DS 4300

Document Databases & MongoDB

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Some material used with permission from Dr. Rachlin, with thanks!

Document Database

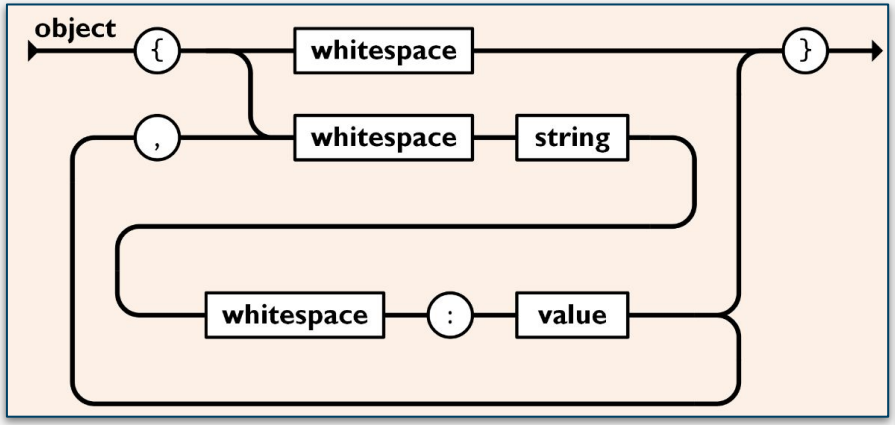
A **Document Database** is a non-relational database that stores data as structured documents, usually in JSON.

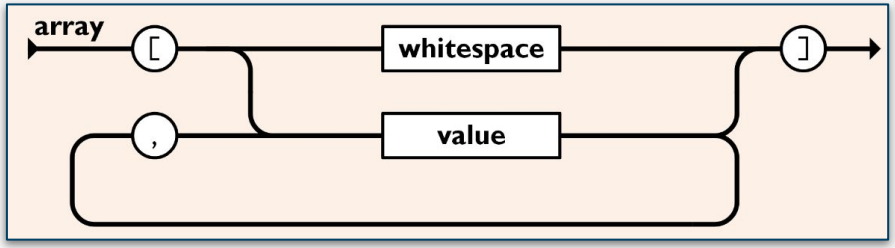
They are designed to be *simple*, *flexible*, and *scalable*.

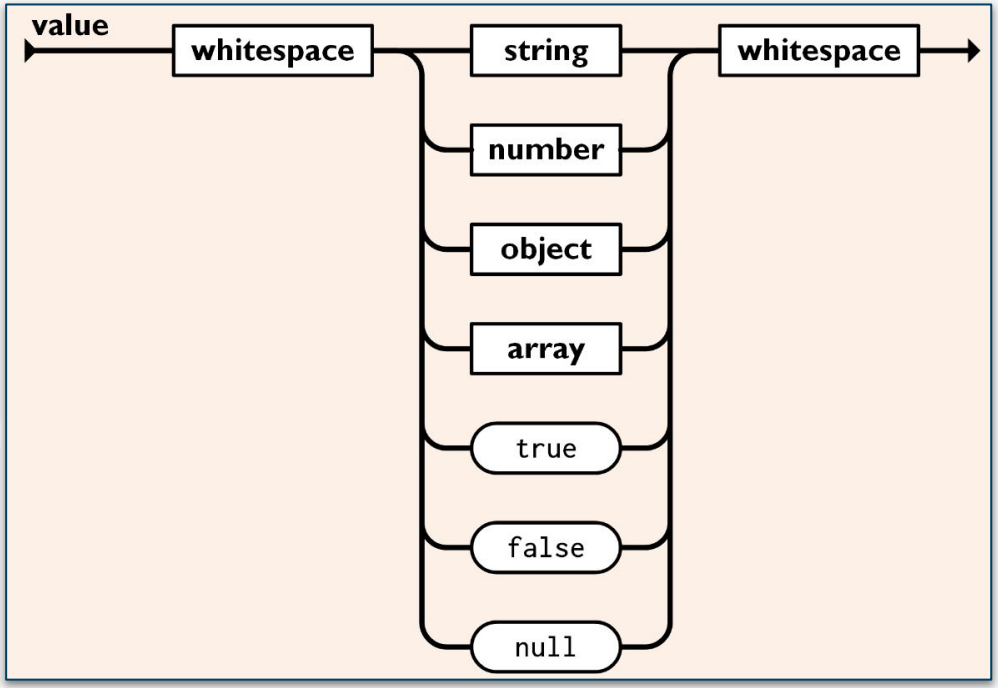
What is JSON?

