MongoDB, Mongoose and Cloud Storage

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Agenda

- NoSQL Databases
- MongoDB
- Mongoose
- Mongo in the cloud

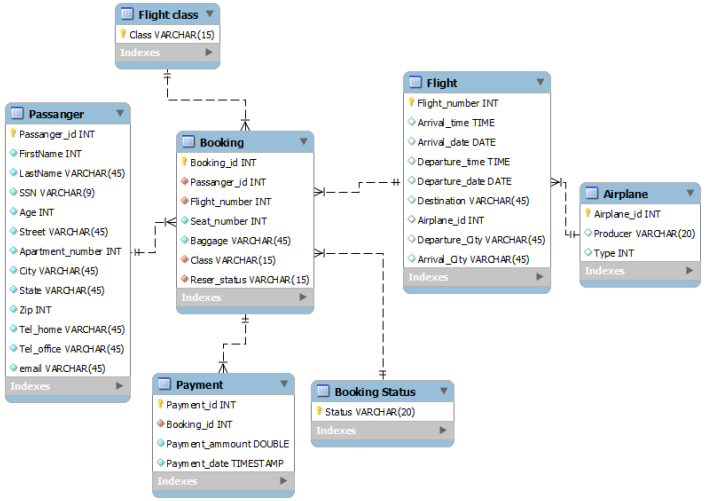
Databases in Enterprise Apps

- Most data driven enterprise applications need a database
  - Persistence: storage of data
  - Concurrency: many applications sharing the data at once.
  - Integration: multiple systems using the same DB
- Enterprise Application DBs require backups, fail over, maintenance, capacity provisioning.
  - Traditionally handled by a Database Administrator (the DBA).

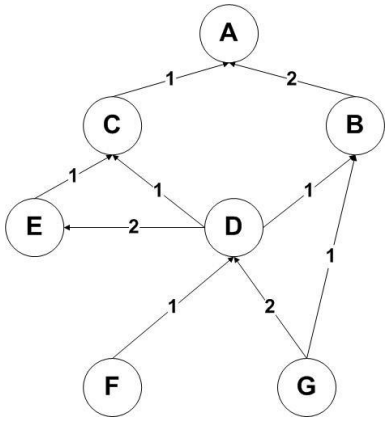
Structured & Unstructured Data

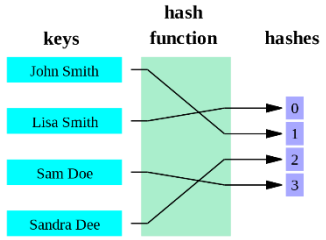
- Relational Databases:
  - Organise data into structured tables and rows
  - Relations have to be simple, they cannot contain any structure such as a nested record or a list
- In memory data structures
  - Much more varied structure
  - Lists, Queues, Stacks, Graphs, Hashing

