

CS 572 Modern Web Applications

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JavaScript Full Stack Development



- MongoDB
 - NoSQL database (document store)
 - Stores JSON documents
- Express
 - JavaScript web framework
 - On top of Node
- Angular
 - JavaScript UI framework
 - Single Page Applications
- Node
 - JavaScript server-side platform
 - Single threaded, fast and scalable

Roadmap and Outcomes

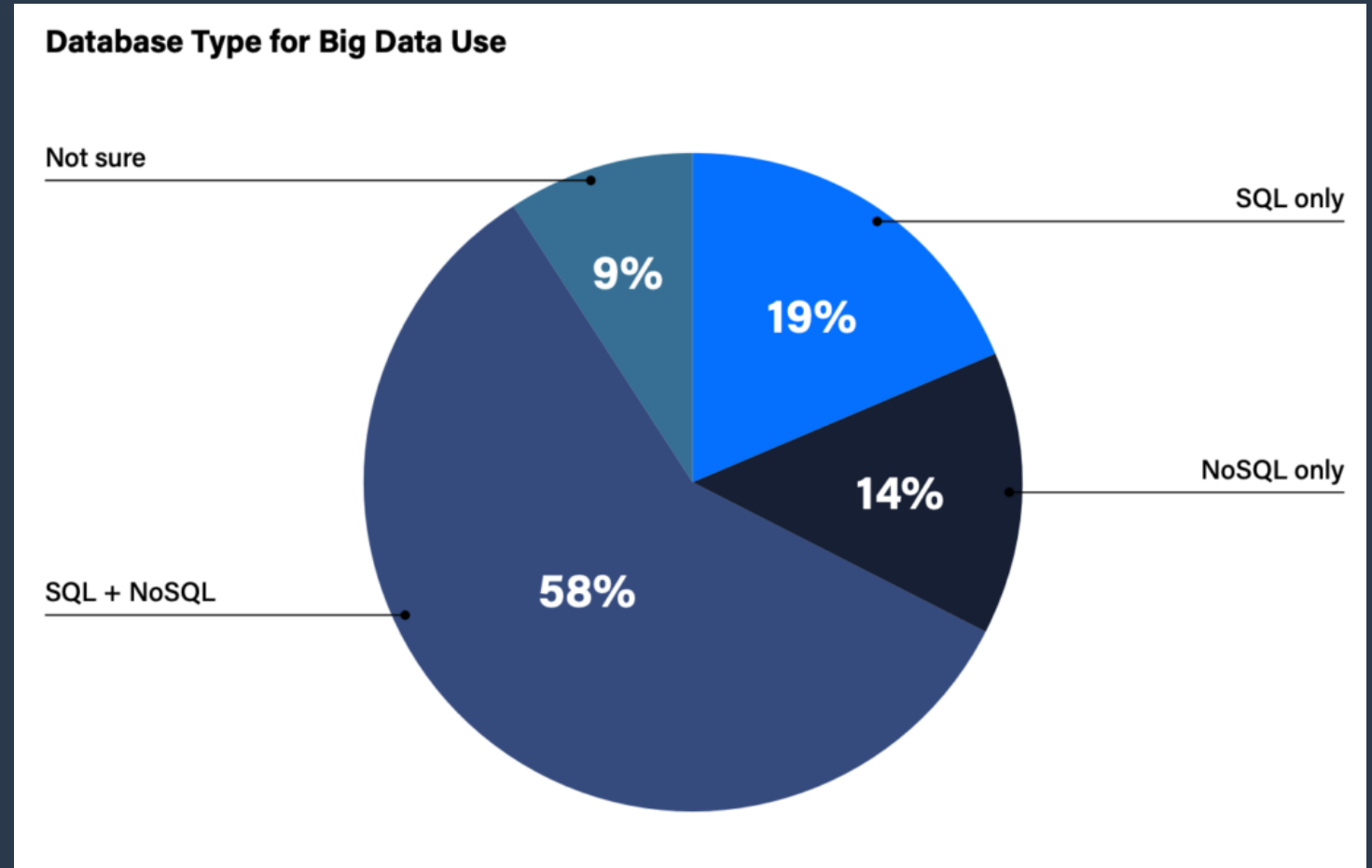
- Node.js: write asynchronous (non-blocking) code. Understand node platform to start a project.
- Express: setup express and get requests and send back responses. REST API.
- MongoDB: what NoSQL DB looks like. Full API interacting with DB.
- AngularJS: Investigate AngularJS and architect it. A single page application.
- MEAN application: Learn by example. We will create a MEAN Games application.