- **JSON** (JavaScript Object Notation)
  - a lightweight data-interchange format
  - It is easy for humans to read and write.
  - It is easy for machines to parse and generate.
- JSON is built on two structures:
  - A **collection of name/value pairs**. In various languages, this is operationalized as an object, record, struct, dictionary, hash table, keyed list, or associative array.
  - An **ordered list of values**. In most languages, this is operationalized as an array, vector, list, or sequence.
- These are two *universal data structures* supported by virtually all modern programming languages
  - Thus, JSON makes a great data interchange format.

JSON Syntax


object
{
whitespace
}
,
whitespace
string
whitespace
:
value


array
[
whitespace
]
,
value


value
whitespace
string
whitespace
number
object
array
true
false
null

Binary JSON? BSON

- BSON → Binary JSON
  - binary-encoded serialization of a JSON-like document structure
  - supports extended types not part of basic JSON (e.g. Date, BinaryData, etc)
  - **Lightweight** - keep space overhead to a minimum
  - **Traversable** - designed to be easily traversed, which is vitally important to a document DB
  - **Efficient** - encoding and decoding *must* be efficient
  - Supported by many modern programming languages

```
{"hello": "world"} →
\x16\x00\x00\x00           // total document size
\x02                       // 0x02 = type String
hello\x00                  // field name
\x06\x00\x00\x00world\x00  // field value
\x00                       // 0x00 = type EOO ('end of object')
```

XML (eXtensible Markup Language)

- Precursor to JSON as data exchange format
- XML + CSS → web pages that separated content and formatting
- Structurally similar to HTML, but tag set is extensible

```
<CATALOG>
  <CD>
    <TITLE>Empire Burlesque</TITLE>
    <ARTIST>Bob Dylan</ARTIST>
    <COUNTRY>USA</COUNTRY>
    <COMPANY>Columbia</COMPANY>
    <PRICE>10.90</PRICE>
    <YEAR>1985</YEAR>
  </CD>
  <CD>
    <TITLE>Hide your heart</TITLE>
    <ARTIST>Bonnie Tyler</ARTIST>
    <COUNTRY>UK</COUNTRY>
    <COMPANY>CBS Records</COMPANY>
    <PRICE>9.90</PRICE>
    <YEAR>1988</YEAR>
  </CD>
</CATALOG>
```

XML-Related Tools/Technologies

- **Xpath** - a syntax for retrieving specific elements from an XML doc
- **Xquery** - a query language for *interrogating* XML documents; the *SQL* of *XML*
- **DTD** - Document Type Definition - a language for describing the allowed structure of an XML document
- **XSLT** - eXtensible Stylesheet Language Transformation - tool to transform XML into other formats, including non-XML formats such as HTML.

Why Document Databases?

