Database Management Systems

MongoDB

Malay Bhattacharyya

Assistant Professor

Machine Intelligence Unit
and
Centre for Artificial Intelligence and Machine Learning
Indian Statistical Institute, Kolkata

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MongoDB

MongoDB is a cross-platform open-source document-oriented database program that works on NoSQL principles. It uses JSON-like documents with schemata.

A MongoDB database is a physical container for collections, a collection is a group of documents, and a document is a set of key-value pairs. The documents within a collection can have different fields. Interestingly, the collections do not enforce a schema and documents have dynamic schema.

Note: MongoDB is written in C++.

Features of MongoDB

- **Indexing:** Fields in a document can be indexed with primary and secondary indices.
- **Replication:** It provides high availability with replica sets.
- **Load balancing:** It scales horizontally using sharding and can run over multiple servers.
- **File storage:** It can be used as a file system, called GridFS, with data replication and load balancing features.
- **Aggregation:** It can adopt aggregation pipeline, map-reduce function, and single-purpose aggregation methods.
- **Server-side JavaScript execution:** JavaScript can be used in queries, aggregation functions (such as MapReduce), and sent directly to the database for execution.
- **Capped collections:** It supports fixed-size collections.
- **Ad hoc queries:** It supports field, range query, and regular expression searches.