SQL vs NoSQL

Market Shares

NoSql vs. NewSQL vs
Distributed SQL: DZone's
2020 Trend Report

Written by Charlotte
Dillon on Sep 9, 2020

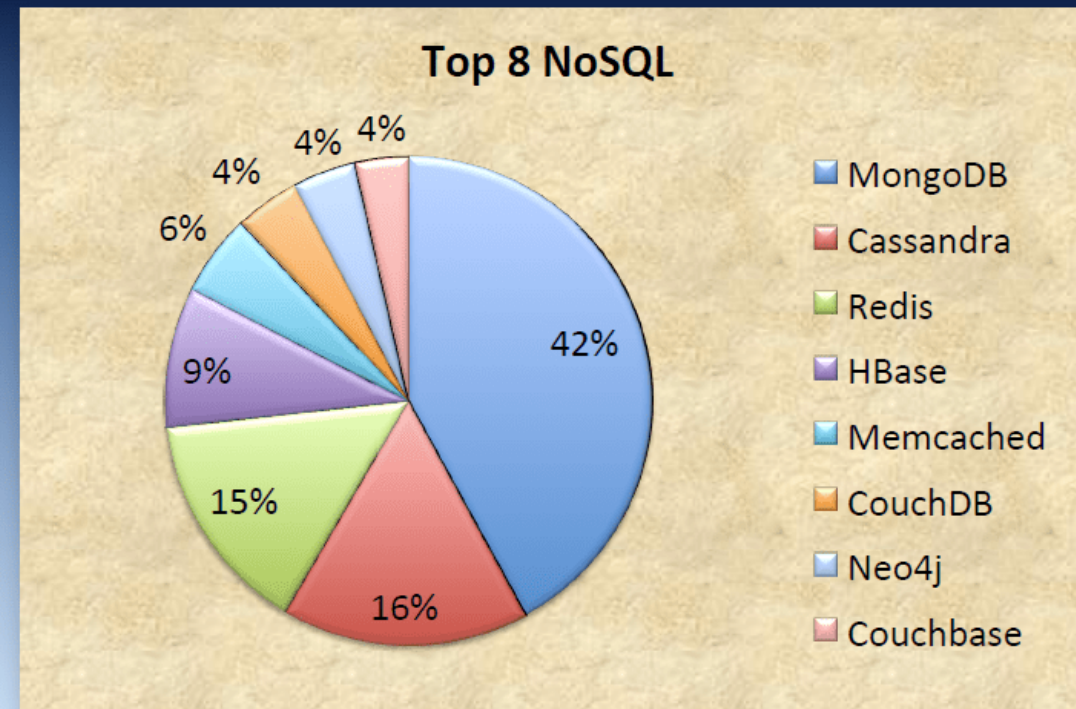


<https://www.cockroachlabs.com/blog/dzone-sql-trend/>

NoSQL Databases

The NoSQL market size was valued at \$2,410.5 million in 2018, and is projected to reach \$22,087 million by 2026, growing at a CAGR of 31.4% from 2019 to 2026.

