The MongoDB Tutorial

Introduction for MySQL Users

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PERCONA
LIVE

Agenda

- Introduction
- Install & First Steps
- CRUD
- Aggregation Framework
- Performance Tuning
- Replication and High Availability
- Sharding

Before we start

- No knowledge of MongoDB is required
- Several interesting topics will intentionally be left out
- Any problem, any question? Raise your hand!

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Typical problems with RDBMS

- SQL is difficult to understand
- Changing the schema is difficult with large tables
  - aka “The relational model is not flexible”
- Scaling out and HA are difficult
  - Support for sharding is limited or non-existent
  - Many HA solutions, which one to choose?

MongoDB solutions (1)

- “SQL is difficult to understand”
  - Everything is a JSON document in MongoDB
  - No joins but a powerful way to write complex queries (aggregation framework)
  - Queries are easy to read/write
    - SQL: `SELECT * FROM people`

      `WHERE name = 'Stephane'`
    - MongoDB: `db.people.find({name:'Stephane'})`

MongoDB solutions (2)

- “The relational model is not flexible”
  - MongoDB is schemaless, no ALTER TABLE!

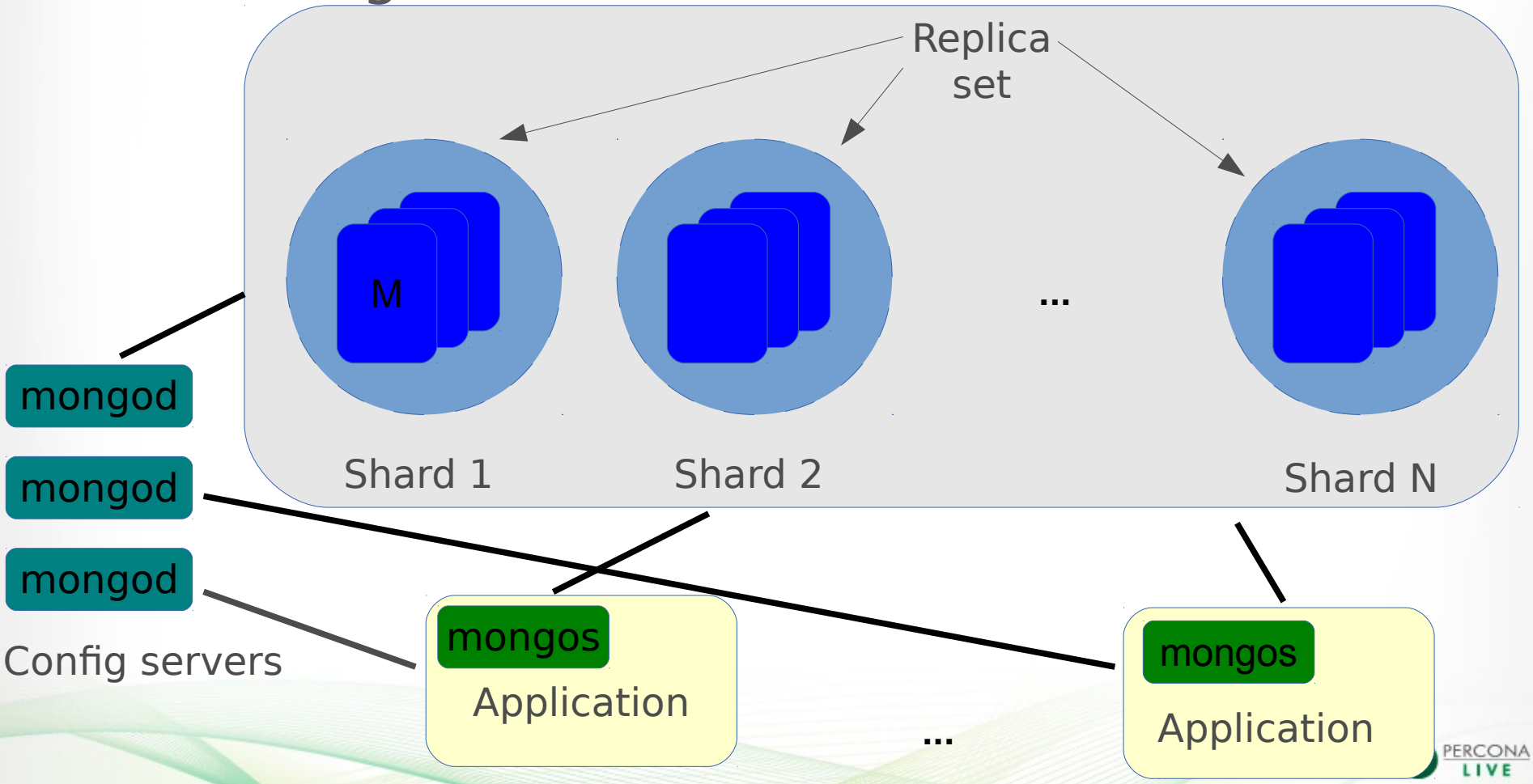
```
db.people.insert({name: 'Stephane'});
db.people.insert({name: 'Joe',age:30});
```