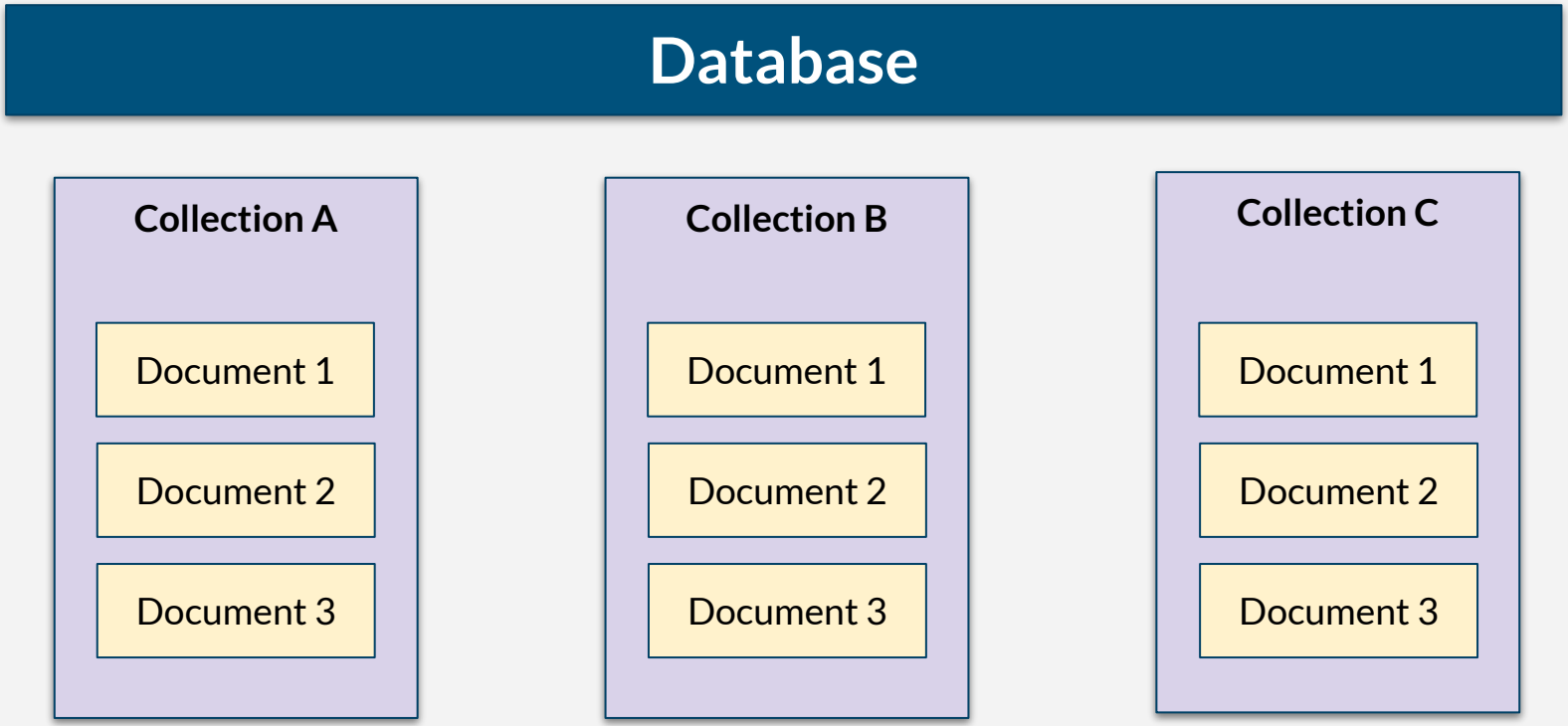
- Document databases address the *impedance mismatch* problem between object persistence in OO systems and how relational DBs structure data.
  - OO Programming → Inheritance and Composition of types.
  - How do we save a complex object to a relational database? *We basically have to deconstruct it*.
- The structure of a document is *self-describing*.
- They are well-aligned with apps that use JSON/XML as a transport layer