DB-Engines ranking



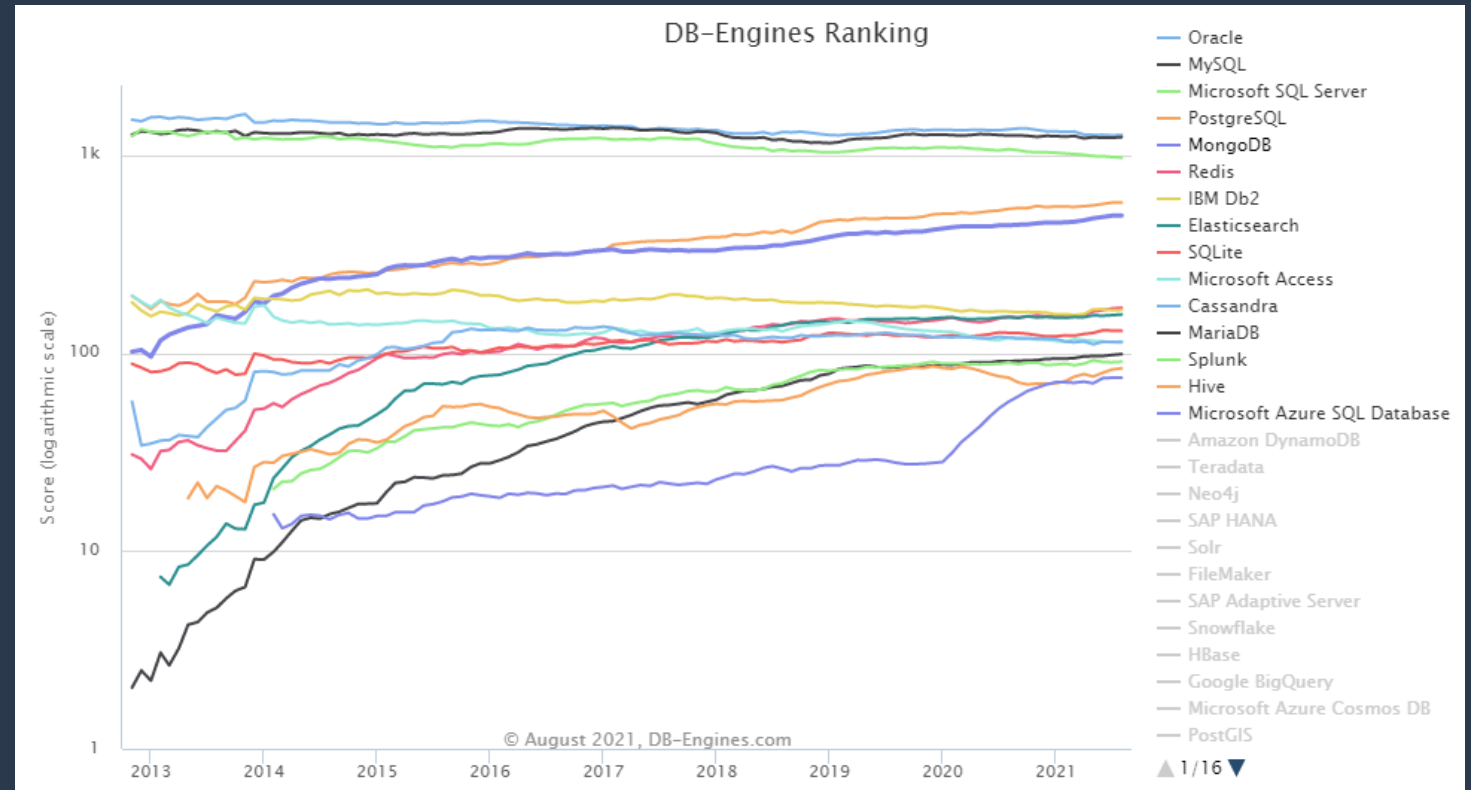
Source: <http://db-engines.com/en/ranking/> (24 March 2015)

NoSQL Databases

DB-Engines Ranking –
Trend Popularity.

August 2021

[historical trend of the
popularity ranking of
database management
systems \(db-engines.com\)](https://db-engines.com)



Introducing NoSQL-DB, MongoDB

Order is Present Everywhere

Wholeness

Data is the center of your application. The way data is presented impacts how it should be stored. Designing data storage to match its presentation creates more efficient applications. The Universe is structured in hierarchical layers from concrete expressions to their abstract basis, life is rich, and nature is efficient because of the underlying universal principles.

Introducing NoSQL-DB MongoDB

Order is Present Everywhere

1. What is MongoDB?
2. How to use MongoDB?
3. Best practices, and why?

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NoSQLDB

NoSQL Database Types

- Key-value store, ArangoDB
 - Store unique key and value, high scalability for caching (session management)
- Document store, MongoDB
 - Store semi-structured data in document format, no schema insert (mobile applications)
- Wide- column store, Amazon DynamoDB
 - Store in columns not rows, fast (catalogs, recommendation engines)
- Graph databases, Amazon Neptune
 - Store data as nodes and edges, show connections (reservation systems)
- More