- But be careful, this is *also* allowed

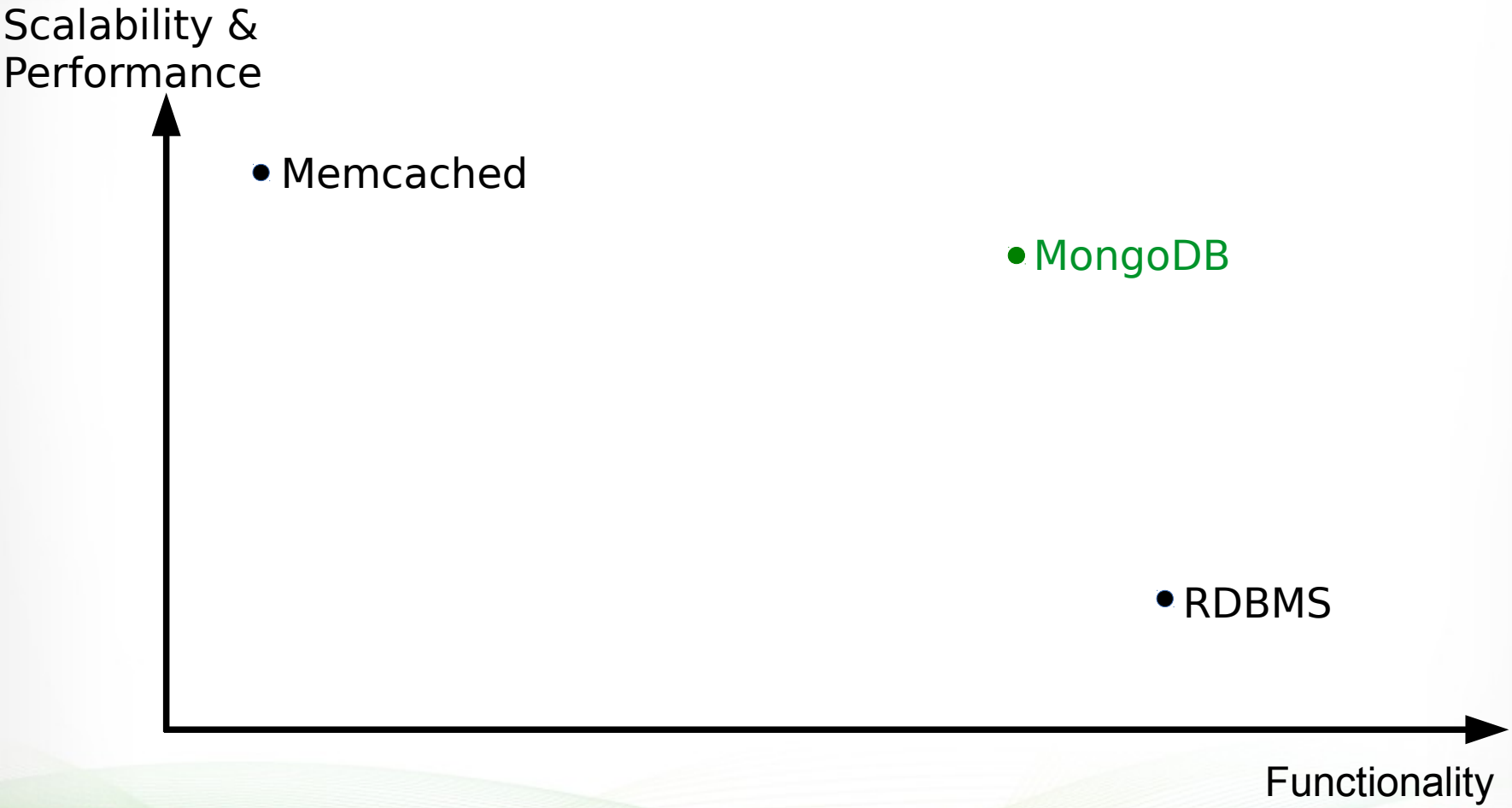
```
db.people.insert({name: 'Stephane')
db.people.insert({n: 'Joe'})
```

MongoDB solutions (3)

- “Scaling and HA are difficult”