MongoDB

MongoDB

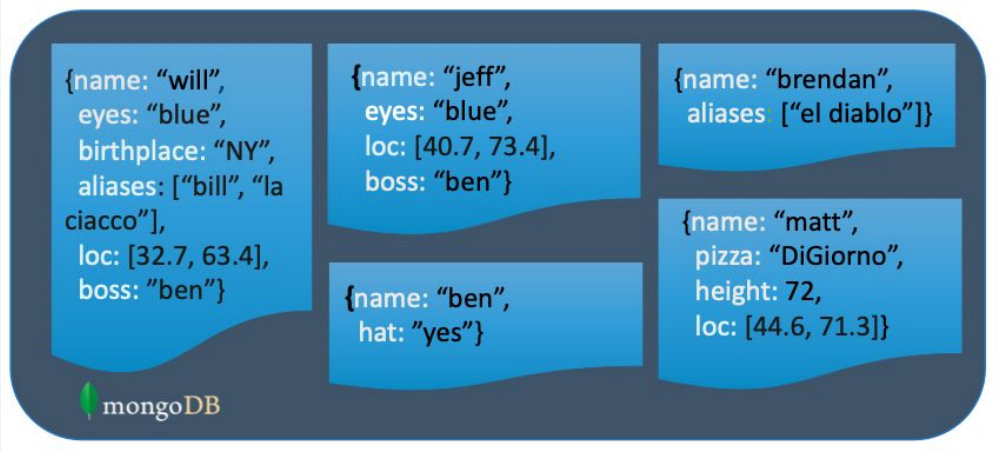
- Started in 2007 after Doubleclick was acquired by Google, and 3 of its veterans realized the limitations of relational databases for serving > 400,000 ads per second
- MongoDB was short for *Humongous Database*
- MongoDB Atlas released in 2016 → documentdb as a service

MongoDB Structure



MongoDB Documents

- No predefined schema for documents is needed
- Every document in a collection could have different data/schema



Relational vs Mongo/Document DB

RDBMS	MongoDB
Database	Database
Table/View	Collection
Row	Document
Column	Field
Index	Index
Join	Embedded Document
Foreign Key	Reference

MongoDB Features

- Rich Query Support - robust support for all CRUD ops
- Indexing - supports primary and secondary indices on document fields
- Replication - supports replica sets with automatic failover
- Load balancing built in

