# CSCI235 Database Systems MongoDB Databases, Collections, Documents

Dr Janusz R. Getta

School of Computing and Information Technology - University of Wollongong

#### Outline

**Basics** 

Architecture

Server

Databases

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**Documents** 

**Formatting** 

DDL

**DML** 

Query Language

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## **Basics**

MongoDB is a database system that belong to a class of so called NoSQL database systems based on a data model different from the relational model and data definition, manipulation, retrievel, and administration languages different from SQL

MongoDB data model (BSON) is based a on concept of key:value pairs grouped into documents and arrays

MongoDB database system operates on a number of databases

A MongoDB database is a set of collections

A MongoDB collection is a set of documents

A MongoDB document is a set of key:value pairs

A MongoDB value is either an atomic value or a document or an array

A MongoDB atomic value is of one of the types included BSON specification like number, string, date, etc

A MongoDB array is a sequence of values

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## **Basics**

Each MongoDB key:value pair must have a unique key within in a document

Each MongoDB document must have a unique identifier within a collection

Each MongoDB collection must have a unique name within a database

```
A sample BSON document
      {" id": ObjectId(),
       "full name": {"first name": "James",
                      "initials":null,
                      "last name": "Bond"},
       "employee number": "007",
       "skills":["cooking", "painting", "gardening"],
       "cars owned": [ { "rego": "007-1",
                        "made": "Porsche"},
                       {"rego": "007-2",
                        "made":"Ferrari"} ],
       "secret codes": [[1,2,3,4],
                         [9,8,7,5]],
       "date of birth":new Date("1960-01-01")
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```

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## **Architecture**

MongoDB flexible storage architecture automatically manages the movement of data between storage engine technologies using native replication

MongoDB stores data as documents in a binary representation called BSON (Binary JSON)

MongoDB query model is implemented as methods or functions within the API of a specific programming language, as opposed to a completely separate language like SQL

MongoDB provides horizontal scale-out for databases on low cost, commodity hardware or cloud infrastructure using a technique called sharding, which is transparent to applications

In-Memory storage engine enables performance advantages of inmemory computing for operational and real-time analytics workloads

MongoDB Enterprise Advanced provides extensive capabilities to defend, detect, and control access to data (data security)

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## **Architecture**

MongoDB Ops Manager makes easy for operations teams to deploy, monitor, backup and scale the system (system management)

MongoDB Atlas provides all of the features of Database as a Service cloud computing model

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## Server

```
Starting MongoDB server with options --dbpath, --port, and
--bind ip
                                                             Starting MongoDB server
  mongod --dbpath data --port 4000 --bind ip 10.0.2.100
Starting MongoDB server with options --dbpath, --port, and server
running on a localhost
                                                             Starting MongoDB server
  mongod --dbpath data --port 4000 --bind ip localhost
or simply ...
                                                             Starting MongoDB server
  mongod --dbpath data --port 4000
Starting MongoDB command based shell
                                                       Starting MongoDB command client
  mongo --port 4000
```

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## Server

#### Getting the first help from MongoDB shell

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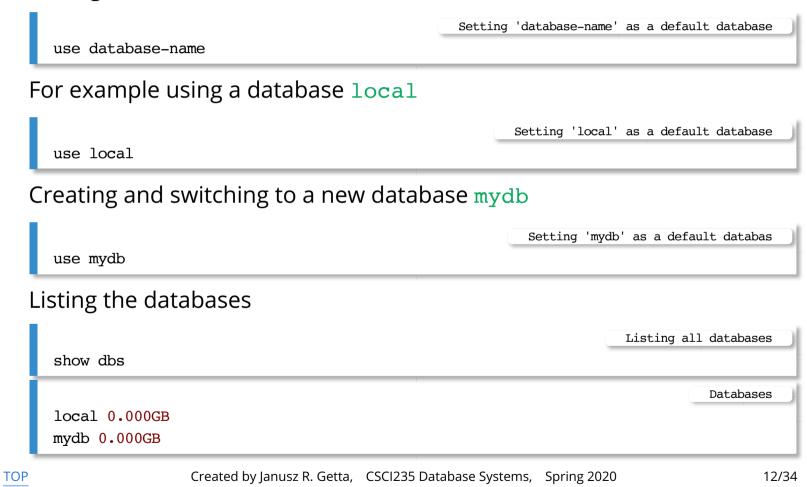
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## **Databases**

#### Setting a default database



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## **Collections**

#### Creating a new collection with an empty document