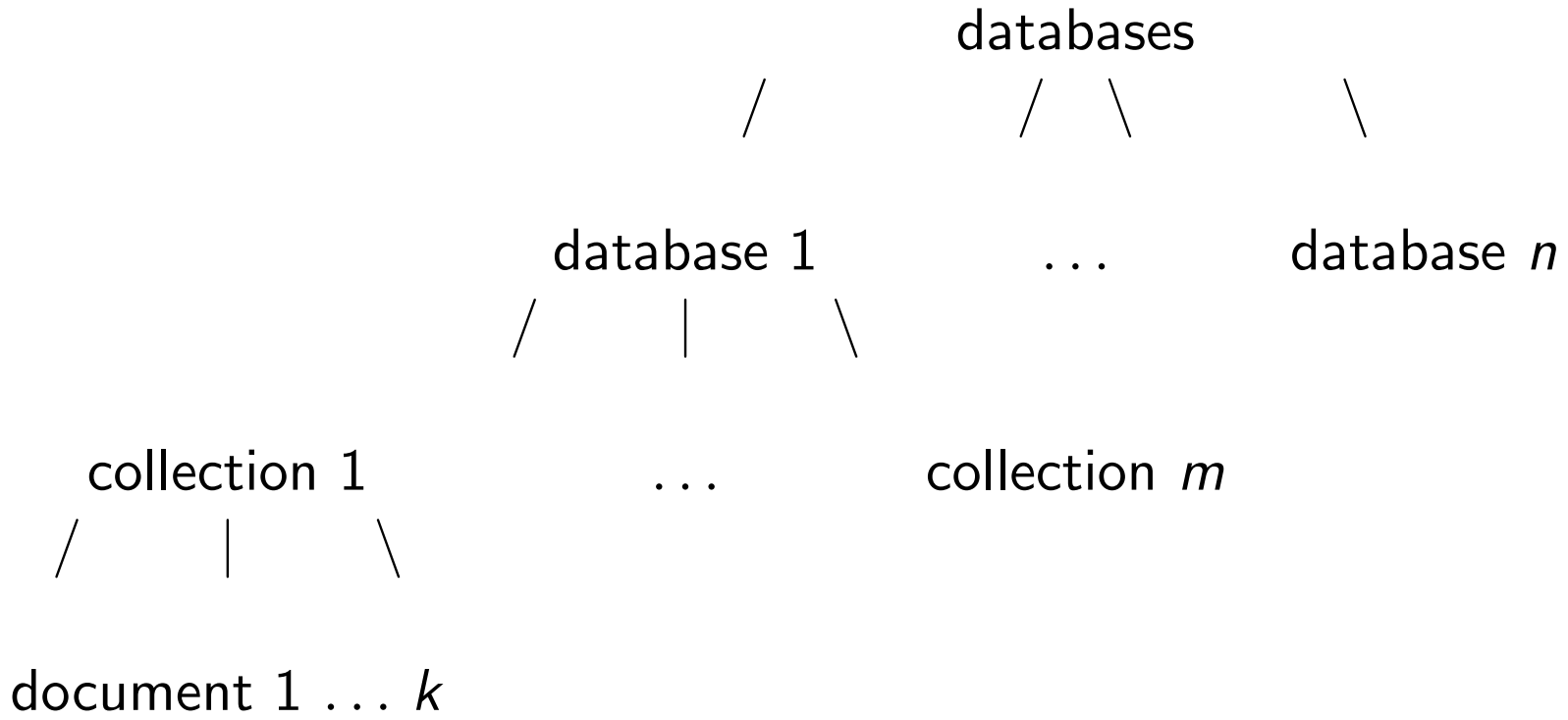
NoSQL functionalities in MongoDB

- **Data-definition language (DDL)** – provides commands for defining collections and documents, deleting collections, and modifying collections.
- **Data-manipulation language (DML)** – includes commands to work on documents, insert documents into, delete documents from, and modify documents in the database.
- **View definition** – includes commands for defining views.

Note: Support for multi-document ACID transactions has been added to MongoDB 4.0 (released in June 2018) and higher versions.

Data view through MongoDB

In practice, the databases (as a whole) comprises several separate database, each database consists of several collections, and each collection comprises several documents.



Installing MongoDB on Linux

```
 $ sudo apt-get install mongodb
[sudo] password for student:
$ sudo apt-get update
$ mongod --version /* MongoDB Server version */
db version v3.6.3
git version:
9586e557d54ef70f9ca4b43c26892cd55257e1a5
OpenSSL version:  OpenSSL 1.1.0g 2 Nov 2017
...
$ mongo -version /* MongoDB Shell version */
MongoDB shell version v3.6.3
...
```

Note: The latest version of MongoDB is 4.2 (available at: https://docs.mongodb.com/manual/release-notes).

Connecting with MongoDB

```
 $ sudo service mongodb start
$ mongo
connecting to:  mongodb://127.0.0.1:27017
...
> _ /* Within MongoDB Shell */
> show dbs; /* The databases present in MongoDB */
admin   0.000GB
config  0.000GB
local   0.000GB
> exit
bye
$ _ /* Out of MongoDB Shell */
$ sudo service mongodb stop
```

Note: The default database is *local*.

Using a database

```
 > use <database_name>
switched to db <database_name>
> _ /* Control is now on <database_name> */
> db
<database_name> /* The current database */
> show collections
<collection_name1>
<collection_name2>
...
system.indexes
> _
```

Note: The default collection is *system.indexes* (may remain hidden).

Data types in MongoDB

Type	Syntax	Details
Number	-	A signed decimal that may contain fractional part
String	"..."	A sequence of zero or more unicode characters
Boolean	true/false	A Boolean value
Array	A[..., ...]	An ordered list of zero or more elements of any type
Object	-	An unordered collection of key-value pairs where the keys are strings
null	null	An empty value

Note: A number cannot include non-numbers such as NaN.

Creating a database

```
 > use <database_new>
switched to db <database_new>
> _ /* Control is now on <database_new> */
> db.<collection_new>.insert({ "Key" :  "Value" }); >
show dbs
admin              0.000GB
config             0.000GB
<database_new>  0.000GB /* unseen until insertion */
local              0.000GB
> _
```

Note: The *use* command creates a database if it does not exist.

