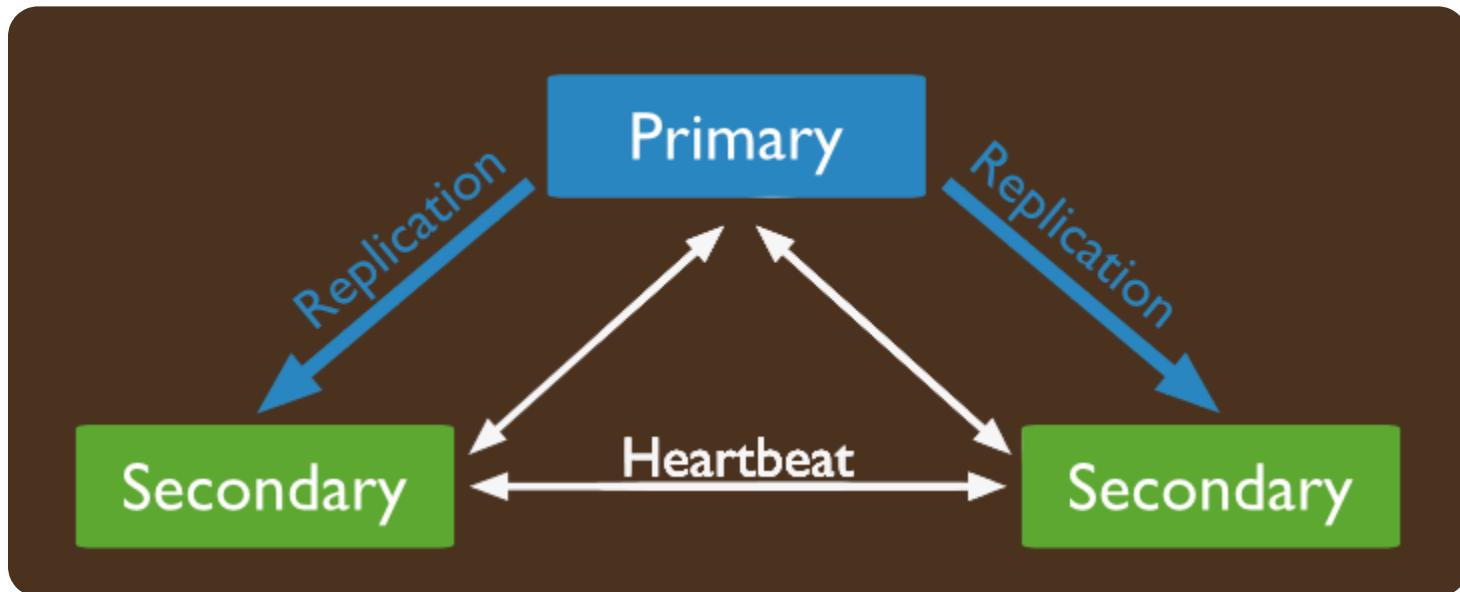
REPLICA SET

Architecture



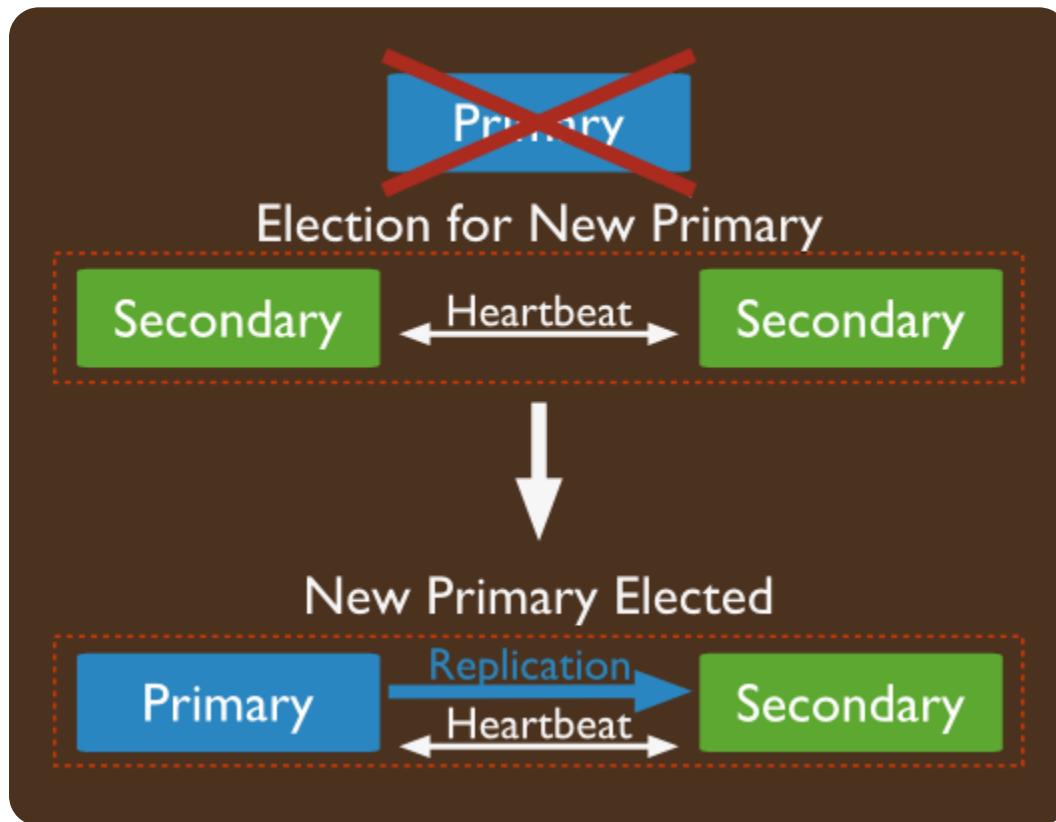
REPLICA SET

Organisation



REPLICA SET

Failover



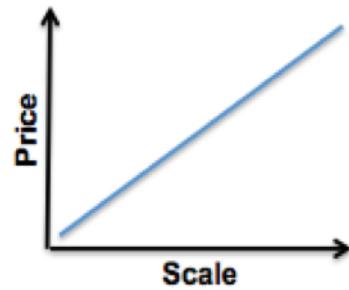
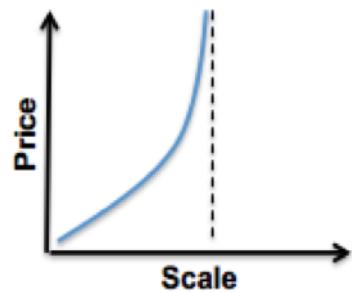
SCALABILITY