```
Creating a new collection mycol

db.mycol.insert({})

Listing the contents of a collection

db.mycol.find()

{ "_id" : ObjectId("57e385f8ffc660a351b58010") }

Listing the collections

show collections

mycol
```

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## **Documents**

#### Creating a new non empty document

```
Inserting a document into a collection mycol db.mycol.insert({"one":"1", "many ones":[1,1,1,1]})
```

#### Listing the contents of a collection

```
MongoDB Shell

db.mycol.find()

{ "_id" : ObjectId("57e385f8ffc660a351b58010") }

{ "_id" : ObjectId("57e38cbeffc660a351b58012"),
    "one" : "1", "many ones" : [ 1, 1, 1, 1 ] }
```

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# **Formatting**

Listing the nicely formatted contents of a collection

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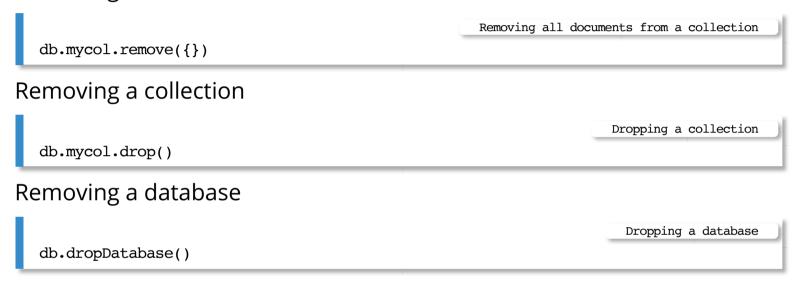
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## **DDL**

#### Removing all documents from a collection



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## **DML**

Let a file dbload.js contains the following insert methods

Processing a script inserts two documents into a collection mycol

```
Processing a script dbload.js load("dbload.js")
```

Listing a collection mycol

```
db.mycol.find().pretty()

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```

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## **DML**

```
"_id" : ObjectId("57e3c817fe6a1bfd5105022a"),
"CITY" : {
          "name" : "Wollongong",
          "population" : "80K",
          "country" : "Australia",
          "state" : "New South Wales"
"_id" : ObjectId("57e3c817fe6a1bfd5105022b"),
"EMPLOYEE" : {
              "enum" : 1234567,
              "full-name" : "Janusz R.Getta",
              "salary" : "200K",
              "hobbies" : [
                            "cooking",
                            "painting",
                            "gardening"
```

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MongoDB query language is based on a concept of pattern matching

A query is expressed as a BSON pattern and all document from a collection that match the pattern are included in an answer

A method find() is used to match a query pattern {"age":25}against the documents in a collection

```
Finding all documents that have a pair "age":25 at the topmost nesting level db.department.find({"age":25})
```

Matching of an empty pattern { } with a collection returns the returns an entire collection

```
Finding all documents in a collection db.department.find({})
```

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#### The first document

```
db.department.insert(
  { "name": "School of Computing and Information Technology",
     "code": "SCIT",
    "total_staff_number":30,
    "budget":1000000,
    "address":{"street":"Northfields Ave",
                "bldg":3,
                "city": "Wollongong",
                "country": "Australia"},
   "courses":[ {"code":"CSCI835",
                 "title": "Database Systems",
                 "credits":6},
                {"code": "CSIT115",
                 "title": "Data Management and Security",
                 "credits":6},
                {"code": "CSCI317",
                 "title": "Database Performance Tuning",
                 "credits":6},
                {"code": "CSIT321",
                 "title": "Software Project",
                 "credits":12}
);
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```

#### The second document