Summary


Scalability &
Performance
Memcached
MongoDB
RDBMS
Functionality

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MongoDB setup

- See mongod_setup.rst

Useful terminology

Relational	MongoDB
Database	Database
Table	Collection
Row	(JSON) document

JSON

- Stands for JavaScript Object Notation
  - But not tied to Javascript
- Open standard for human-readable data interchange
- Lightweight alternative to XML
- Internally, docs are stored in BSON
  - Binary JSON
  - See http://bsonspec.org

Invoking the shell

$ mongo (--port=xxx, default 27017)

```
> show dbs
local   0.03125GB
test    0.0625GB
> use test
switched to db test
> show collections
people
system.indexes
> db.people.find()
{ "_id" : ObjectId("523ef7bf8108101415e7d1d1"), "age" : 30, "country" : "XXX", "name" : "Joe"
}
{ "_id" : ObjectId("523ef7ac8108101415e7d1d0"), "age" : 33, "country" : "XXX", "name" : "Steph
ane" }
> db.people.find().pretty()
{
        "_id" : ObjectId("523ef7bf8108101415e7d1d1"),
        "age" : 30,
        "country" : "XXX",
        "name" : "Joe"
}
{
        "_id" : ObjectId("523ef7ac8108101415e7d1d0"),
        "age" : 33,
        "country" : "XXX",
        "name" : "Stephane"
}
```

Inserting data (1)


```
use test
db.people.insert({name:'Stephane',country:'FR'})
```

- This inserts a document
  - In the people collection
  - Collection is in the test database
- Collection is created if it did not exist

Inserting data (2)

- The shell embeds a JS interpreter
  - You can also use a variable to build the JSON document step by step

```
> x = {name:'Stephane'}
{ "name" : "Stephane" }
> x.country = 'FR'
FR
> x
{ "name" : "Stephane", "country" : "FR" }
> db.people.insert(x)
> db.people.findOne()
{
        "_id" : ObjectId("526fd69e64ea1df71b82f55b"),
        "name" : "Stephane",
        "country" : "FR"
}
```

_id

- Unique identifier of a doc
- You can set it explicitly

```
db.people.insert({_id:'Stephane',country:'FR'})
```

- If you don't, it will be created for you

```
"_id" : ObjectId("523ef7bf8108101415e7d1d1")
```

- Monotonically increasing on a single node
  - Think auto_increment in MySQL

Structure of a document

- Set of key/value pairs
  - `{'key1':'value1','key2':'value2',...}`
- A value can be an array
- A value can be another document

Lab #1

- See lab1.rst

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Inserting a document

- SQL
  - `INSERT INTO t (fn, ln) VALUES ('John', 'Doe')`
- MongoDB
  - `db.t.insert({fn:'John', ln: 'Doe'})`
- No need to specify non-existing fields

Updating a document (1)

- SQL
  - `UPDATE t SET ln='Smith' WHERE ln='Doe'`
- MongoDB
  - `db.t.update({ln:'Doe'},{$set:{ln:'Smith'}})`
- Only 1 doc. is updated by default
  - Specify `{multi:true}` for multi-doc updates
  - `db.t.update({ln:'Doe'},{$set:{ln:'Smith'}}, {multi:true})`

Updating a document (2)

- To add a new field
  - No need to run ALTER TABLE!
  - It is a regular update
  - `db.t.update({ln:'Smith'},{$set:{age:30}})`

Removing documents

- SQL
  - `DELETE FROM t WHERE fn='John'`
- MongoDB
  - `db.t.remove({fn:'John'})`

Dropping a collection

- SQL
  - `DROP TABLE t`
- MongoDB
  - `db.t.drop()`

Selecting all documents

- SQL
  - `SELECT * FROM t`
- MongoDB
  - `db.t.find()`
- SQL
  - `SELECT id, name FROM t`
- MongoDB
  - `db.t.find({},{name:1})`

Specifying a “WHERE” clause

- SQL
  - `SELECT * FROM t WHERE fn='John'`
- MongoDB
  - `db.t.find({ln:'John'})`
- SQL
  - `SELECT id, age FROM t WHERE fn='John' AND ln='Smith'`
- MongoDB
  - `db.t.find({fn:'John',ln:'Smith'},{age:1})`

Sorts, limits

- SQL
  - ```
    SELECT country FROM t
    WHERE fn='John'
    ORDER BY age DESC LIMIT 10
    ```
- MongoDB
  - ```
    db.t.find(
      {fn:'John'},
      {country:1, _id:0}
    ).sort({age:1}).limit(10)
    ```

Inequalities

- SQL
  - `SELECT fn,ln FROM t`

    `WHERE age > 30`
- MongoDB
  - `db.t.find(`

    `{age:{$gt:30}},`

    `{fn:1, ln:1, _id:0}`

    `)`

Conditions on subdocuments


```
{
  _id:...
  fn:'John', ln:'Doe'
  address:{
    country:'US',
    state:'CA'
  }
}

db.t.find(
  {address.country:'US'},
  {fn:1, ln:1, _id:0}
)
```