Document Store vs Relational DB

RELATIONAL DB

STUDENT_ID	NAME	GPA
1	Jack	3.0
2	Jill	3.3
3	John	2.8

ID	COURSE_NAME	STUDENT_ID
1	Software Engineering	1
2	Web Programming	2
3	Algorithms	2

DOCUMENT STORE

```
[
  { "StudentID" : 1,
    "Name" : "Jack",
    "GPA" : 3.0,
    "Courses" : [
      { "ID" : 1,
        "CourseName" : "Software Engineering" } ] },
  { "StudentID" : 2,
    "Name" : "Jill",
    "GPA" : 3.3 },
    "Courses" : [
      { "ID" : 2,
        "CourseName" : "Web Programming" },
      { "ID" : 3,
        "CourseName" : "Algorithms" } ] },
  { "StudentID" : 3,
    "Name" : "John",
    "GPA" : 2.8 }
]
```

NoSQL DB Design

- What is all the data you wish to output (at once) on a pages.
 - Put that information in one place.
- If on some page you wish to display some of the information from another document.
 - Add what needs to be displayed and include an ID to link to the other document.
- Optimize for the most common operation.
 - Reduce updates for the most common changeable items.
 - Increase speed of displaying most common pages.
- Keep number of Collections (Tables) to a minimum.
- Try to reduce each page to one collection (or minimum number of joined collections)
- Most common operations must run faster (even at the expense of less common operations)



MongoDB

MongoDB Collections

REVIEW.JSON

```
[
  { "ReviewID" : 1,
    "Title" : "Good Game.",
    "Review" : "I enjoyed the game.",
    "Stars" : 4,
    "Game" : {
      "ID" : 1,
      "Name" : "Trains"
    }
  },
  { "ReviewID" : 2,
    "Title" : "Too Long.",
    "Review" : "The game is nice, but it was too long.",
    "Stars" : 3,
    "Games" : {
      "ID" : 2,
      "Name" : "Monopoly"
    }
  }
]
```

GAME.JSON

```
[{ "ID" : 1,
  "Name" : "Trains",
  "Price" : 48.82,
  "MinPlayers": 2,
  "MaxPlayers": 4,
  "EstimatedTimeToPlay": 45,
  "ReleaseYear": 2013},
  { "ID" : 2,
    "Name" : "Monopoly",
    "Price" : 29.97,
    "MinPlayers": 2,
    "MaxPlayers": 8,
    "EstimatedTimeToPlay": 180,
    "ReleaseYear": 1933},
  { "ID" : 3,
    "Name" : "Risk",
    "Price" : 20.99,
    "MinPlayers": 2,
    "MaxPlayers": 6,
    "EstimatedTimeToPlay": 120,
    "ReleaseYear": 1959}
]
```

Learning Activity

- Break into groups (4 individuals in each group). Group ID will be distributed.
- Given the application X design a MongoDB database.
 - Identify the collection(s).
 - Identify the document layout in each collection.
- Then consider application Y, and state if it should use the same database or a different one and why.
- Even Group ID X= 1, Y=2
- Odd Group ID X=2, Y=1

MongoDB Design

Design DB for application X, state if it can be used for application Y

APPLICATION 1

Model: F-150
Year: 2010
Make: Ford
Millage: 166,350
Color: Red
Price: \$14,837
Seller: Rusty Eck

Send
Offer

Buy

Next

APPLICATION 2

Dealer: Rusty Eck
7310 E Kellogg Dr
State: KC
City: Wichita
Phone: 316 395 9488
Car: F-150 166,350
Car: Escape 105,397

Send
Email

Next

MongoDB Design

One Application Simple Decision?

Model: F-150
Year: 2010
Make: Ford
Millage: 166,350
Color: Red
Price: \$14,837
Seller: Rusty Eck

Send
Offer

Buy

Next

Dealer: Rusty Eck
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State: KC
City: Wichita
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Car: Escape 105,397

Send
Email

Next

MongoDB Design

One Application Hard Decision?