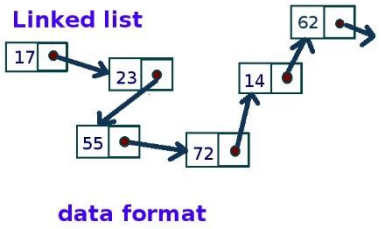
Relational Database

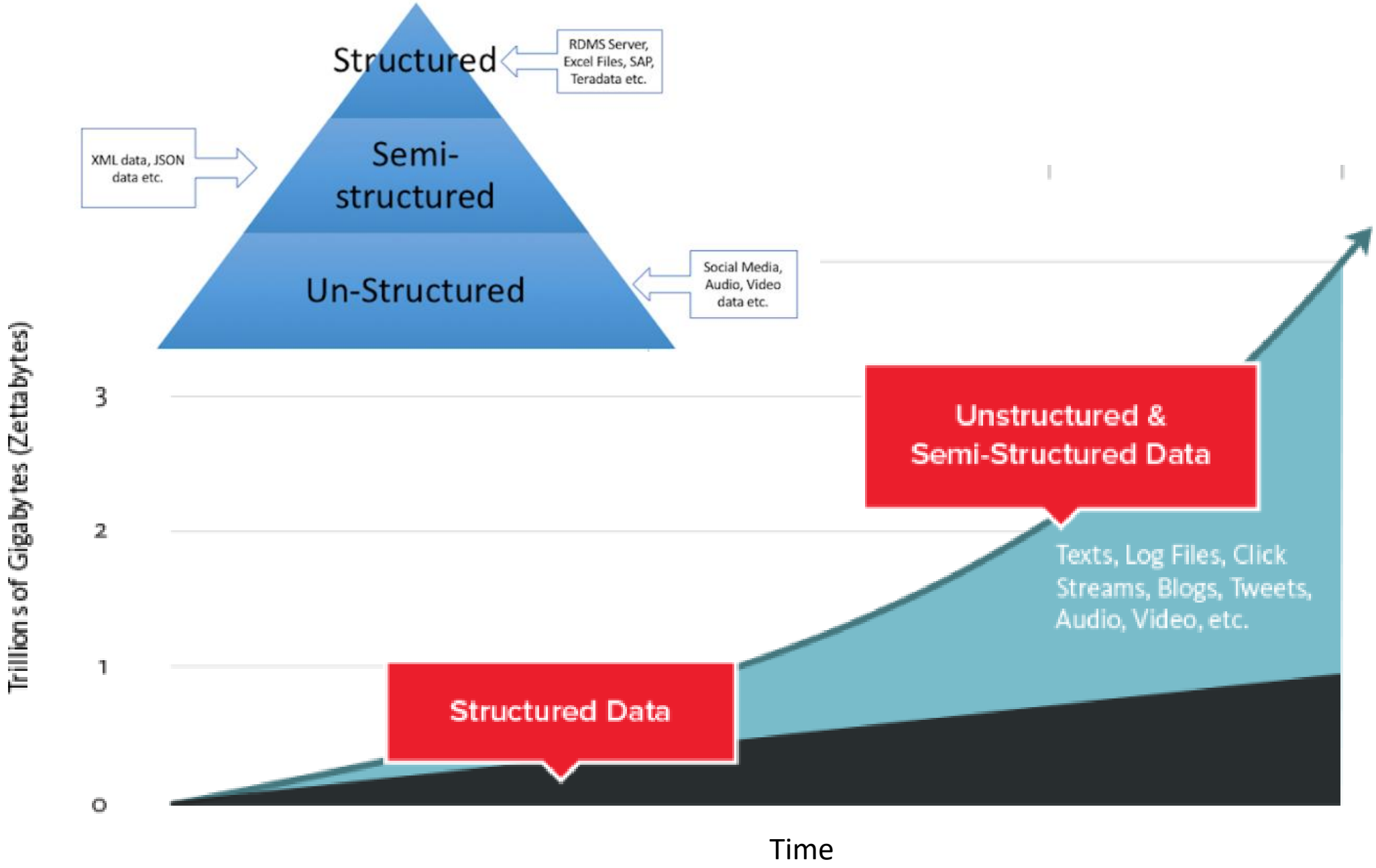


In Memory Data Structures



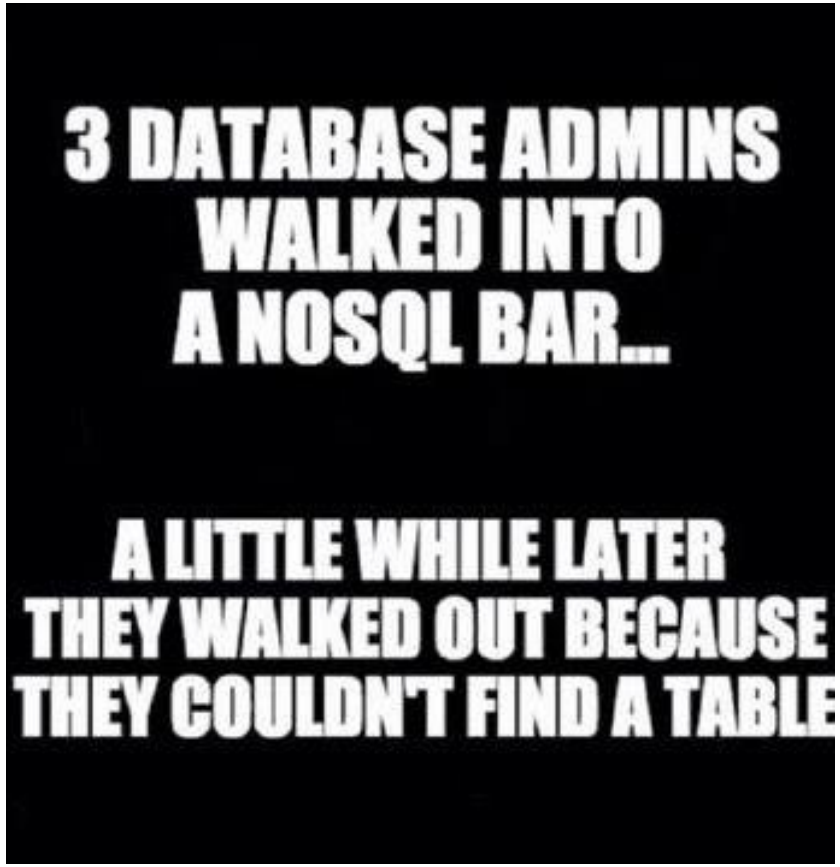





Structured
RDMS Server, Excel Files, SAP, Teradata etc.
XML data, JSON data etc.
Semi-structured
Un-Structured
Social Media, Audio, Video data etc.
Trillions of Gigabytes (Zettabytes)
3
2
1
0
Unstructured & Semi-Structured Data
Texts, Log Files, Click Streams, Blogs, Tweets, Audio, Video, etc.
Structured Data
Time

NoSQL Databases

- Non-tabular(no tables) databases and store data differently than relational tables.
- Variety of types based on their data model
  - Document based, key-value, graph
- NoSQL databases allow developers to work with semi-structured/unstructured data, giving them a lot of flexibility
- No need to define exact schema(i.e. structure) for data



Databases in the Cloud

- For some apps, a traditional relational database may not be the best fit
  - Organisations are capturing more data and processing it quicker – can be expensive/difficult on traditional DB
  - Traditionally, relational database is designed to run on a single machine in predicable environment
  - Hard to estimate scaling requirements, particularly if it's a web app?
  - Are you going to do Data mining?
- One approach is to use the **Cloud** for you DB
  - Designed for scale
  - Can be outsourced so you don't have to deal with infrastructure requirements.

NoSQL Cloud DB Advantages

- Removes Management costs
- Inherently scalable
- No need to define schemas(if NoSQL) etc.
- Lots of Cloud DB offerings out there
  - SQL based
  - NoSQL based
- If organisation policy/standards do not allow outsourcing:
  - Can host yourself, most NoSQL DBs are free.

NoSQL Cloud Database Practices

- Drop Consistency(if you can)
  - this makes distributed systems much easier to build
- Drop SQL and the relational model
  - simpler structures are easier to distribute:
    - key/value pairs
    - **structured documents**
    - **pseudo-tables**
    - tend to be schema-free, accepting data as-is
- Offer HTTP interfaces using XML or **JSON**
  - Web APIs!!!