Vertical

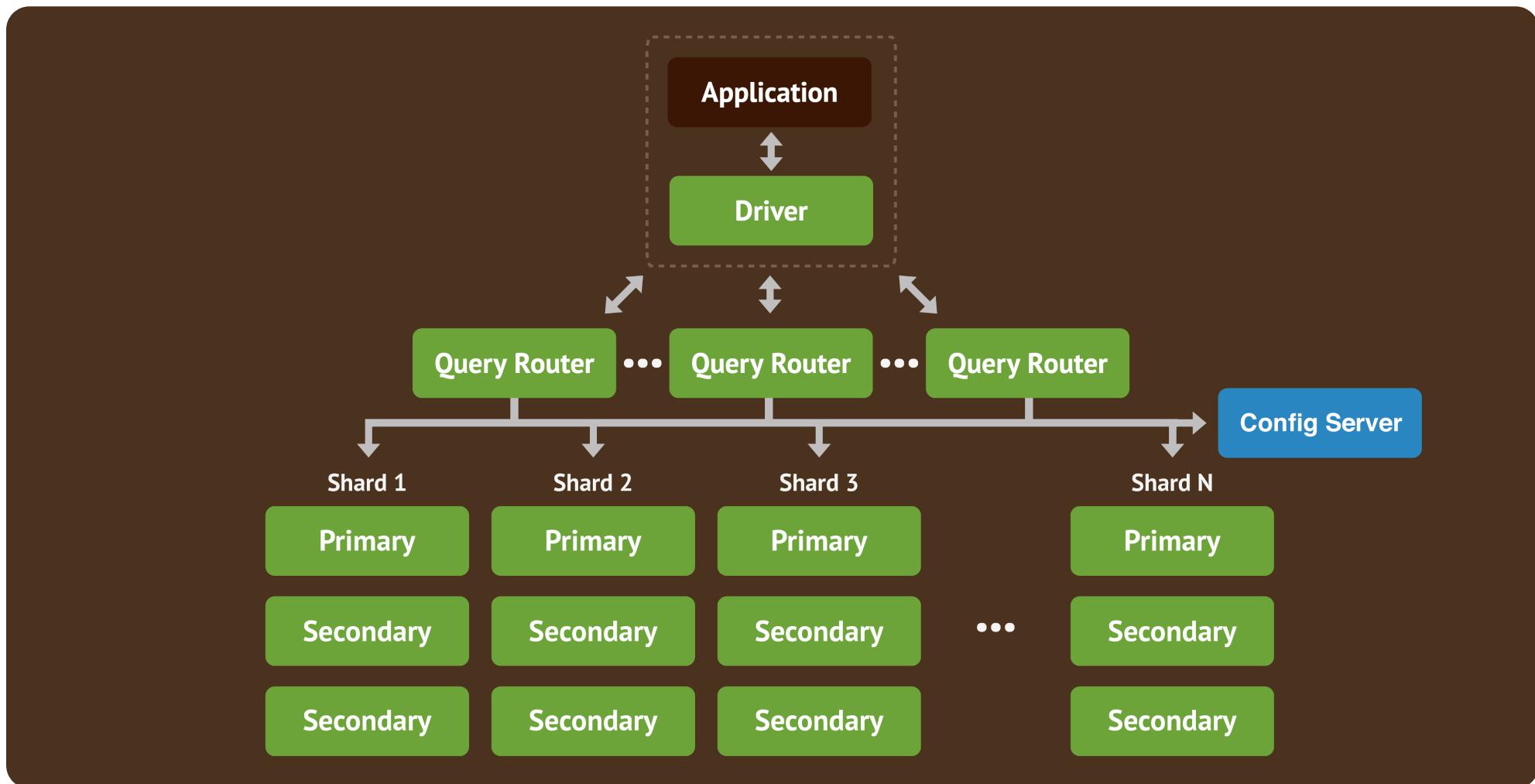


Horizontal



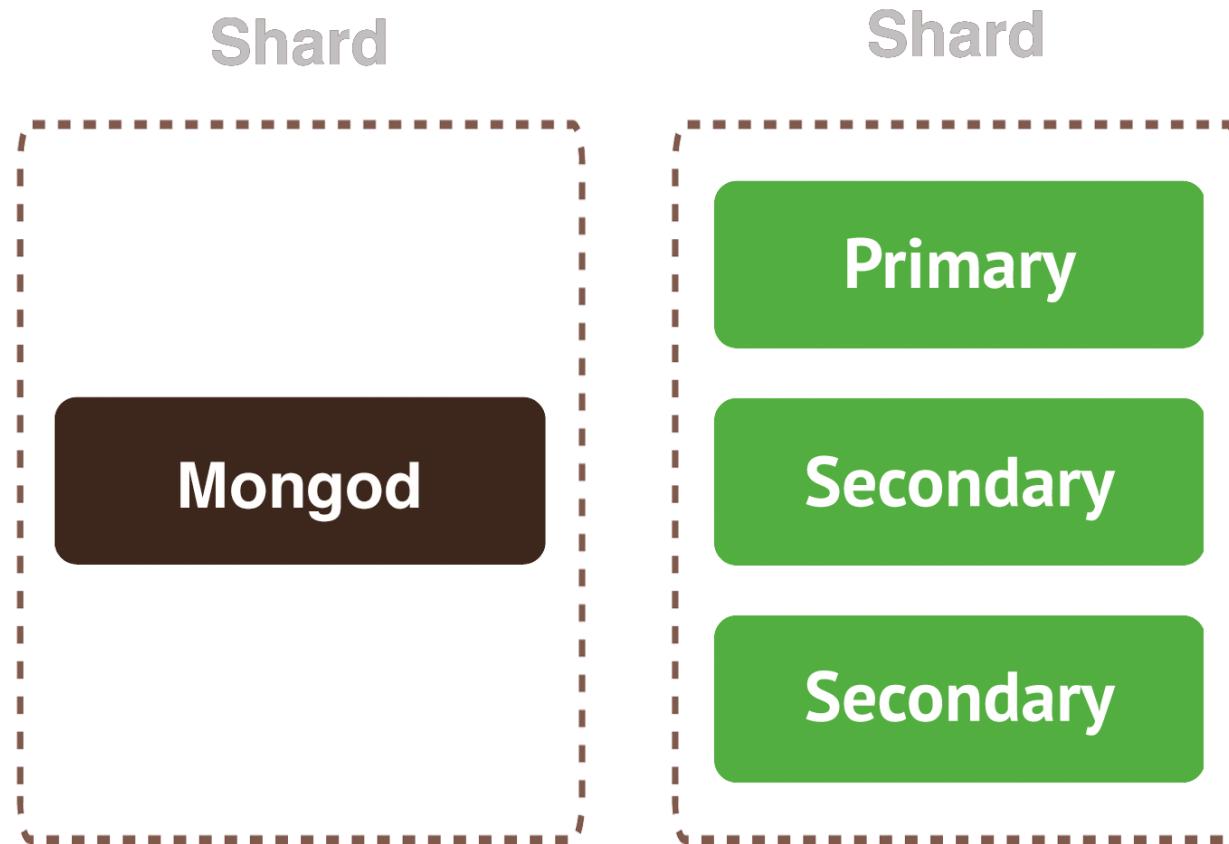
SHARDING

Architecture



SHARDING

Shard : Cluster Node



SHARDING

Config Server

Contains cluster metadatas

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

SHARDING

Mongos : Query Router

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

SHARDING

Sharding Key

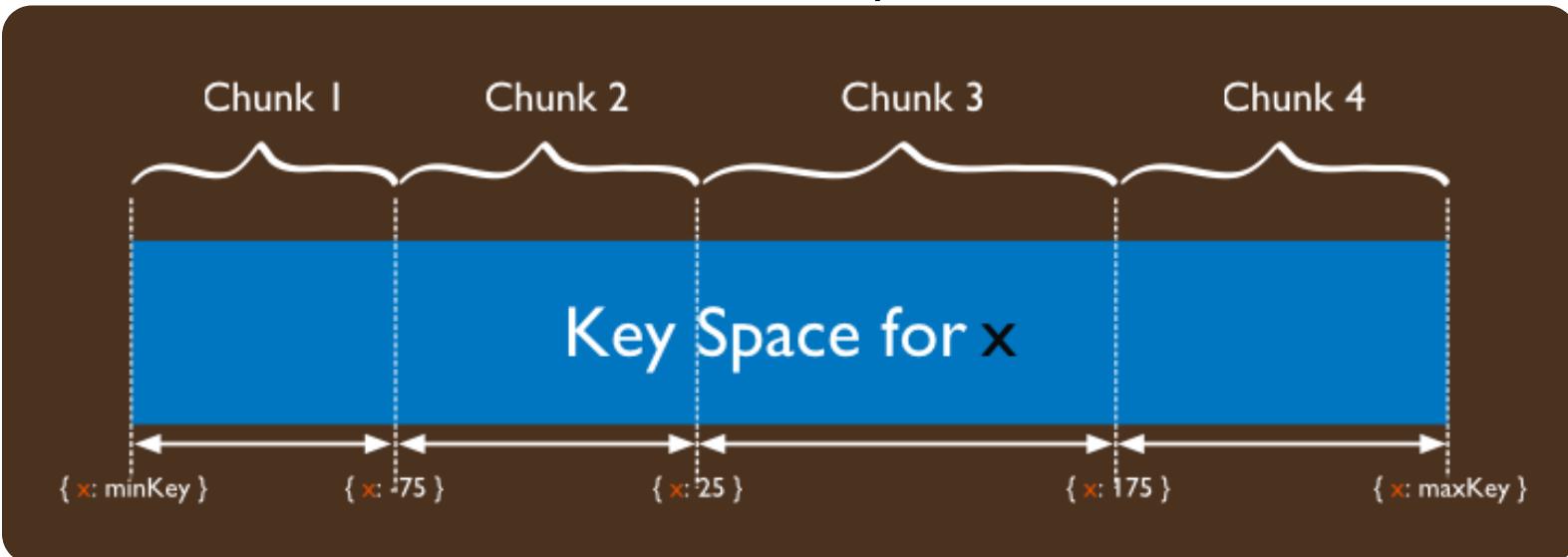
Requirement :

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

SHARDING

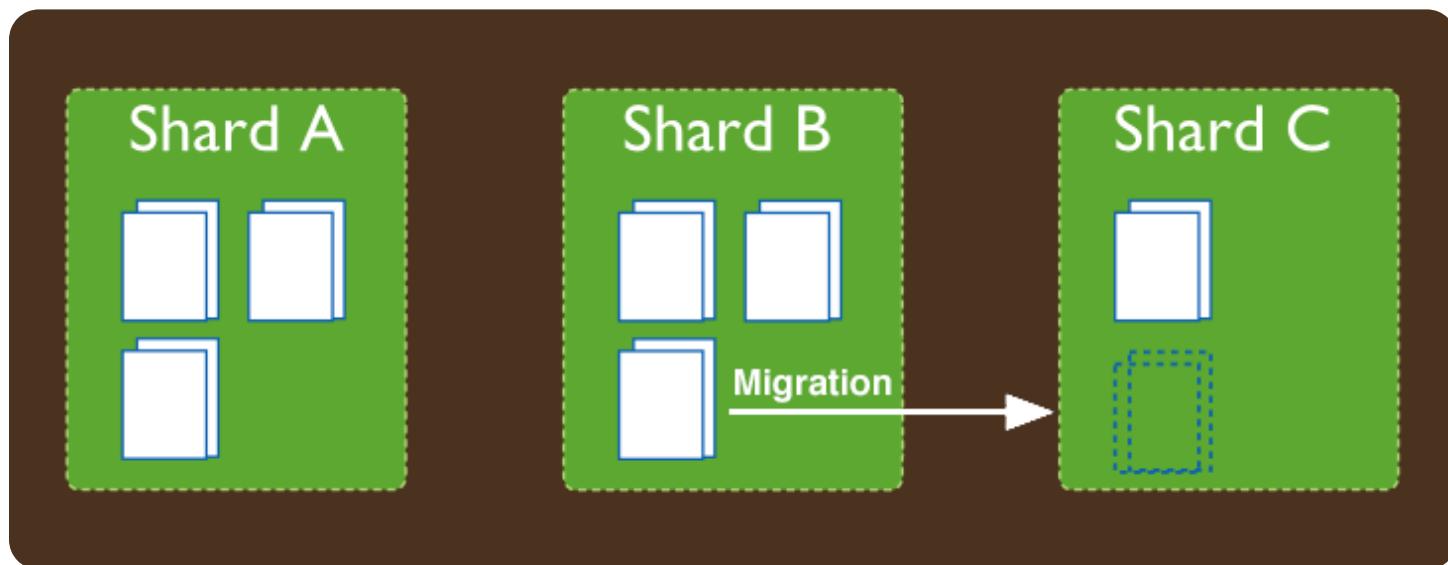
Chunk

- Split if bigger than 64Mo
- Split ≠ Moved
- Split only between 2 different values
- Moved Automatically



SHARDING

Balancing





CRUD

CRUD

C Create

R Read

U Update

D Delete

CRUD

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

QUERYING

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

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" : "Doe", "age" : 25, "city" : "New York", "state" : "NY", "country" : "USA", "zip" : "10001", "email" : "john.doe@example.com", "phone" : "123-456-7890", "date_joined" : ISODate("2014-01-01T00:00:00Z") }
```

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:

```
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

Querying in array

- 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"]  
}
```

READ

Querying in nested document

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

Or

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

Can return :

```
{  
  first_name: 'Victor',  
  surname: 'Hugo',  
  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

Querying combinaison :

- Natural :

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

- Or (\$or) :

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

- And (\$and) :

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

READ

Querying 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})
```

Or

```