Dealer: Rusty Eck
7310 E Kellogg Dr
State: KC
City: Wichita
Phone: 316 395 9488
Car: F-150 166,350
Car: Escape 105,397

Send
Email

Next

Percentage of usage (Profile)
20%

Model: F-150
Year: 2010
Make: Ford
Millage: 166,350
Color: Red
Price: \$14,837
Seller: Rusty Eck

Send
Offer

Buy

Next

Percentage of usage (Profile)
50% (20%)

Model: F-150
Year: 2010
Make: Ford
Millage: 166,350
Color: Red
Price: \$14,837
Dealer: Rusty Eck
7310 E Kellogg Dr
State: KC
City: Wichita
Phone: 316 395 9488

Enter Offer Amount:

Send
Offer

Call

Percentage of usage (Profile)
30% (60%)

How to Design a Document Students' views

MongoDB Collections

REVIEW.JSON

```
[
  { "ReviewID" : 1,
    "Title" : "Good Game.",
    "Review" : "I enjoyed the game.",
    "Stars" : 4,
    "Game" : {
      "ID" : 1,
      "Name" : "Trains"
    }
  },
  { "ReviewID" : 2,
    "Title" : "Too Long.",
    "Review" : "The game is nice, but it was too long.",
    "Stars" : 3,
    "Games" : {
      "ID" : 2,
      "Name" : "Monopoly"
    }
  }
]
```

GAME.JSON

```
[{ "ID" : 1,
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    "Price" : 29.97,
    "MinPlayers": 2,
    "MaxPlayers": 8,
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    "ReleaseYear": 1933},
  { "ID" : 3,
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    "Price" : 20.99,
    "MinPlayers": 2,
    "MaxPlayers": 6,
    "EstimatedTimeToPlay": 120,
    "ReleaseYear": 1959}
]
```

How to Design a Document

- Why not have one Collection and store everything in it?
 - Not good logically and performance.
 - Hard to maintain.
- A review is for a game, so why not only have one Collection of Games.
 - A review can exist by itself.
 - Get all positive reviews, negative, ...
 - A Game could also have several reviews.
- Collections may reference each other.
- You do not use a collection to get data from another collection.
 - What you want from another collection embed in your collection.

JSON and BSON

- JSON is what you use in your application.
- JSON is a close representation of what MongoDB stores.
- BSON is Binary-JSON, it is what MongoDB uses.
- BSON not human readable but maintains the flexibility and ease of use of JSON plus the speed of binary format.
- MongoDB accepts JSON and returns JSON (but stores it as BSON).

JSON ID

- MongoDB creates unique ID for a document when created.
- `_id` property is what MongoDB creates.
- The value is `ObjectId("5f9aef68980db44d37c1aaed")`
unique combination of time (Unix epoch) , machine ID,
process ID, and counter.

Main Points

Introducing NoSQL-DBs, MongoDB

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Install and Work With MongoDB

- Install from MongoDB website (www.mongodb.com/try/download)
- Running MongoDB
 - `mongo --version`
 - `mongo`
 - `exit` (or `Ctrl + C`)
- Create Database
- Create Collection
- Retrieve Collection

MongoDB

Database Collection



List all databases on your system

```
show dbs
```

```
admin 0.000GB
```

```
config 0.000GB
```

```
local 0.000GB
```

Select database to work with

```
use local
```

```
switched to db local
```

Create new database, make sure it does not exist

```
use newTestDb
```

```
switch to newTestDB
```

Note: new database not created until you add a collection to it.

Get the current database being used

```
db (or db.getName());
```

```
newTestDB
```

Delete database

```
db.dropDatabase();
```

```
{ "dropped" : "newTestDb", "ok" : 1 }
```

MongoDB

Database

Collection



List collections in current database

```
use local
```

```
show collections
```

```
startup_log
```

```
use newTestDB
```

```
show collections
```

Create collection

```
db.createCollection("technology")
```

```
{ "ok" : 1 }
```

Delete collection

```
db.technology.drop()
```

```
true
```

CRUD

Create

Read

Update

Delete



Add document in current collection

```
db.technology.insert(  
... {  
... name : "MongoDB",  
... role : "Database"  
... }  
... );  
WriteResult({ "nInserted" : 1 })
```

List documents in current collection

```
db.technology.find();  
{ "_id" : ObjectId("5f9aef68980db44d37c1aaed"), "name" : "MongoDB",  
"role" : "Database" }  
db.technology.find().pretty();
```