Conditions on arrays


```
{
  _id:...
  hobbies:['music', 'MongoDB', 'Python']
}
```

- Exact match on array

```
db.t.find({hobbies:['music', 'MongoDB', 'Python']})
```

- Match on array element

```
db.t.find({hobbies:'Python'})
```

Counting

- SQL
  - `SELECT COUNT(*) FROM t WHERE country='US'`
- MongoDB
  - `db.t.count({country:'US'})`

Lab #2

- See lab2.rst file

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Aggregation

- “Means” GROUP BY, SUM(), ...
- Not possible with the operators we saw previously (exception: count)
- 2 ways to aggregate
  - Map-Reduce # Not covered here
  - Aggregation Framework

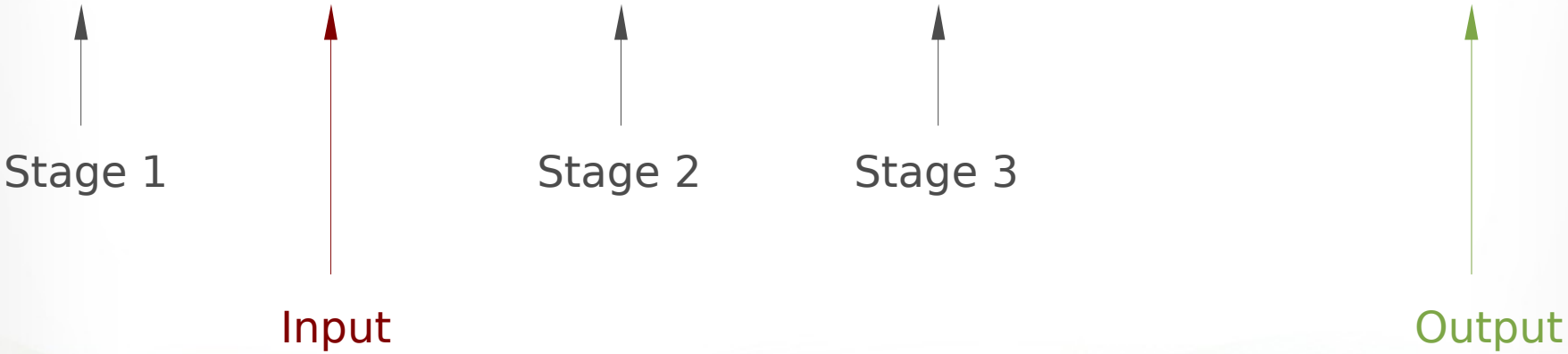
Aggregation Framework

- Available from MongoDB 2.2
- Easier and faster than Map-Reduce
- Some limitations
  - AF is perfect for simple cases
  - Map-Reduce can be needed for complex situations

10,000 feet overview

- Documents are modified through pipelines
- Similar to Unix pipelines

```
grep oo /etc/passwd | sort -rn | awk -F ':' '{print $1,$3,$4}'
```



First example

- SQL

```
SELECT fn,count(*) AS total FROM people WHERE fn >=
'M%' GROUP BY fn
```

- MongoDB

```
db.people.aggregate({$match:{fn:{$gte:'M'}}},{$group:
{_id:"$fn",total:{$sum:1}}})
```

- You probably want some explanation!

First example, explained


```
db.people.aggregate(
   {$match:XXX},        # Pipeline 1, filtering criteria
   {$group:XXX}         # Pipeline 2, group by
)
```

- Filtering condition like with find()

```
$match:{fn:{$gte:'M'}}
```

- Specifying the grouping field

```
$group:{_id:"$fn",...}
```

- Specifying the aggregated fields

```
$group:{..., total:{$sum:1}}
```

Pipeline order matters


```
db.people.aggregate(
   {$match:...},
   {$group:...}
)

vs

db.people.aggregate(
   {$group:...},
   {$match:...}
)
```

SQL analogy


```
SELECT … FROM people
WHERE …
GROUP BY …
```

vs

```
SELECT … FROM people
GROUP BY …
HAVING …
```

Clean the output

- The projecting operator allows renaming keys/values

```
db.people.aggregate(
   {$match:...},
   {$group:...},
   {$project:{_id:0, name:{$toUpper:"$_id"}, total:1}}
)
```

Final query

- SQL

```
SELECT UPPER(fn) AS name, count(*) AS total
FROM people
WHERE fn >= 'M%'
GROUP BY fn
```

- MongoDB

```
db.people.aggregate(
  {$match:{fn:{$gte:'M'}}},
  {$group:{_id:"$fn",total:{$sum:1}}},
  {$project:{_id:0, name:{$toUpper:”$_id”}, total:1}}
)
```