> 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:

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

They can be combined

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

UPDATE

Syntax

```
update( {find_query} , {update_query}, {update_params} )
```

UPDATE

Example

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

on

```
{
  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" ]}}
```

```
WriteResult({ "nMatched" : 1, "nUpserted" : 0, "nModified" : 1 })
```

- Supprimer des champs (\$unset)

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

```
WriteResult({ "nMatched" : 1, "nUpserted" : 0, "nModified" : 1 })
```

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

Update or insert

=> Upsert

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

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

UPDATE

Multiple update

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

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

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

DELETE

Syntax

- Removing lines

```
> db.member.remove({find_query})
```

- Drop a collection

```
> db.member.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}).
```

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

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",
    "gitVersion" : "009580ad490190ba33d1c6253ebd8d91808923e4"
}
```

ADVANCED

Distinct (**details**)

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

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

ADVANCED

Geospatial (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"
{ "_id" : "84760", "city" : "PARAGONAH", "loc" : [ -112.773972, 37.89172 ], "pop"
{ "_id" : "84717", "city" : "BRYCE CANYON", "loc" : [ -112.074311, 37.608427 ], "pop"
{ "_id" : "84761", "city" : "PAROWAN", "loc" : [ -112.832251, 37.844861 ], "pop"
```

ADVANCED

Aggregate (details)

```
> db.zips.aggregate([{ $group: {group} } , { $match: {group} }])
```