Insert multiple documents at once

```
db.technology.insert([{name : "Express", role: "Web application server"},  
... {name : "Angular", role: "Front-end framework"},  
... {name : "Node.js", role: "Platform"}]);  
BulkWriteResult({ ... "nInserted" : 3 ... })
```

CRUD

Create

Read

Update

Delete



List all documents in current collection

```
db.technology.find();  
{ "_id" : ObjectId("5f9aef68980db44d37c1aaed"), "name" : "MongoDB",  
  "role" : "Database" }  
db.technology.find().pretty();
```

List based on document id in current collection

```
db.technology.find({"_id" : ObjectId("5f9aef68980db44d37c1aaed")});  
{ "_id" : ObjectId("5f9aef68980db44d37c1aaed"), "name" : "MongoDB",  
  "role" : "Database" }
```

List based on name in current collection

```
db.technology.find({"name" : "Angular"});  
{ "_id" : ObjectId("5f9af651980db44d37c1aaef"), "name" : "Angular",  
  "role" : "Front-end framework" }
```

Sorting, 1 for ascending -1 for descending

```
db.technology.find().sort({"name" : 1});
```

Limit returned fields, projection (the second parameter in find).

```
db.technology.find({}, {"name" : true});  
db.technology.find({}, {"name" : true, "_id" : false});
```

CRUD

Create

Read

Update

Delete



Update a document , finds the documents of interest the updates them. The first parameter is the query, the second is the data to set.

```
db.technology.update( {"name" : "Angular"}, {$set : {"name" : "AngularJS"}} );
```

```
WriteResult({ "nMatched" : 1, "nUpserted" : 0, "nModified" : 1 })
```

Update more than one document at once

```
db.technology.update({},{$set:{"language":JavaScript"}},{multi:true} );  
{ "_id" : ObjectId("5f9aef68980db44d37c1aaed"), "name" :  
  "MongoDB", "role" : "Database", "language" : "JavaScript" }  
{ "_id" : ObjectId("5f9af651980db44d37c1aaee"), "name" : "Express",  
  "role" : "Web application server", "language" : "JavaScript" }  
{ "_id" : ObjectId("5f9af651980db44d37c1aaef"), "name" : "Angular",  
  "role" : "Front-end framework", "language" : "JavaScript" }  
{ "_id" : ObjectId("5f9af651980db44d37c1aaf0"), "name" : "Node.js",  
  "role" : "Platform", "language" : "JavaScript" }
```


CRUD

Create

Read

Update

Delete

Delete document from collection, you provide a query object

```
db.technology.remove( { "name" : "Express" })
```

```
WriteResult({ "nRemoved" : 1 })
```

```
db.technology.remove( {})
```

This will remove all the documents from the collection :(





Import & Export Data

BSON

Import

Export



Import MongoDB data from BSON file

```
mongorestore --db newTestDB2 --gzip dump/newTestDb
```

```
2020-11-01T13:46:25.982-0800 building a list of  
collections to restore from dump/newTestDb dir
```

```
2020-11-01T13:46:25.987-0800 reading metadata for  
newTestDb2.technology from  
dump/newTestDb/technology.metadata.json.gz
```

```
2020-11-01T13:46:26.058-0800 restoring  
newTestDb2.technology from  
dump/newTestDb/technology.bson.gz
```

```
2020-11-01T13:46:26.076-0800 no indexes to restore
```

```
2020-11-01T13:46:26.076-0800 finished restoring  
newTestDb2.technology (4 documents)
```

```
2020-11-01T13:46:26.076-0800 done
```

BSON

Import

Export

Export MongoDB data as BSON file

```
mongodump --db newTestDB
```

writing newTestDb.technology to

done dumping newTestDb.technology (4 documents)

```
/dump/newTestDb/technology.bson
```

Compress the BSON output data

```
mongodump --db newTestDB --gzip
```

```
/dump/newTestDb/technology.bson.gz
```



JSON

Export

Import



Export MongoDB data as JSON file (for a collection only)

```
mongoexport --db newTestDB --collection technology
```

```
{"_id":{"_id":"5f9aef68980db44d37c1aaed"},"name":"MongoDB","role":"Database","language":"JavaScript"}
```

```
{"_id":{"_id":"5f9af651980db44d37c1aaee"},"name":"Express","role":"Web application server","language":"JavaScript"}
```

```
{"_id":{"_id":"5f9af651980db44d37c1aaef"},"name":"Angular","role":"Front-end framework","language":"JavaScript"}
```

```
{"_id":{"_id":"5f9af651980db44d37c1aaf0"},"name":"Node.js","role":"Platform","language":"JavaScript"}
```