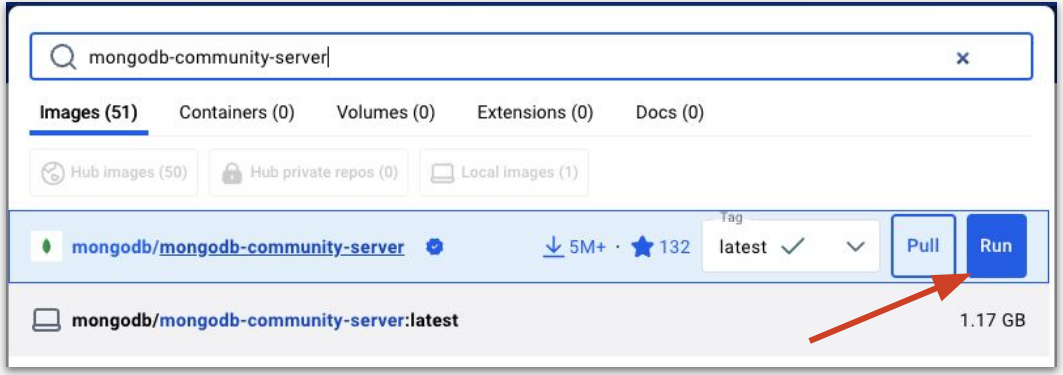
MongoDB Versions

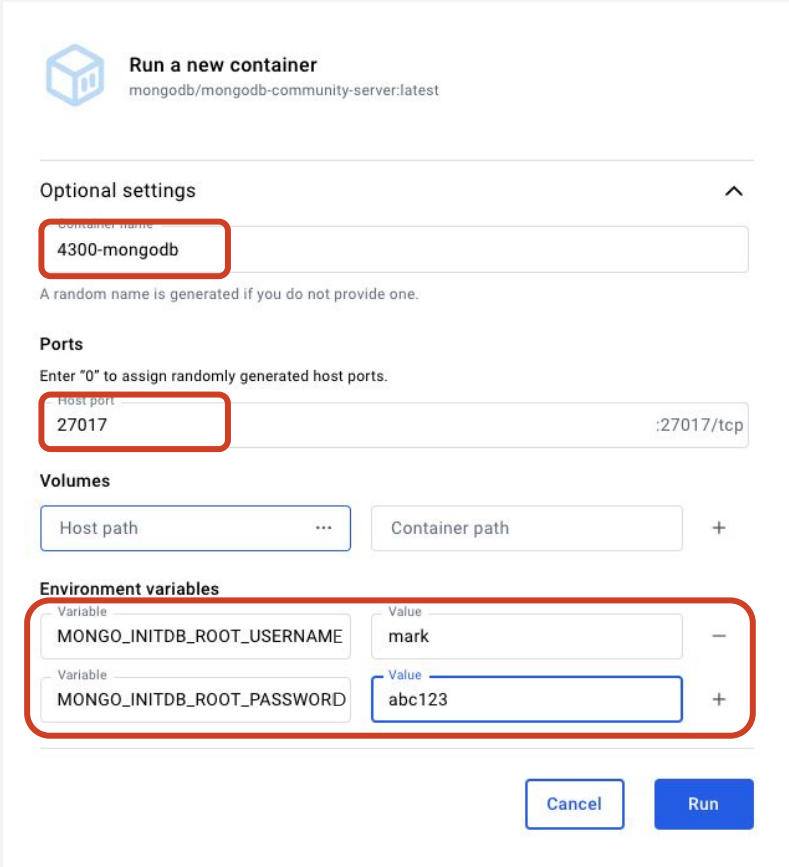
- MongoDB Atlas
  - Fully managed MongoDB service in the cloud (DBaaS)
- MongoDB Enterprise
  - Subscription-based, self-managed version of MongoDB
- MongoDB Community
  - source-available, free-to-use, self-managed

Interacting with MongoDB

- **mongosh** → MongoDB Shell
  - CLI tool for interacting with a MongoDB instance
- MongoDB Compass
  - free, open-source GUI to work with a MongoDB database
- DataGrip and other 3rd Party Tools
- Every major language has a library to interface with MongoDB
  - PyMongo (Python), Mongoose (JavaScript/node), …