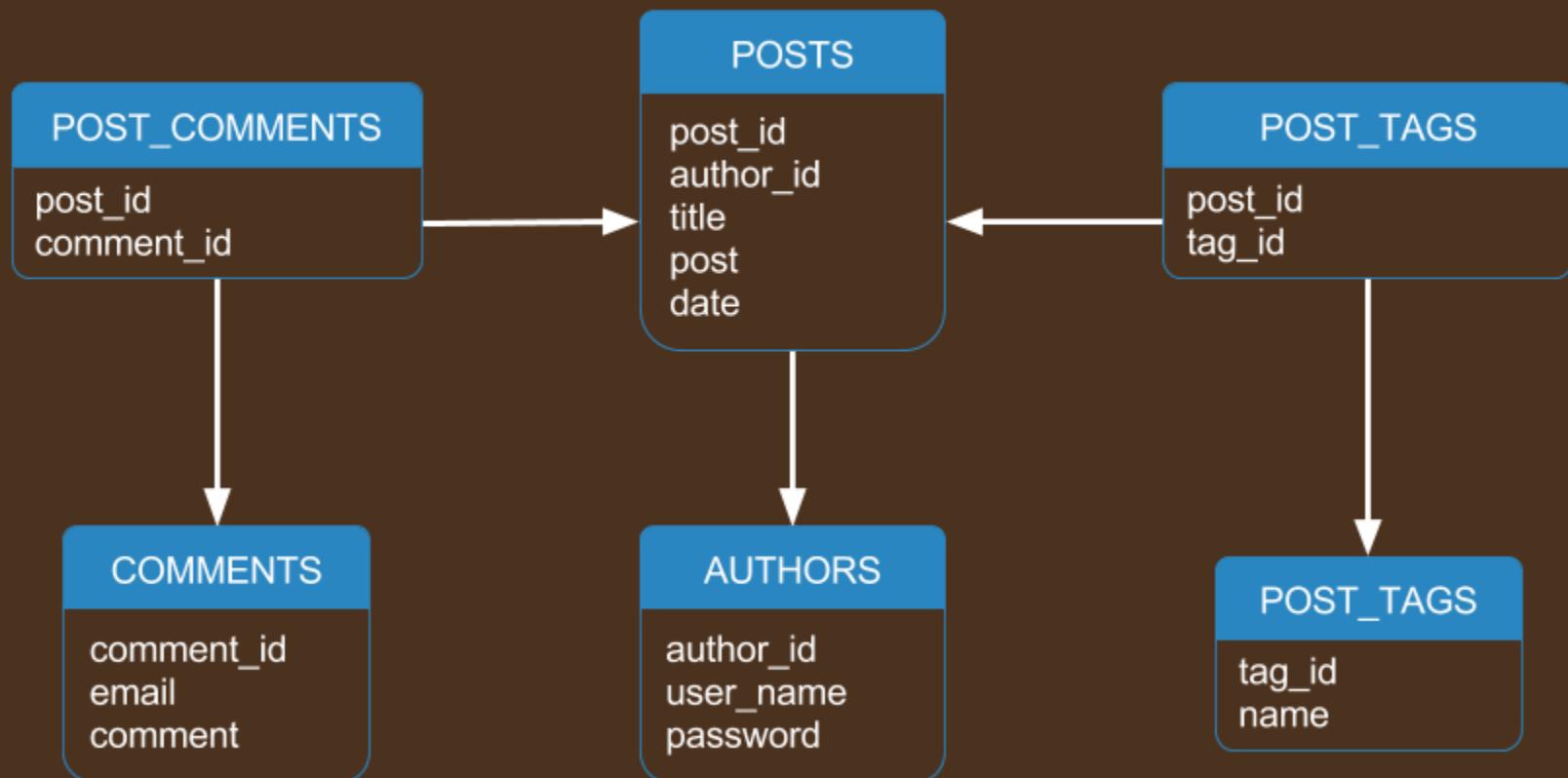
```
> db.zips.aggregate([{ $group: { _id: "$city", totalPop: { $sum: "$pop" } } }])  
{ "_id" : "CHALKYITSIK", "totalPop" : 99 }  
{ "_id" : "WRANGELL", "totalPop" : 2573 }  
{ "_id" : "SKAGWAY", "totalPop" : 692 }  
{ "_id" : "THORNE BAY", "totalPop" : 744 }  
...
```



Case Study

SIMPLE BLOG

Relational



SIMPLE BLOG

MongoDB

Posts

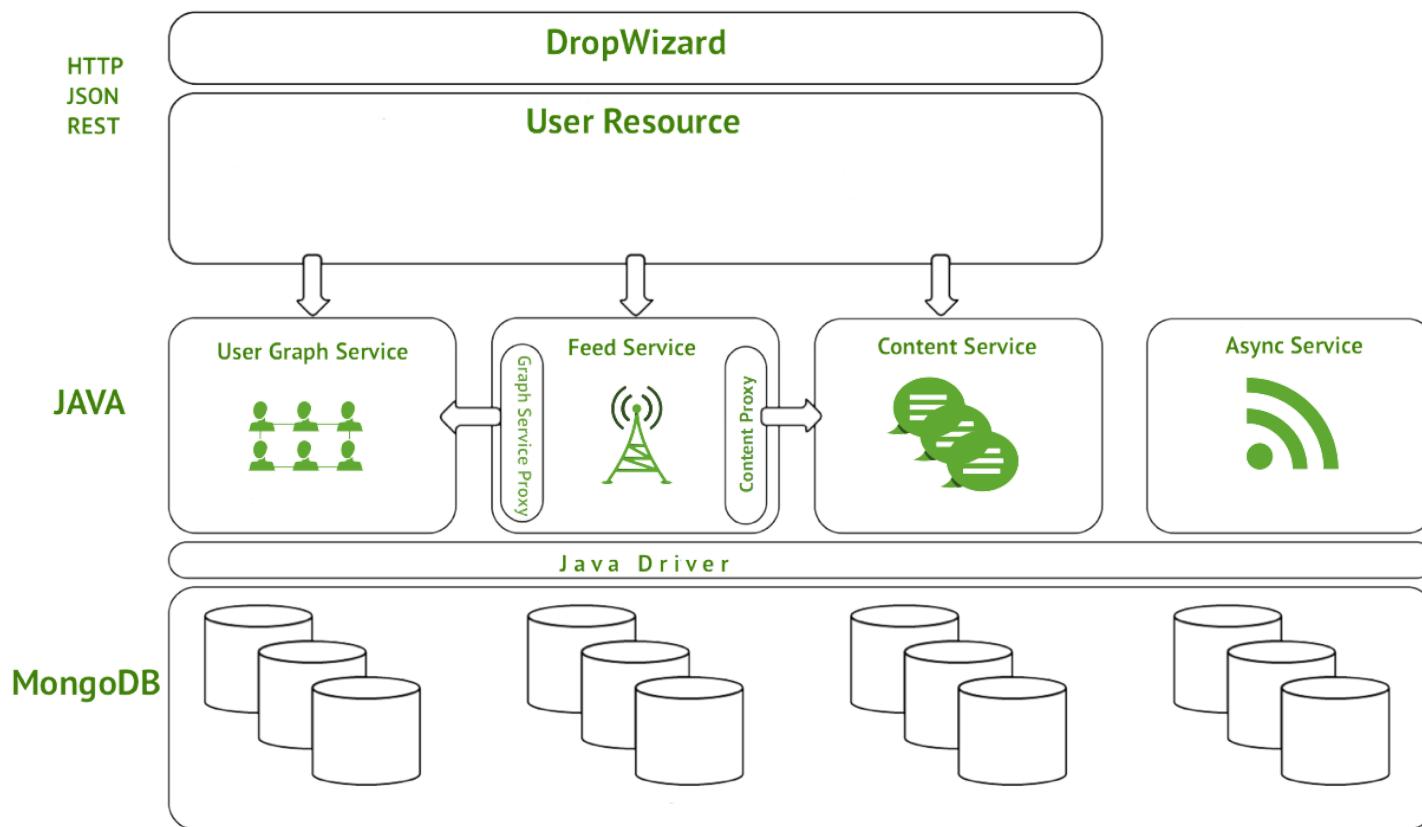
```
{  
  _id : ObjectId("54853dd6dd8fc0fec931fcbc") ,  
  title : "Title" ,  
  body : "..."  
  author : "Author" ,  
  date : "Date" ,  
  comments : [  
    {  
      name: "Observer" ,  
      comment: "Comment" ,  
    }  
  ] ,  
  tags: [ "Course" , "MongoDB" ]  
}
```

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 - Problem



A screenshot of Katy Perry's Twitter profile card. It features a circular profile picture of her smiling. Below the picture, her name "KATY PERRY" is displayed with a blue verified checkmark, and her handle "@katyperry". To the right of her name are four metrics: "Tweets 9 321", "Abonnements 216", "Abonnés 107 M" (which is circled in red), and "J'aime 6 130". To the far right are "Suivre" and three vertical dots.