2020-11-01T13:54:18.608-0800 exported 4 records

Export to file

```
mongoexport --db newTestDB --collection technology --out  
output/technology.json
```

exported 4 records

Export as an array

```
mongoexport --db newTestDB --collection technology --  
out output/technology.json --jsonArray --pretty
```

exported 4 records

JSON

Export

Import

Import MongoDB data from JSON file

```
mongoimport --db newTestDB3 --collection technology --  
jsonArray output/technology.json
```

imported 4 documents





Connecting MongoDB to NodeJS

MongoDB & NodeJS

- Installing mongoDB driver in our app.
- Creating reusable connections.
- Defining connection string.
- Accessing connections from controllers.
- Best practices while doing all this.

Connect to DB

Install driver

Connections

Use DB

Install MongoDB native driver

```
npm install mongodb --save
```

```
mongodb@2.1.7 node_modules/mongodb
```



Connect to DB

Install driver

Connections

Use DB



Create file to manage connections,
File api/data/dbconnection.js

```
const MongoClient= requires("mongodb").MongoClient;
const dbName= "meanGamesDb";
const dburl= "mongodb://localhost:27017/"+dbName;
var _connection= null;
var open= function() {
  MongoClient.connect(dburl,{useUnifiedTopology: true}, function(err, client) {
    if(err) {
      console.log("DB connection failed");
      return;
    }
    _connection= client.db(dbName);
    console.log("DB connection open", _connection);
  });
};
var get= function() {
  return _connection;
};
module.exports= {
  open: open,
  get: get
};
```

Connect to DB

Install driver

Connections

Use DB

Open the connection as soon as the application starts,
app.js

```
require("../api/data/dbconnection.js").open();
```

Run

```
npm start
```

DB connection open

Check for error, change the port number in
dbconnection.js and run again.



Connect to DB

Install driver

Connections

Use DB

Use the db connection in the controllers.

api/controllers/games.controllers.js

```
const dbConnection= require("../data/dbconnection.js");
```

```
... gameGetAll= ..
```

```
const db= dbConnection.get();
```

```
console.log("db", db);
```

Run on browser (<http://localhost:3000/api/games>)

```
npm start
```

```
db ...
```

Opening db is asynchronous. So make sure you get it when you need it. Don't just open it at the start of the file.

Opening db connection is slow. Best to open it once at application start and reuse it.

No need for a global variable for db. Encapsulated in dbconnection.



Main Points

Introducing NoSQL-DBs, MongoDB

Order is Present Everywhere

1. MongoDB is a document-based NoSQL database. It is a schema-less database, but each diverse and similar document carries its schema. Science and Technology of Consciousness: All diverse aspects of nature get unified at the Unified Field level. Everyone can experience this Unified Field.
2. We use MongoDB driver to connect to a MongoDB instance. We must remember to create the DB connection only once (asynchronously) and then use it several times. Also, the connection must be available when needed. These steps may sometimes become tricky and complex. Science and Technology of Consciousness: In contrast, connecting to the Unified Field is effortless, simple, and easy. You only need a mantra and 20 minutes to connect to the source of knowledge.

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Working with MongoDB in NodeJS

Query DB

GetAll

Pagination

GetOne



Use the db connection in the controllers.

api/controllers/games.controllers.js

```
... gameGetAll= ..
```

```
const collection= db.collection("games");
```

```
// const docs= collection.find(); //Sync not good :(
```

```
collection.find().toArray(function(err, docs) {
```

```
    console.log("Found games", docs);
```

```
    res.status(200).json(docs);
```

```
}
```

Run on browser (<http://localhost:3000/api/games>)

```
npm start
```

Found games ...

Query DB

GetAll

Pagination

GetOne



Use the db connection in the controllers.
api/controllers/games.controllers.js

```
... gameGetAll= ..  
const collection= db.collection("games");  
var offset= 0;  
var count= 5;  
if (req.query && req.query.offset) {  
    offset= parseInt(req.query.offset, 10);  
}  
if (req.query && req.query.count) {  
    count= parseInt(req.query.count, 10);  
}  
collection.find().skip(offset).limit(count).toArray(function(err, docs) {  
    console.log("Found games", docs);  
    res.status(200).json(docs);  
})
```

Run on browser (<http://localhost:3000/api/games>)

npm start

Found games ...