Consider a JSON data

```
{
    "FirstName" : "Douglas",
    "LastName" : "Crockford",
    "Age": 64,
    "Address": {
        "State": "CA",
        "Country": "USA"
    },
    "PhoneNumbers": [
        {
            "Type": "internal",
            "Number": "1-888-221-1161"
        },
        {
            "Type": "external",
            "Number": "1-402-935-2050"
        }
    ]
}
```

Creating a collection

```
 > db.<collection_name>.insert({ "FirstName" :
"Douglas", "LastName" :  "Crockford", "Age":  64,
"Address":  { "State":  "CA", ...  }, "PhoneNumbers":
[ { ...  }, { ...  } ] })
> show collections
<collection_name>
system.indexes
> _
```

Note: Inserting a document in the collection and creating that collection can be done simultaneously.

Deleting a database

```
 > use <database_new>
switched to db <database_new>
> db.dropDatabase()
> show dbs
admin               0.000GB
config              0.000GB
local               0.000GB
> _
```

Note: Alternatively, it is possible to stop MongoDB, delete the data files from the data directory, and then restart.

Deleting a collection

Syntax:

$$db.<collection\_name>.drop()$$

```
 > db.<collection_name>.drop()
> show collections
> _
```

Note: If the Collection is deleted successfully then 'true' is echoed back as acknowledgement, else 'false' would be echoed back.

Deleting all documents within a collection

Syntax:

$$db.<collection\_name>.remove(\{<query>\})$$

```
 > db.<collection_name>.remove({ })
> show collections
> <collection_name>
> _
```

Note: An empty <query> will remove all the documents within a collection. The `remove()` method cannot be used on a capped collection.

Deleting selected documents within a collection

Syntax:

$$db.<collection\_name>.remove(\{<query>, <justOne>\})$$

```
 > db.<collection_name>.remove({ <query>, true })
> show collections
> <collection_name>
> _
```

Note: To limit the deletion to just one document, set the value of <justOne> to **true**, otherwise keep the default value **false**.

Selecting all documents

Syntax:

$$db.<collection\_name>.find(\{<query>\})$$

```
 > db.<collection_name>.find({ })
> {"_id" :  ObjectId("<Id_Number>"), "FirstName" :
"Douglas", "LastName" :  "Crockford", ...  }
> db.<collection_name>.find({ }).pretty()
> {
    "_id" :  ObjectId("<Id_Number>"),
    "FirstName" :  "Douglas",
    "LastName" :  "Crockford",
    ...
} /* Structured (pretty) output */
```

Note: An empty <query> will retrieve all the documents from a collection.

Selecting documents based on equality

Syntax:

$$db.<collection\_name>.find(\{<query>\})$$

```
 > db.<collection_name>.find({ "Age" :  64 })
> {"_id" :  ObjectId("<Id_Number>"), "FirstName" :
"Douglas", "LastName" :  "Crockford", "Age" :  64,
...  }
```

Note: This is similar to the SQL query "`select * from <collection_name> where Age = 64;`".

Writing complex queries

Let us consider the following document entries in a MongoDB collection:

```
{ "_id" : ObjectId("<Id_Number>"), "Name" : "ISI",
"Description" : "Research institute", "YoE" :
"1931" }
{ "_id" : ObjectId("<Id_Number>"), "Name" : "JU",
"Description" : "University", "YoE" : "1955" }
{ "_id" : ObjectId("<Id_Number>"), "Name" :
"IITKGP", "Description" : "Engineering institute",
"YoE" : "1951" }
{ "_id" : ObjectId("<Id_Number>"), "Name" :
"IIMCAL", "Description" : "Management institute",
"YoE" : "1961" }
```

Using regular expressions – $regex

```
 > db.<collection_name>.find({ "Description" :  {
$regex :  /institute$/ } }) /* SQL LIKE match */
> { "_id" :  ObjectId("<Id_Number>"), "Name" :  "ISI",
"Description" :  "Research institute", "YoE" :
"1931" }
{ "_id" :  ObjectId("<Id_Number>"), "Name" :
"IITKGP", "Description" :  "Engineering institute",
"YoE" :  "1951" }
{ "_id" :  ObjectId("<Id_Number>"), "Name" :
"IIMCAL", "Description" :  "Management institute",
"YoE" :  "1961" }
```

Note: MongoDB uses Perl compatible regular expressions (i.e. PCRE) version 8.41 with UTF-8 support.

