

Fundamentals of Database Systems

[MongoDB]

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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.

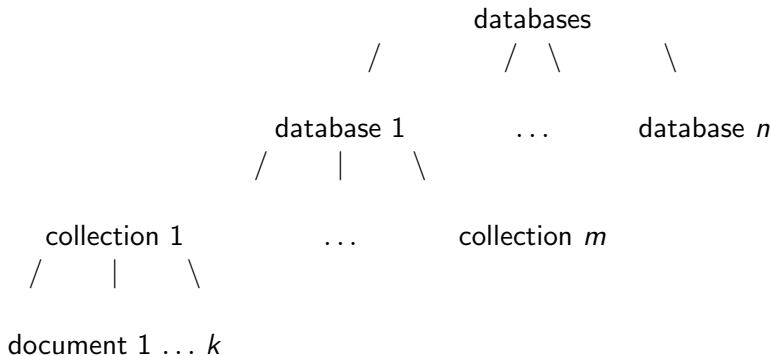
NoSQL functionalities in MongoDB

- **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 mongod 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 mongod 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" }
```

Creating views

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

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