Query DB

GetAll

Pagination

GetOne



Use the db connection in the controllers.

api/controllers/games.controllers.js

```
const ObjectId= require("mongodb").ObjectId;  
... gameGetOne= ..  
const db= dbConnection.get();  
const collection= db.collection("games");  
const gameId= req.params.gameId;  
collection.findOne({_id : ObjectId(gameId)}, function(err,  
doc) {  
    console.log("Found game", doc);  
    res.status(200).json(doc);  
}
```

Run on browser (<http://localhost:3000/api/games>)

npm start

Found games ...

Insert DB

Error Checking

InsertOne



Use the db connection in the controllers.

api/controllers/games.controllers.js

```
const ObjectId= require("mongodb").ObjectId;
```

```
... gameAddOne= ..
```

```
const db= dbConnection.get();
```

```
const collection= db.collection("games");
```

```
if (req.body && req.body.name && req.body.starts) {
```

```
  console.log(req.body);
```

```
  res.status(200).json(req.body);
```

```
} else {
```

```
  console.log("Data missing from POST body");
```

```
  res.status(400).json({error : "Required data missing from  
POST"});
```

```
}
```

Run app.boomerangapi.com/workspace on browser

```
npm start
```

error: "Required data missing from POST" ...

Insert DB

Error Checking

InsertOne



Use the db connection in the controllers.

api/controllers/games.controllers.js

```
... gameAddOne= ..  
var newGame= {};  
if (req.body && req.body.title&& req.body.price) {  
  newGame.title= req.body.title;  
  newGame.price= parseFloat(req.body.price);  
  collection.insertOne(newGame, function(err, response) {  
    console.log(response.ops);  
    res.status(201).json(response.ops);  
  })  
} ...
```

Run `app.boomerangapi.com/workspace` on browser

`npm start`

Found games ...

MongoDB & NodeJS

- We will not be using MongoDB directly from NodeJS.
- There is a much easier way to work with MongoDB from Node.
- We will use Mongoose.

Main Points

- MongoDB is a document-based NoSQL database. It is ideal for mobile application development. It is schema-less, but each document carries its schema.
- We can use MongoDB driver to connect to a MongoDB instance from our node code. You will need a connection, make sure you create only once and use it several times. Also make sure it is available when needed (since it is asynchronous).
- The best practice when working with MongoDB from your node code is to create a connection then have all your DB related code in controllers.

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1. MongoDB is a document-based NoSQL database. It is a schema-less database, but each diverse and similar document carries its schema. Science and Technology of Consciousness: All diverse aspects of nature get unified at the Unified Field level. Everyone can experience the Unified Field.
2. We use MongoDB driver to connect to a MongoDB instance. We must remember to create the DB connection only once (asynchronously) and then use it several times. Also, the connection must be available when needed. These steps may sometimes become tricky and complex. Science and Technology of Consciousness: In contrast, connecting to the Unified Field is effortless, simple, and easy. You only need a mantra and 20 minutes to connect to the source of knowledge.
3. One best practice when working with MongoDB is to separate the creation of a connection (in a db.js file) from the DB operations (in the controllers). DB operations are asynchronous. So, we deal with results in callbacks. All this results in more efficient performance in database-driven programs. Science and Technology of Consciousness: Neuroscience, the scientific study of the human nervous system, verifies that efficient performance in activities is more dependent upon the coherent functioning of the brain than it does on education, work experience, and age.^[1] TM creates coherent brain functioning.^[2]

[1]: Travis, Frederick; and Arenander, Alarik. Cross-sectional and longitudinal study of effects of Transcendental Meditation practice on interhemispheric frontal asymmetry and frontal coherence. International Journal of Neuroscience 116: 1519-1538, 2006.

[2]: Travis, Frederick; Grosswald, Sarina; and Stixrud, William. ADHD, brain functioning, and Transcendental Meditation practice. Mind & Brain, The Journal of Psychiatry 2: 73-81, 2011.