Other operators

- $sort
  - `{$sort: {total: -1}}`
- $limit
  - `{$limit: 10}`
- $skip
  - `{$skip: 100}`
- $unwind
  - Splits a document with an array into multiple documents

Lab #3

- See lab3.rst

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Indexes

- MongoDB supports indexes
  - At the collection level
  - Similar to indexes on RDBMS
- Can be used for
  - More efficient filtering
  - More efficient sorting
  - Index-only queries (covering index)

Main types of indexes

- Single-field/multiple field index
  - `db.t.ensureIndex({fn:1})`
  - `db.t.ensureIndex({fn:1, age:-1})`
- Unique index
  - All collections have an index on _id
  - `db.t.ensureIndex({username:1}, {unique:true})`
- Indexes on arrays, embedded fields, subdocuments are also supported

Compound indexes (1)

- Sort order
  - Traversal in either direction

```
db.t.find().sort({country:1,age:-1})
```

  - Good indexes
    - `{country:1, age:-1}`
    - `{country:-1, age:1}`
  - Bad index
    - `{country:1, age:1}`

Compound indexes (2)

- Prefixes
  - Leftmost prefixes are supported

```
db.t.ensureIndex({age:1,country:1})
```

  - Good for
    - `db.t.find({age:30})`
    - `db.t.find({age:30,country:'US'})`
  - Not good for
    - `db.t.find({country:'US'})`

Lab #4

- See lab4.rst

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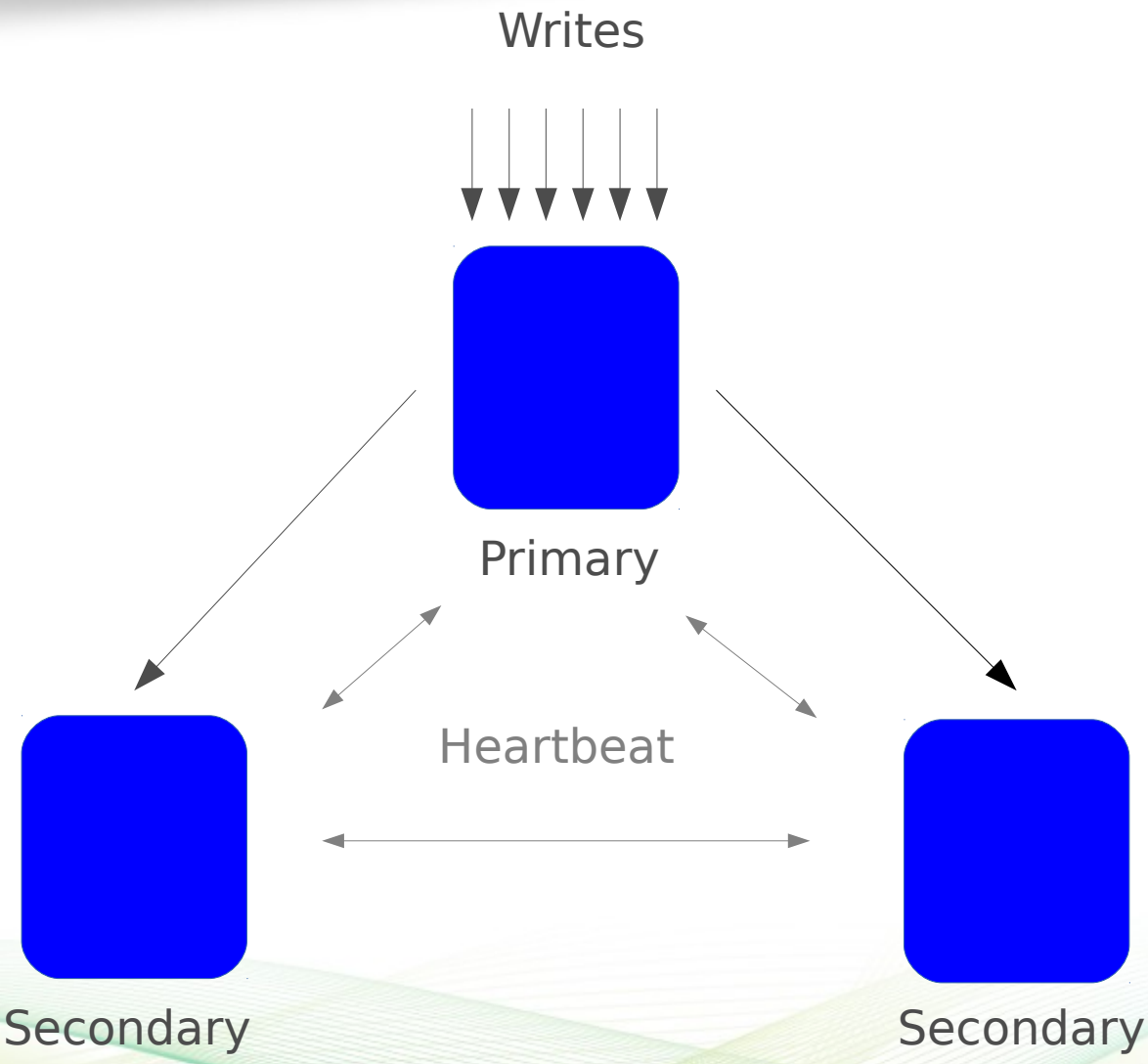
Overview