A screenshot of a fake Twitter profile card for "kat pery". It features a placeholder user icon. Below the icon, the name "kat pery" and handle "@katperry1" are shown. To the right of the handle are two metrics: "Abonnements 2" and "Abonnés 8" (which is circled in red). To the far right are "Suivre" and three vertical dots.

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"}
```



Practical

INSTALLING MONGODB

Linux & MacOS

- Download mongodb zip [here](#)
- Unzip and go in the file

```
$ cd path_to_downloaded_file  
$ tar xvf mongodb-osx-x86_64-4.0.4.tgz
```

- Create the storage directory

```
$ sudo mkdir -p /data/db  
$ sudo chmod 777 /data/db
```

RUNNING MONGODB

Linux & MacOS

- Go to the directory

```
$ cd mongodb-osx-x86_64-4.0.4/bin
```

- Run MongoDB Daemon (server)

```
$ ./mongod
```

- Run MongoShell (client) in an other shell

```
$ ./mongo
```

INSTALLING MONGODB

Windows

- Download mongodb zip [here](#)
- Install it
- Create the storage directory

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

RUNNING MONGODB

Windows

- Go to the directory

```
$ cd "C:\Program Files\MongoDB\Server\4.0\bin\"
```

- Run MongoDB Daemon (server)

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

- Run MongoShell (client) in an other cmd

```
$ mongo.exe
```

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 inhabitant located on the west side of meridian 110. [[Query](#)]
- II.5. What is the closest zones to coordinates -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](#)]

MongoNotes

MongoDB with JAVA

The screenshot shows the MongoNotes application interface. At the top, there is a blue header bar with the title "MongoNotes". To the right of the title are three buttons: "All" (selected), "Important", and a red circular button with a plus sign (+). Below the header, there are three note cards, each with a small icon, a title, and a body of text. The first card has a green location pin icon and the title "Cat research". The body text is "Has anyone seen my cat?". The second card has a brown clipboard icon and the title "Nested Component". The body text is "Yo, I heard you like components, so I put a component in your component.". The third card has a red film strip icon and the title "Lecture proposition". The body text is "Pretty sure I came up with that first." Each note card has a red flag icon and a close (X) icon in the top right corner.

MongoNotes

All

Important

Cat research

Has anyone seen my cat?

Nested Component

Yo, I heard you like components, so I put a component in your component.

Lecture proposition

Pretty sure I came up with that first.

MongoNotes Project

Github : [goo.gl/xszvRW](https://github.com/goo.gl/xszvRW)



MongoNotes

Bootstrap

Startup project

```
$ git clone https://github.com/geofberard/MongoNotes.git  
$ cd MongoNotes  
$ mvn clean install  
$ git checkout step-0
```

MongoNotes

Git Detail

Each step of the practical is saved in a special branch.

If you are stuck, you can checkout the next branch to go to the next step with :

```
$ git reset HEAD --hard  
$ git checkout branch_name
```

(all your current modification will be lost)

The branches are :

- Step-0 : Empty implementation
- Step-1 : Service bootstrap + find() implementation
- Step-2 : findAll() implementation
- Step-3 : create() implementation
- Step-4 : delete() implementation
- Step-final : full implementation

MongoNotes

Step 0

```
$ git checkout step-0
```

- NoteService.java : The file you need to work in
- Note.java : Modelisation for a note:

```
String id;           //String extracted from MongoDB ObjectId
String title;
String text;
String type;         //Can be description/room/today/theaters
boolean important;   //Say if the document is flagger or not
```

- NotesServer.java : Web Server, run the with main() to start server
- JSonTransformet.java : format data to/from client
- Resources : web content

MongoNotes

Step 1

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

You need to get all the notes from the collection

There are some hints :

- Use find() of DBCollection to get a cursor
- Use hasNext() and next() to iterate through elements
- Cast DBObject to BasicDBObject to get more methods

MongoNotes

Step 2

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

You need to add a new document in the collection

There are some hints :

- Use use insert() of DBCollection
- Use new Gson().fromJson(body, Note.class) to get a note object

MongoNotes

Step 3

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

You need to delete a document from the collection

There are some hints :

- You must specify a query on `_id:{_id:...}`
- Use `use delete()` of `DBCollection`
- You can create a query with `BasicDBObject` or with `QueryBuilder`
- You need to transform the String id to an `ObjectId` (`new ObjectId(uid)`)

MongoNotes

Step 4

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

You need to update document in the collection

There are some hints :

- You must specify a query on `_id : {_id:...}`
- You must specify a modifier on `_id : {$set:...}`
- Use `use update()` of `DBCollection`
- You can create a query with `BasicDBObject` or with `QueryBuilder`
- You need to transform the String id to an `ObjectId` (`new ObjectId(uid)`)

MongoNotes

Step Final