Mongodb Community Edition in Docker

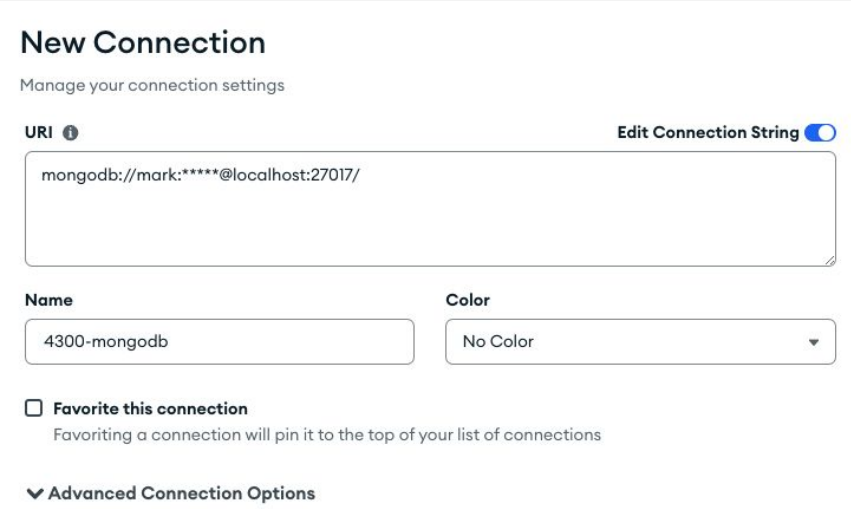


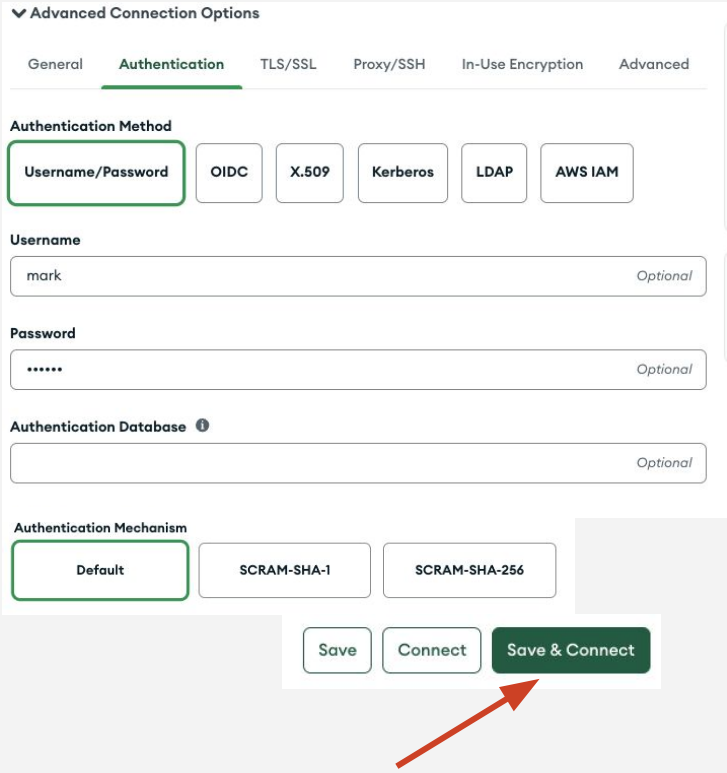


- Create a container
- Map host:container port 27017
- Give initial username and password for superuser

MongoDB Compass

- GUI Tool for interacting with MongoDB instance
- Download and install from > here <.





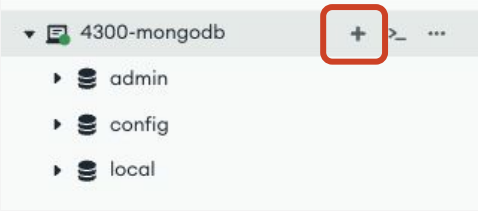
Load MFlix Sample Data Set

- In Compass, create a new Database named **mflix**

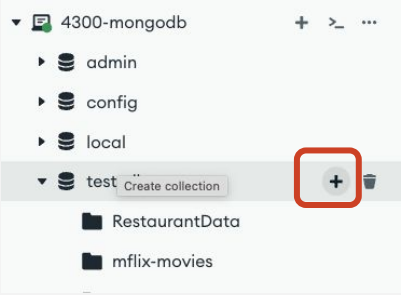
- Download **mflix** sample dataset and unzip it
- Import JSON files for users, theaters, movies, and comments into new collections in the mflix database

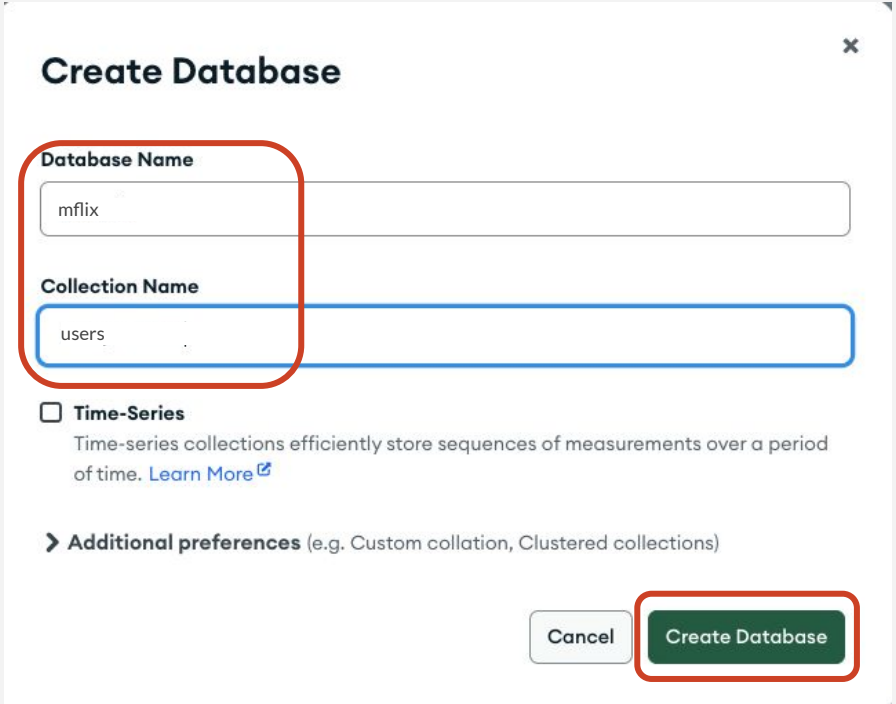
Creating a Database and Collection

To Create a new DB:



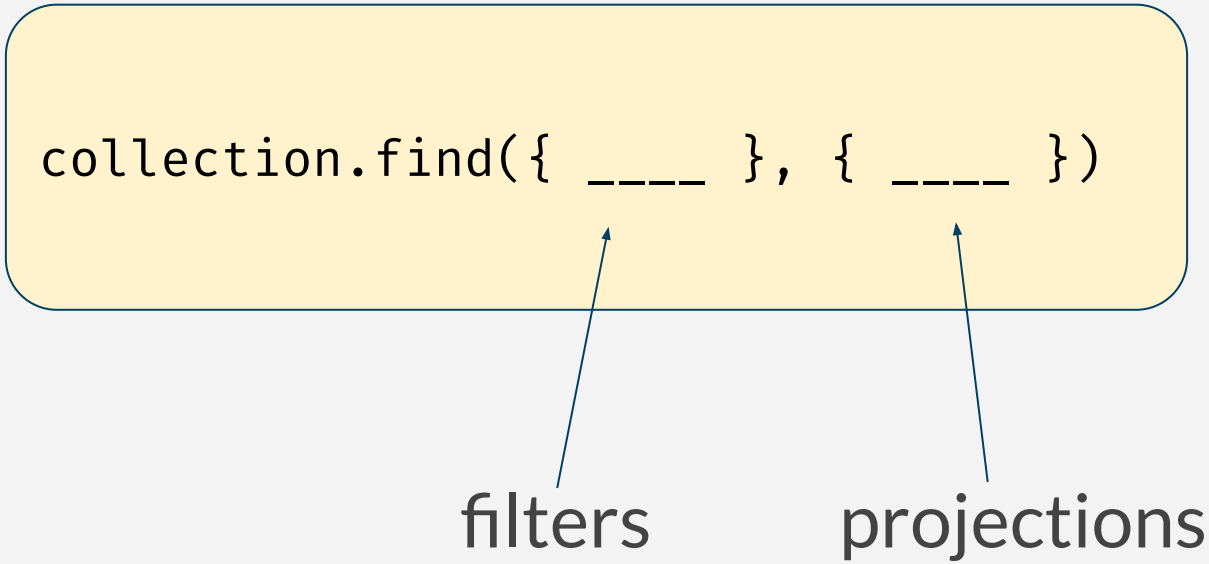
To Create a new Collection:





mongosh - Mongo Shell

- find(...) is like SELECT



mongosh - find()

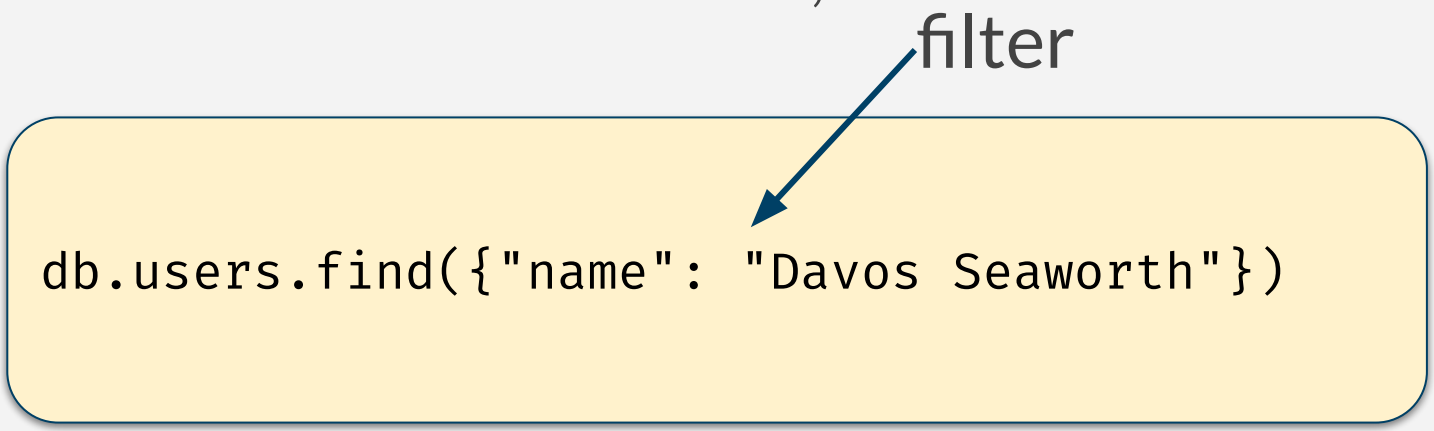
- SELECT * FROM users;

```
use mflix

db.users.find()
```