- Replication is asynchronous
- All writes go to the master
- Secondary can accept reads
- A new master is elected if the current master fails
- An arbiter (no data) can be set up for the election process


Writes
Primary
Heartbeat
Secondary
Secondary

Setup of a 3 node replica set

- Start 3 instances with `--replSet rsname`
- Then on the master

```
rsconf = {
        _id: "RS",
        members: [{
                _id: 0,
                host: "localhost:30001"
                }]
}
rs.initiate(rsconf)
rs.add("localhost:30002")
rs.add("localhost:30003")
```

If the master crashes

- If a heartbeat does not return within 10s, the master is considered unavailable
- Election of a new master starts then
- You can influence the choice by setting a priority (between 0 and 100)

Setting priorities


```
cfg = rs.conf()
cfg.members[1].priority = 0
cfg.members[2].priority = 10
rs.reconfig(cfg)
```

- A node set to have higher priority than the master will be elected the new master

Write concerns (aka w option)

- How many nodes should ack a write?
  - w=1
  - Primary only (default setting)
  - w=2
  - Primary and one secondary
  - w=majority
  - Majority of the nodes

Setting a write concern


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

Read preferences

- Can be any of
  - primary
  - primaryPreferred
  - secondary
  - secondaryPreferred
  - nearest
  - Or you can use a custom tag

Lab #5

- See lab5.rst

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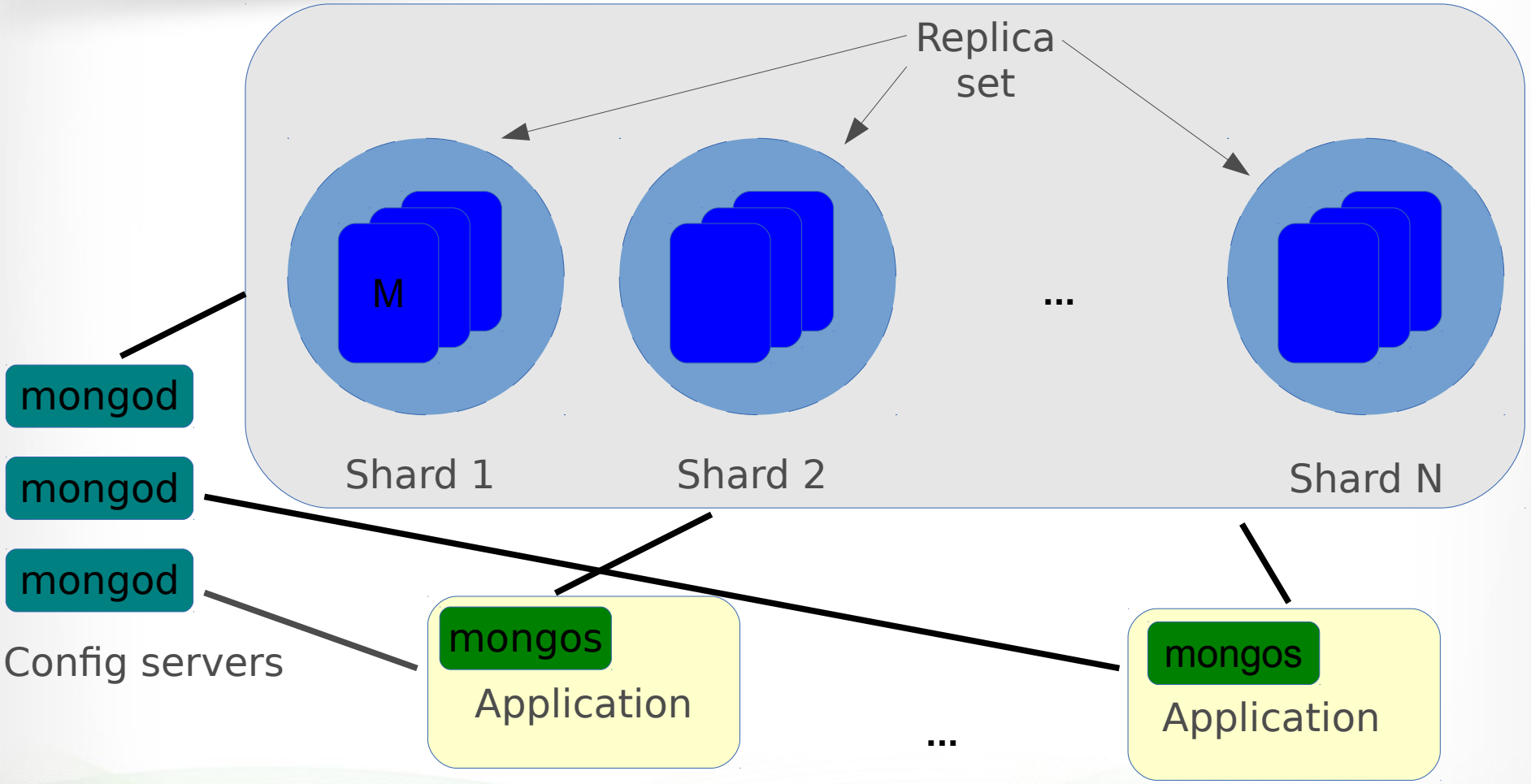
When to shard