```
$ git checkout step-final
```

You can add a new feature



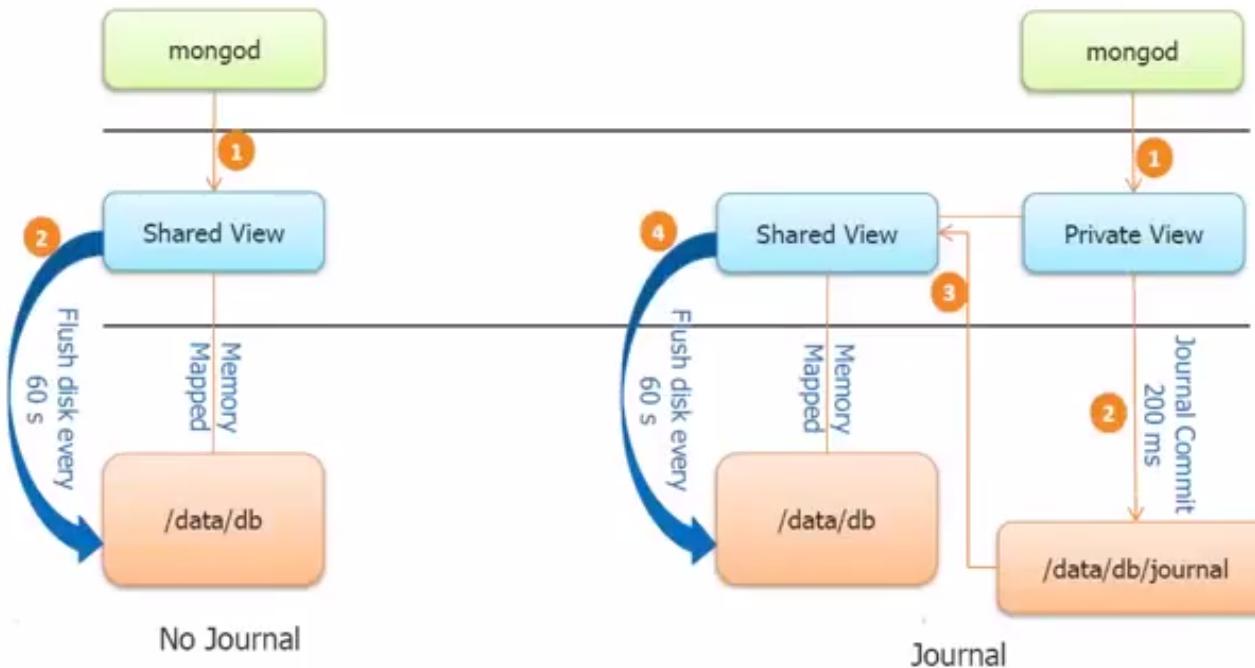
Replication

MongoDB Replication

1. MongoDB write path
2. Replication principles
3. Replica set Read and Write Semantics
4. Replica set in practice

MongoDB write path

Journaling Mechanics



MongoDB Journal vs Oplog

- **journal**
 - low level log of an operation for crash recovery (can be turned off)
- **oplog**
 - similar to RDBMS binlog
 - stores (idempotent) 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/>

MongoDB Replication

1. MongoDB write path
2. **Replication principles**
3. Replica set Read and Write Semantics
4. Replica set in practice

Replica set

- **Replica set** = a group of *mongod* processes that provide **redundancy** and **high availability**
- Writes: write to single node replicated to the others members of the replica set
- Read: read from a single member of the replica set

Disclaimer:

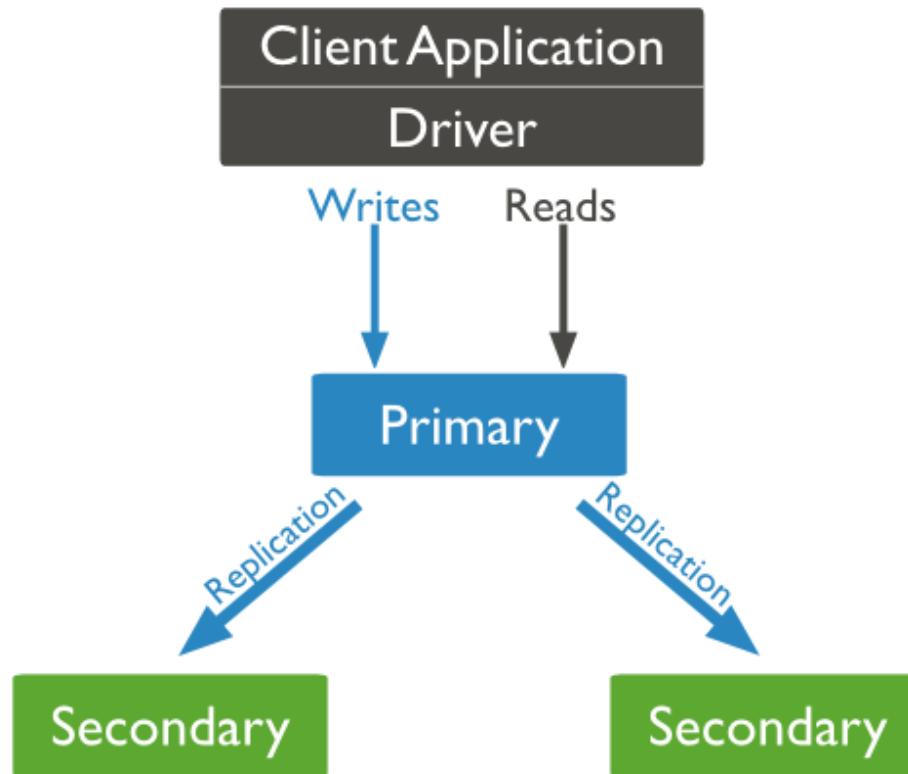
- we only consider replica sets **without sharding** (for now)
- we not include proposed MongoDB 3.2 replication modifications (readConcern...)

Replica set members

- **Primary**
 - accepts all **writes** and reads
 - 1 primary per replica set
- **Secondaries** replicates data (and can serve **reads** ⇒ reads preferences)
 - Priority 0 ⇒ Hidden members ⇒ Delayed
- **Arbiters** (usually at most one) : break ties

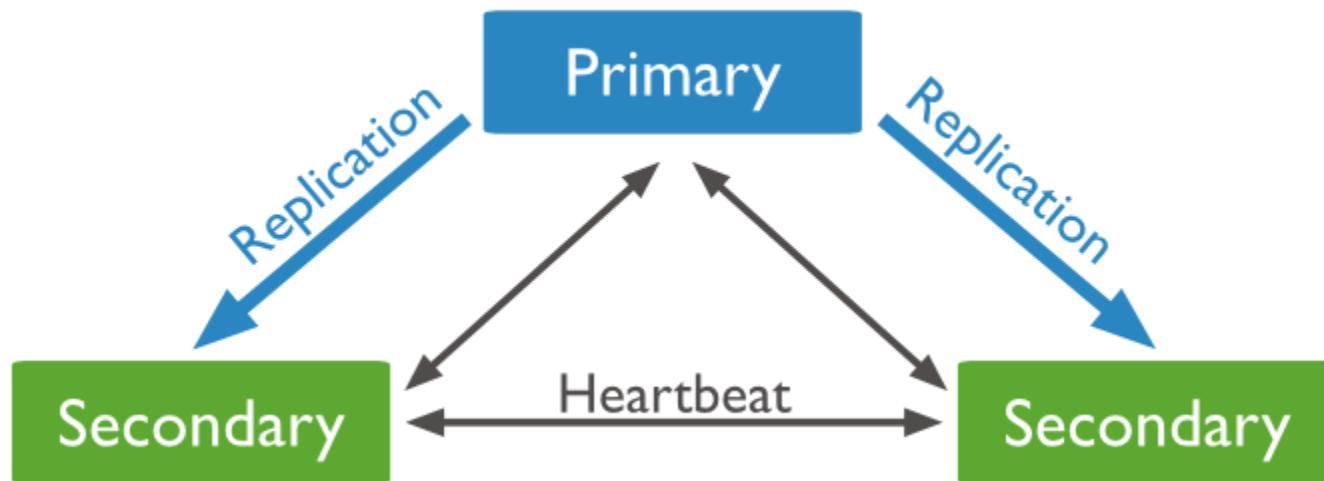
Primary and secondary members

- Primary accepts all writes + reads + records them in oplog
- Secondary replicates primary oplogs (also accept reads)

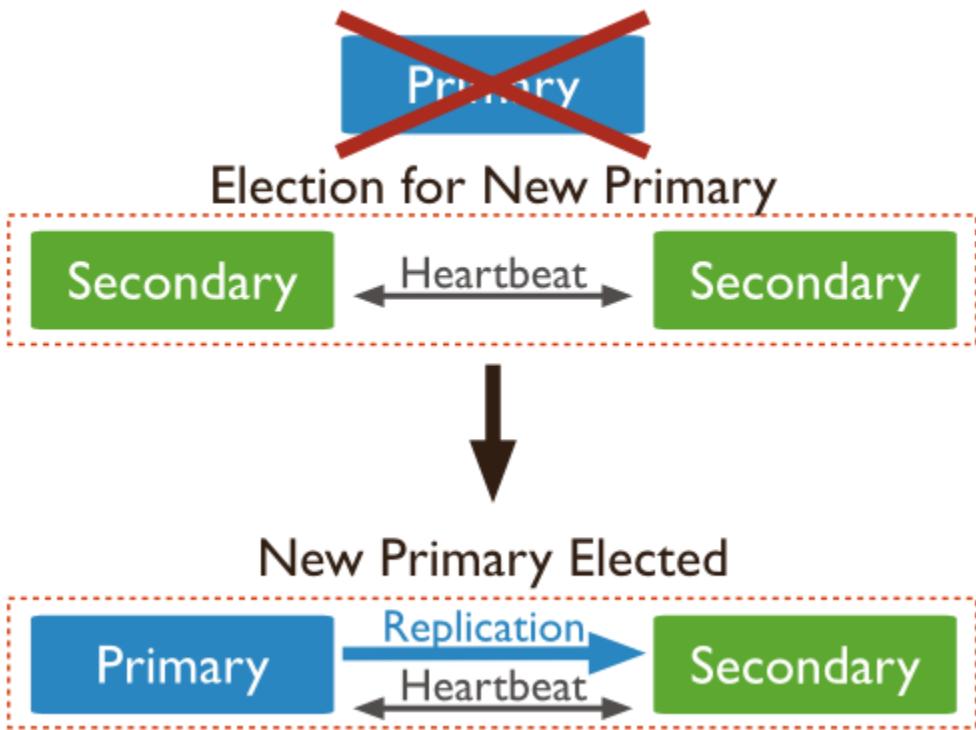


Replication data flow

- asynchronous **oplog** replication
- heartbeat for monitoring status



Automatic failover via new primary election



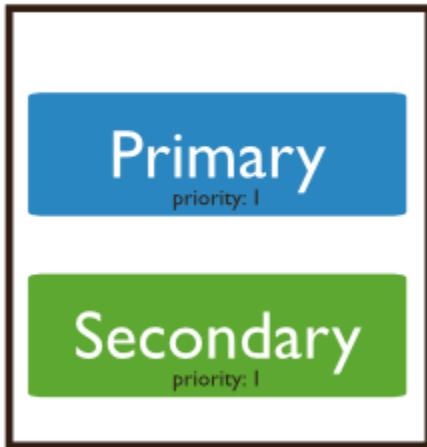
Strategy for election

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

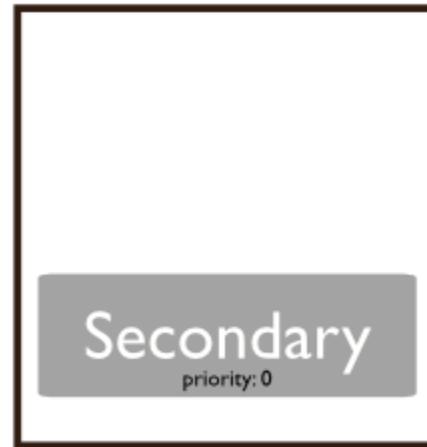
Secondary members: Priority 0

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

Data Center 1