```
db.department.insert(
  { "name": "School of Astronomy",
    "code": "SOA",
    "total staff number":5,
    "budget":10000,
    "address":{"street":"Franz Josef Str",
               "bldg":4,
               "city": "Vienna",
               "country":"Austria"},
   "courses":[ {"code":"SOA101",
                "title": "Astronomy for Kids",
                "credits":3},
               {"code": "SOA201",
                "title": "Black Holes",
                "credits":6},
               {"code": "SOA301",
                "title": "Dark Matter",
                "credits":12}
             ]
);
```

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#### The third document

```
db.department.insert(
  { "name": "School of Physics",
    "code": "SOPH",
    "total staff number":25,
    "budget":100000,
    "address":{"street":"Victoria St",
               "bldg":25,
               "city": "Cambridge",
               "country": "UK"},
   "courses":[ {"code":"SOPH101",
                "title": "Special Relativity",
                "credits":6},
               {"code": "SOPH102",
                "title": "General Relativity",
                "credits":12},
               {"code": "SOPH103",
                "title": "Quantum Mechanics",
                "credits":18}
);
```

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Find total number of documents in a collection

```
Counting the documents db.department.count()
```

Find all departments whose code is **SCIT** 

```
Tinding the documents that match a given search pattern db.department.find({"code":"SCIT"})
```

Find total number of departments whose code is **SOPH** 

```
Counting the documents that match a given search pattern db.department.find({"code":"SOPH"}).count() db.department.count({"code":"SOPH"})
```

Find all departments whose name is **School** of **Physics** and whose code is **SOPH** 

```
Finding the documents that match a given search pattern db.department.find({"name":"School of Physics", "code":"SOPH"})
```

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Comparison "key"="value"

```
Search pattern
  {"key":"value"}
                                                                  Search pattern
  {"key": {$eq:"value"}}
Comparison "key" > "value"
                                                                  Search pattern
  {"key": {$gt:"value"}}
Disjunction ("key1"="value1") or ("key2"="value2")
                                                                  Search pattern
  {$or: [{"key1":"value1"},{"key2":"value2"}]}
Conjunction ("key1"="value1") and ("key2"="value2")
                                                                  Search pattern
  {$and: [{"key1":"value1"},{"key2":"value2"}]}
```

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```
Boolean expression (("key1"="value1") or ("key2"="value2"))
  and ("key3"="value3")
                                                                    Search pattern
     {$and: [{$or: [{"key1":"value1"},{"key2":"value2"}]},{"key3"="value3"}]}
  Negation of a comparison "key" not = "value"
                                                                    Search pattern
     {"key": {$not: {$eq:"value"}}}
  Negation of an expression not (("key1"="value1") or
  ("key2"="value2"))
                                                                    Search pattern
     {$nor: [{"key1":"value1"},{"key2":"value2"}]}
  Negation not ("key1"="value1")
                                                                    Search pattern
     {$nor: [{"key1":"value1"}]}
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```

#### A sample nested document

```
db.department.insert(
  { "name": "School of Computing and Information Technology",
    "code": "SCIT",
    "total staff number":30,
    "budget":1000000,
    "address":{"street":"Northfields Ave",
               "bldg":3,
               "city": "Wollongong",
               "country": "Australia"},
   "courses":[ {"code":"CSCI835",
                "title": "Database Systems",
                "credits":6},
               {"code": "CSIT115",
                "title": "Data Management and Security",
                "credits":6},
               {"code": "CSCI317",
                "title": "Database Performance Tuning",
                "credits":6},
               {"code": "CSIT321",
                "title": "Software Project",
                "credits":12}
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```

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# **Query Language**

Find all departments located in Wollongong

```
An access path
db.department.find({"address.city":"Wollongong"})
```

Find all departments such that any offered course is worth less than 6 credits

```
An access path db.department.find({"courses.credits":{"$lt":6}})
```

Find all departments that offer courses worth more than 12 and less than 18 credits

```
An access path db.department.find({"courses.credits": {"$gt":12, "$lt":18}})
```

Find all departments such that offer Quantum Mechanics course worth 6 credits

```
Two access paths

db.department.find({"courses.credits":6,"courses.title":"Quantum Mechanics"})

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```

## References

MongoDB Architecture, https://www.mongodb.com/mongodb-architecture

Chodorow K. MongoDB The Definitive Guide, O'Reilly, 2013, Chapter 2

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