- When the dataset no longer fits in a single server
- When write activity exceeds the capacity of a single node
- When the working set no longer fits in memory

Architecture of a sharded cluster



Setup (1)

- Start the config servers
  - `mongod --configsvr --dbpath <path> --port 40001`
  - `mongod --configsvr --dbpath <path> --port 40002`
  - `mongod --configsvr --dbpath <path> --port 40003`
- Start a router
  - `mongos –configdb localhost:40001, localhost:40002, localhost:40003 --port 31000`
- Connect to mongos
  - `mongo --host localhost --port 31000`

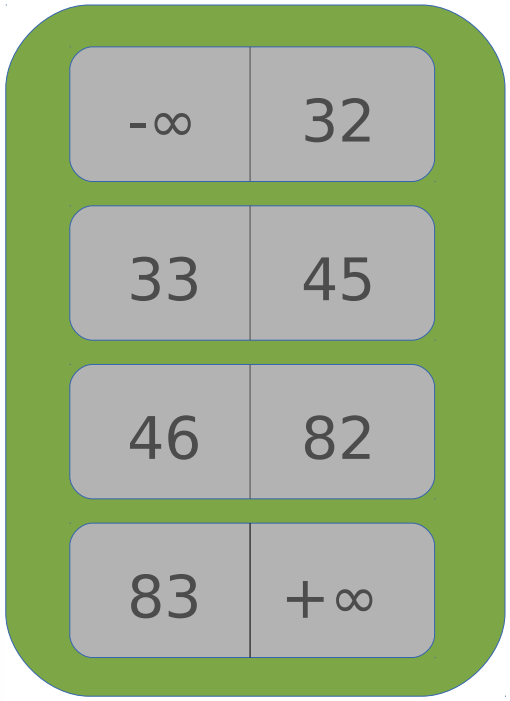
Setup (2)

- Add shards
  - `sh.addShard('RS/localhost:30001')`
- Enable sharding for a database
  - `sh.enableSharding('test')`
- Enable sharding for a collection
  - `sh.shardCollection('test.people',{'fn':1})`

Balancing (1)