Data Center 2



Secondary members: Hidden replica set member

- Priority 0 members that don't accept reads

Secondary

Secondary

Primary

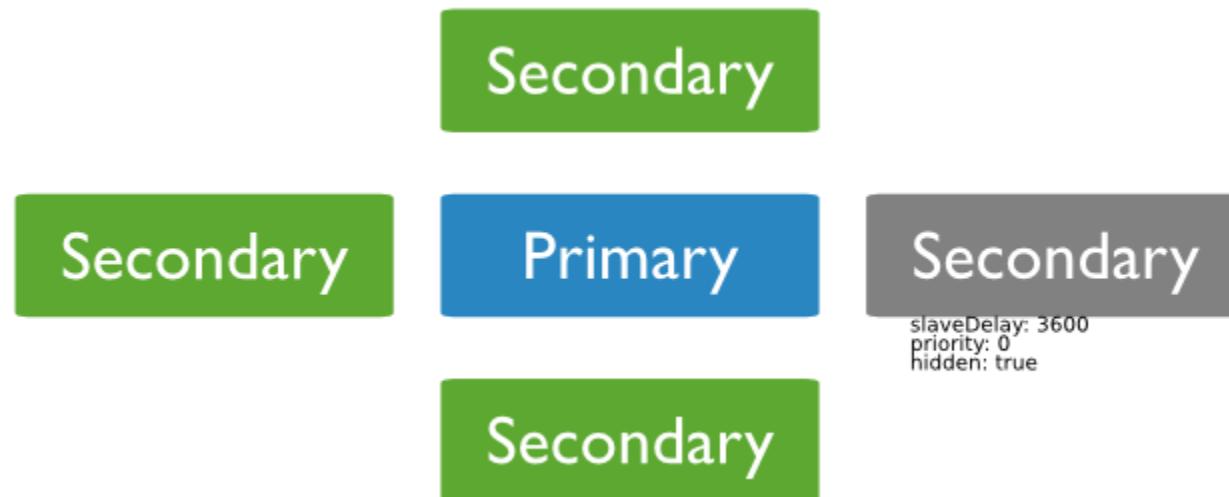
Secondary

priority: 0 hidden: true

Secondary

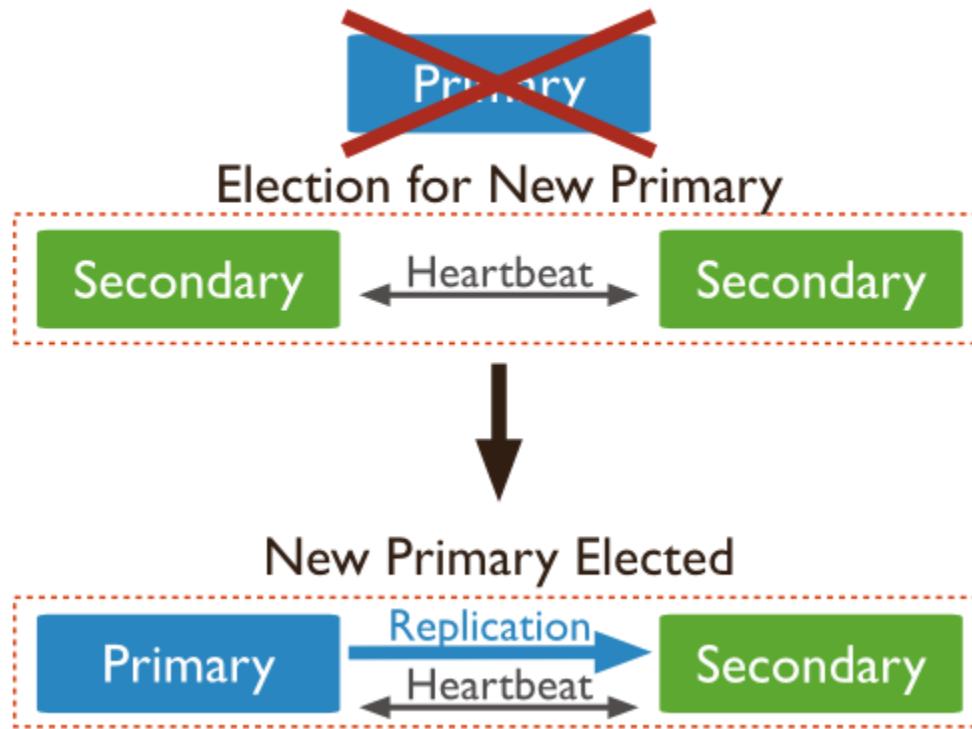
Secondary members: Delayed replica set members

- reflect an delayed state of the set
 - **must be priority 0** ⇒ prevent them to become primary
 - **should be hidden** ⇒ prevent application to query stale data



Elections on odd number of nodes

- a replica cannot become primary with only 1 vote
- majority with even numbers of members ?



- use **Arbitrators** to break ties
 - does not hold data
 - cannot became a primary

Arbiters

Secondary

votes: 1

Secondary

votes: 1

Primary

votes: 1

Secondary

votes: 1

Arbiter

votes: 1

Fault tolerance

- **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

Number of members	Majority required to elect a primary	Fault tolerance
3	2	1
4	3	1
5	3	2
6	4	2

<https://docs.mongodb.org/manual/core/relica-set-architectures/>

Rollbacks during replica set failover

- a rollback reverts write operations on a former primary when the member rejoins its replica set after a failover
 - the primary accepted a write that was not sucessfully replicated to secondaries !

Cause of the problem ?

default write semantics { w:1 } ⇒ the primary acknowledge the write after the local write (local Journal!)

How to handle rollbacks

- manually apply/discard rollbacks (**rollback/** folder)
- *avoid rollbacks use { w:majority }*
 - READ UNCOMMITTED SEMANTICS
 - ! Regardless of write concern, other clients can see the result of the write operations before the write operation is acknowledged to the issuing client.
 - ! Clients can read data which may be subsequently rolled back.
<https://docs.mongodb.org/manual/core/replica-set-rollbacks/>
<https://docs.mongodb.org/manual/core/read-isolation-consistency-recency/>

MongoDB Replication

1. MongoDB write path
2. Replication principles
3. **Replica set Read and Write Semantics**