mongosh - find()

- SELECT *
  FROM users
  WHERE name = “Davos Seaworth”;




```
{
  _id: ObjectId('59b99dbecfa9a34dcd7885c9'),
  name: 'Davos Seaworth',
  email: 'liam_cunningham@gameofthron.es',
  password: '$2b$12$jbgNoWG97LHNIm4axwXDz.tkFITsmw/aylIY/lZDaJRgnHZjB029e'
}
```

mongosh - find()

- SELECT *
  FROM movies
  WHERE rated in ("PG", "PG-13")

```
db.movies.find({rated: {$in:[ "PG", "PG-13" ]}})
```

mongosh - find()

- Return movies which were released in Mexico and have an IMDB rating of at least 7

```
db.movies.find( {
     "countries": "Mexico",
     "imdb.rating": { $gte: 7 }
} )
```

mongosh - find()

- Return movies from the **movies** collection which were released in 2010 and either won at least 5 awards or have a genre of Drama

```
db.movies.find( {
   “year”: 2010,
   $or: [
      { "awards.wins": { $gte: 5 } },
      { “genres”: "Drama" }
   ]
})
```

Comparison Operators

Name	Description
`$eq`	Matches values that are equal to a specified value.
`$gt`	Matches values that are greater than a specified value.
`$gte`	Matches values that are greater than or equal to a specified value.
`$in`	Matches any of the values specified in an array.
`$lt`	Matches values that are less than a specified value.
`$lte`	Matches values that are less than or equal to a specified value.
`$ne`	Matches all values that are not equal to a specified value.
`$nin`	Matches none of the values specified in an array.

mongosh - countDocuments()

- How many movies from the **movies** collection were released in 2010 and either won at least 5 awards or have a genre of Drama

```
db.movies.countDocuments( {
   “year”: 2010,
   $or: [
      { "awards.wins": { $gte: 5 } },
      { “genres”: "Drama" }
   ]
})
```

mongosh - project

- Return the names of all movies from the **movies** collection that were released in 2010 and either won at least 5 awards or have a genre of Drama

```
db.movies.countDocuments( {
    “year”: 2010,
    $or: [
       { "awards.wins": { $gte: 5 } },
       { “genres”: "Drama" }
    ]
}, {“name”: 1, “_id”: 0} )
```

1 = return; 0 = don’t return

PyMongo

PyMongo

- PyMongo is a Python library for interfacing with MongoDB instances

```
from pymongo import MongoClient

client = MongoClient(

    'mongodb://user_name:pw@localhost:27017'

)
```

Getting a Database and Collection

```
from pymongo import MongoClient
client = MongoClient(
    'mongodb://user_name:pw@localhost:27017'
)

db = client['ds4300']
collection = db['myCollection']
```

Inserting a Single Document

```
db = client['ds4300']
collection = db['myCollection']

post = {
    "author": "Mark",
    "text": "MongoDB is Cool!",
    "tags": ["mongodb", "python"]
}

post_id = collection.insert_one(post).inserted_id
print(post_id)
```

Count Documents in Collection

- SELECT count(*) FROM collection

```
demodb.collection.count_documents({})
```