- Data is stored in chunks

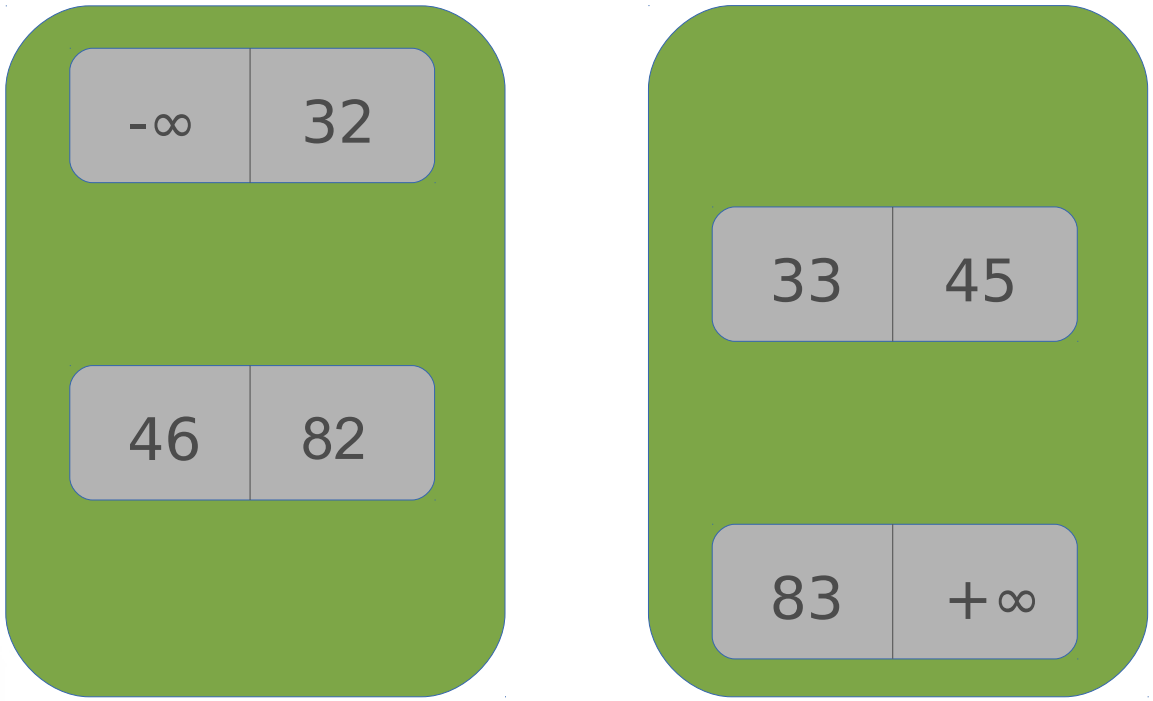
```
sh.addShard(shard1)
```



Shard 1

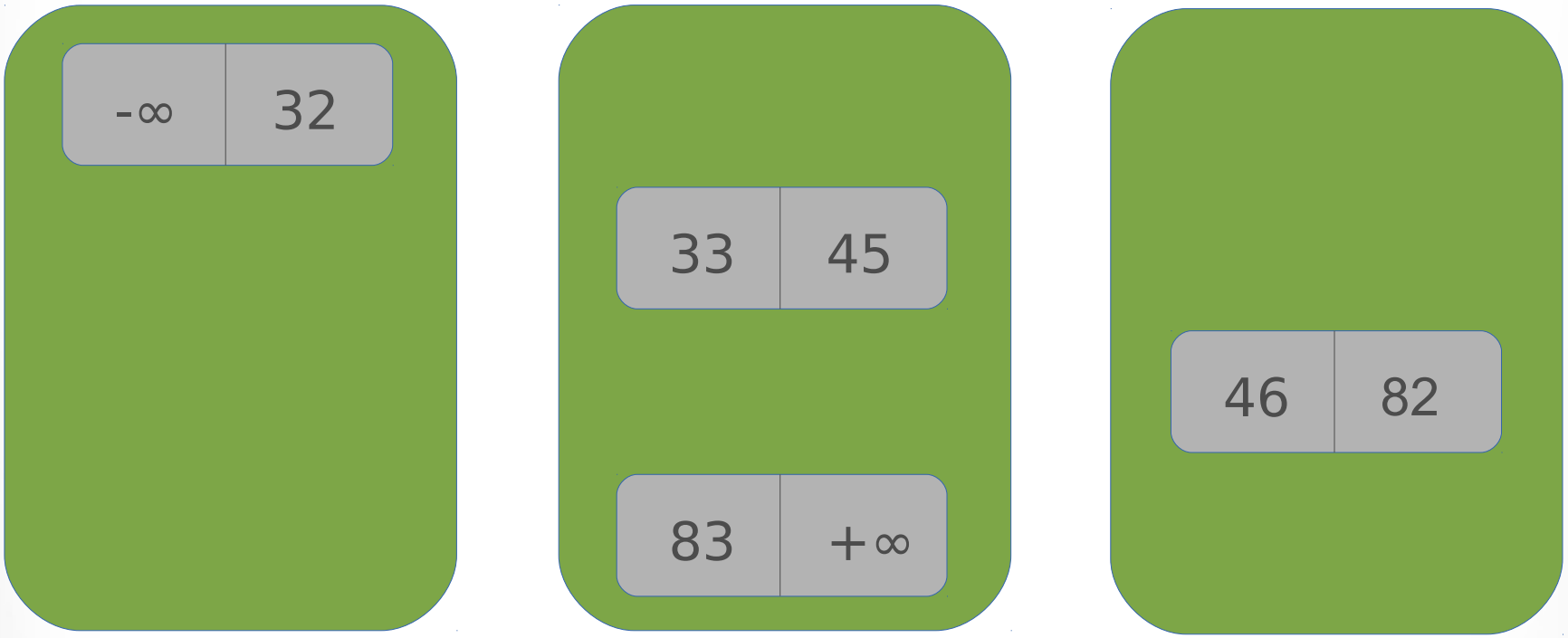
Balancing (2)


```
sh.addShard(shard2)
```



Balancing (3)


```
sh.addShard(shard3)
```



Lab #6

- See lab6.rst

Thank you for your attention!

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