 1. Write concerns
 2. Read preferences
4. Replica set in practice

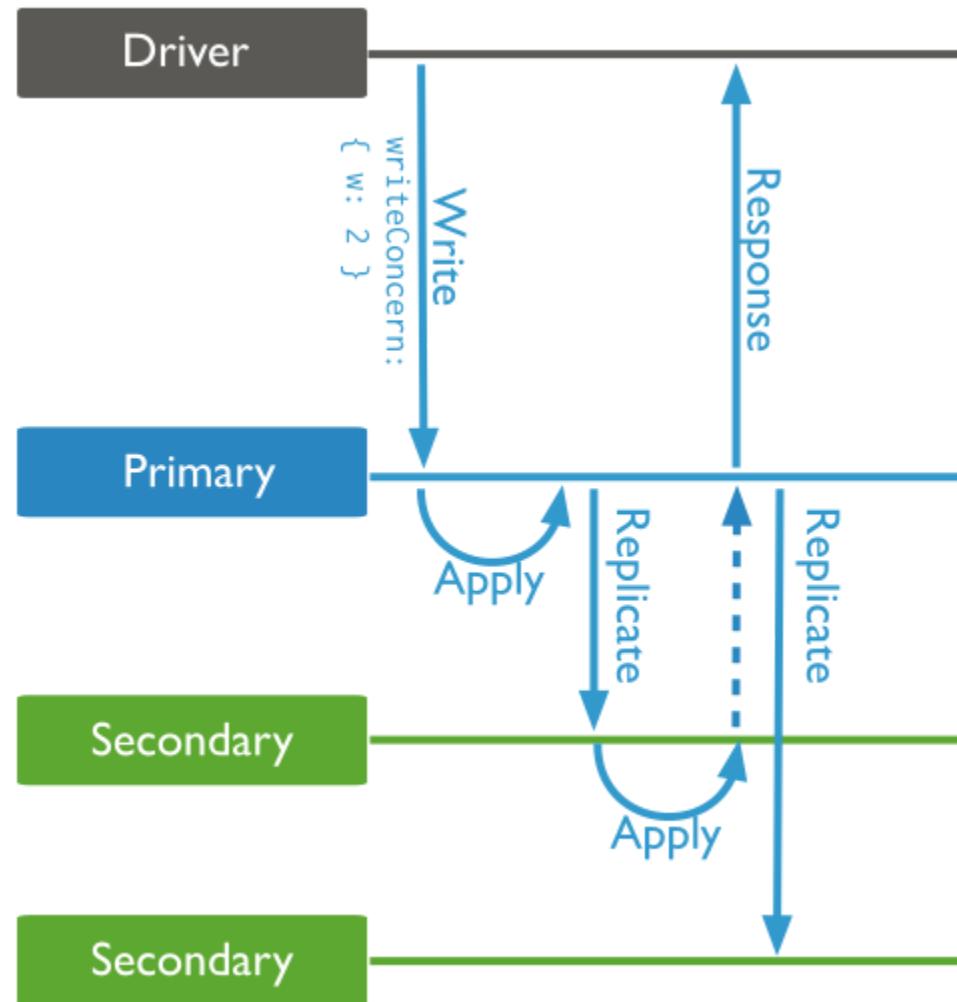
Replica set Read and Write Semantics

- parameters that change the default read/write semantics (**move the CAP cursor**)
 - **write concern**
 - is the guarantee an application requires from MongoDB to consider a write operation successful
 - **read preference**
 - applications specify read preference to control how drivers **direct read operations** to members of the replica set

Write semantics

- **w:1** (*default*)
 - the primary acknowledge the write after the local write
- other options:
 - **w:N**
 - ack the write after the ack of N members
 - **x:majority**
 - ack the write after the ack of the majority of the members
- optional parameter **wtimeout**
 - prevents write operations from blocking indefinitely if the write concern is unachievable

W:2 write semantics



Changing the write semantics

- at the query level

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

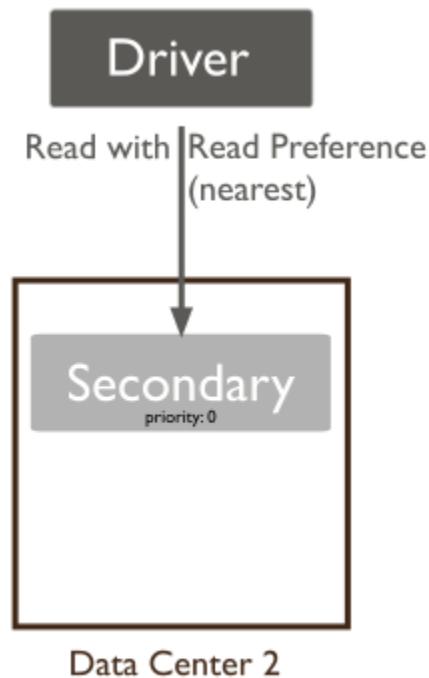
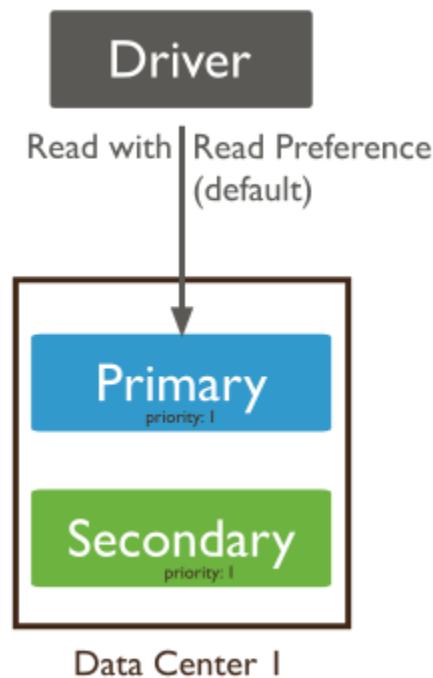
- change the default write concern:

```
cfg = rs.conf()  
    cfg.settings = {}  
    cfg.settings.getLastErrorDefaults = { w: "majority", wtimeout  
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
- Async replication ⇒ stale data if read from replica**

Read preferences example



Read preferences use cases

- Maximize Consistency ⇒ **primary** read preference
- Maximize Availability ⇒ **primaryPreferred** read preference
- Minimize Latency ⇒ **nearest** read preference

MongoDB Replication

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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>

Learn more:

- read the MongoDB documentation and the Jepsen blog entry:
 - [MongoDB Documentation](#)
 - [Jepsen MongoDB Stale reads on](#)
- do the replica set tutorial in the MongoDB documentation:
 - <https://docs.mongodb.org/manual/administration/replica-set-deployment/>

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