Using regular expressions – $regex

```
 > db.<collection_name>.find({ "Name":  { $regex:
/^isi/i } }) /* Case-insensitive match */
> { "_id" :  ObjectId("<Id_Number>"), "Name" :  "ISI",
"Description" :  "Research institute", "YoE" :
"1931" }
```

Using logical expressions – $and

```
 > db.<collection_name>.find({ $and:  [{"Name":  {
$regex:  /^isi/i }}, {"Description" :  {$regex :
/institute$/}}] })
> { "_id" :  ObjectId("<Id_Number>"), "Name" :  "ISI",
"Description" :  "Research institute", "YoE" :
"1931" }
> db.<collection_name>.find({ $and:  [{"Name":  {
$regex:  /^II/ }}, {"Description" :  "University"}]
})
>
```

Using logical expressions – $or

```
 > db.<collection_name>.find({ $or:  [{"Name":  {
$regex:  /^II/ }}, {"Description" :  "University"}]
})
> { "_id" :  ObjectId("<Id_Number>"), "Name" :  "JU",
"Description" :  "University", "YoE" :  "1955" }
{ "_id" :  ObjectId("<Id_Number>"), "Name" :
"IITKGP", "Description" :  "Engineering institute",
"YoE" :  "1951" }
{ "_id" :  ObjectId("<Id_Number>"), "Name" :
"IIMCAL", "Description" :  "Management institute",
"YoE" :  "1961" }
```

Using comparative expressions – $gt, $lt

```
 > db.<collection_name>.find({ "YoE" :  { $gt :  1960
} })
> { "_id" :  ObjectId("<Id_Number>"), "Name" :
"IIMCAL", "Description" :  "Management institute",
"YoE" :  "1961" }
> db.<collection_name>.find({ "YoE" :  { $lt :  1940
} })
> { "_id" :  ObjectId("<Id_Number>"), "Name" :  "ISI",
"Description" :  "Research institute", "YoE" :
"1931" }
```

Aggregating collections – $lookup

Consider the following collection "orders":

```
 db.orders.insert([
{ "_id" :  1, "item" :  "mango", "price" :  50,
"quantity" :  2 },
{ "_id" :  2, "item" :  "orange", "price" :  20,
"quantity" :  1 },
{ "_id" :  3 }
])
```

Aggregating collections – $lookup

Consider another collection "inventory":

```
 db.inventory.insert([
{ "_id" :  1, "froot" :  "mango", description:
"product 1", "instock" :  90 },
{ "_id" :  2, "froot" :  "guava", description:
"product 2", "instock" :  10 },
{ "_id" :  3, "froot" :  "banana", description:
"product 3", "instock" :  60 },
{ "_id" :  4, "froot" :  "orange", description:
"product 4", "instock" :  70 },
{ "_id" :  5, "froot":  null, description:
"Incomplete" }, { "_id" :  6 }
])
```

Aggregating collections – $lookup

The collections "orders" and "inventory" can be aggregated as shown below:

```
 db.orders.aggregate([
{
$lookup:
{
from:  "inventory",
localField:  "item",
foreignField:  "froot",
as:  "inventory_docs"
}
}
])
```

Aggregating collections – $lookup

The output:


```
{
"_id" : 1,
"item" : "mango",
"price" : 50,
"quantity" : 2,
"inventory_docs" : [
"_id" : 1, "froot" : "mango", "description" :
"product 1", "instock" : 90
]
}
{
"_id" : 2,
"item" : "orange",
"price" : 20,
...
```

Creating views

```
 > db.createView(<view>, <source>, <pipeline>,
<options>)
```

Note: Views act as read-only collections, and are computed on demand during read operations.