MONGODB

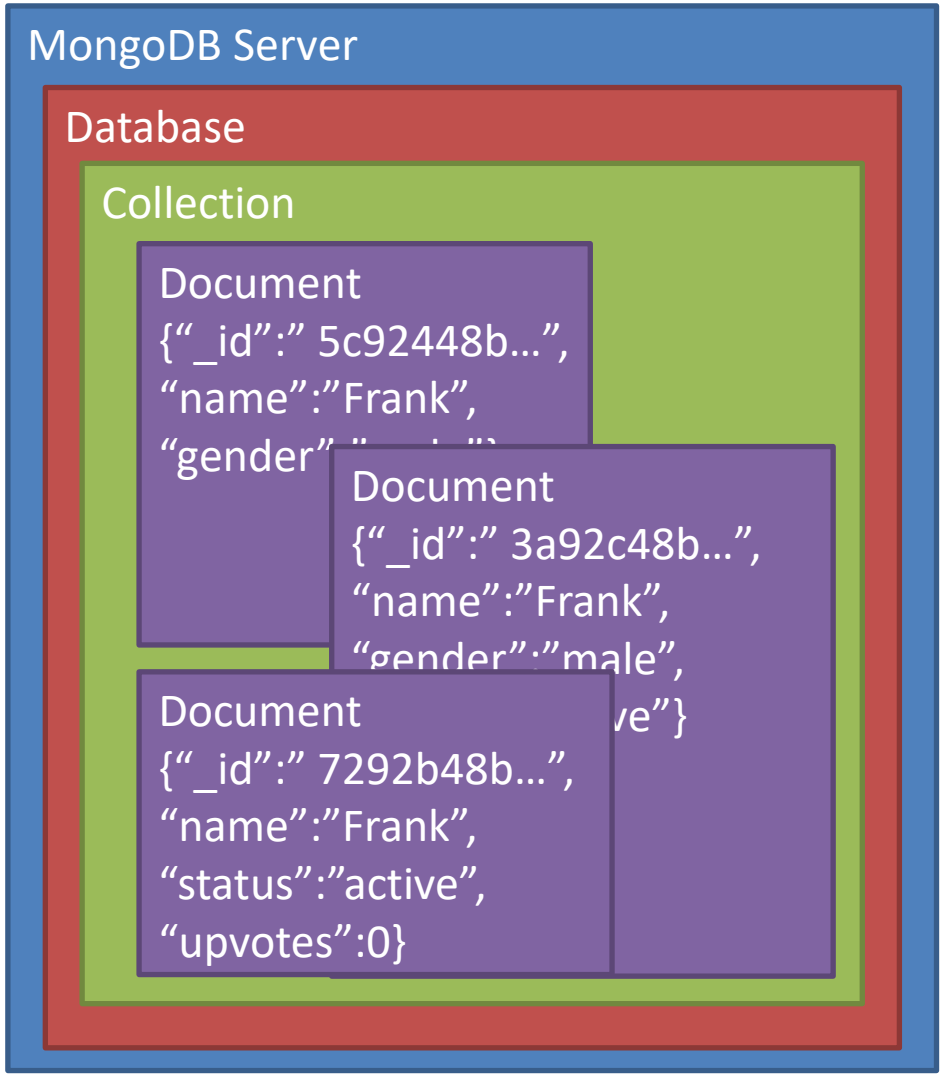
Introduction

- Document-oriented database
- A record in MongoDB is a **document**, which is a data structure composed of **field** and **value** pairs.
- MongoDB documents are similar to **JSON objects**
- Field Values can be other documents, arrays, arrays of other documents.
  - Reduces need for “Joins”
- Community support - popular choice

```
{
  name: "sue",                    ←  field: value
  age: 26,                        ←  field: value
  status: "A",                    ←  field: value
  groups: [ "news", "sports" ]    ←  field: value
}
```

Mongo Terminology

- Each **database** contains a set of "**Collections**"
- Collections contain a set of **JSON documents**
  - there is no schema (in the DB…)
- The documents can all be different
  - means you have rapid development
  - adding a property is easy - just starting using in your code
- Makes deployment easier and faster
  - roll-back and roll-forward are safe - unused properties are just ignored
- Collections can be indexed and queries
- Operations on individual documents are atomic



Mongo Documents

- MongoDB stores data records as **BSON** documents(Binary JSON.
  - BSON is a binary representation of JSON documents.
- Each document stored in a collection requires a unique ***_id*** field and is reserved for use as a primary key.
- If an inserted document omits the _id field, the MongoDB driver automatically generates an ObjectId for the ***_id*** field.
  - ObjectId values consist of 12 bytes.

```
_id: ObjectId("5c92448b7fbccf28a0c501aa")
name: "Contact 4"
address: "49 Upper Street"
phone_number: "934-4290"
```

Getting Started (locally)

- Install Mongo community edition for your OS:

Install MongoDB > Install MongoDB Community Edition

Install MongoDB Community Edition

These documents provide instructions to install MongoDB Community Edition.

Install on Linux

Install MongoDB Community Edition and required dependencies on Linux.

Install on macOS

Install MongoDB Community Edition on macOS systems from MongoDB archives.

Install on Windows

Install MongoDB Community Edition on Windows systems and optionally start MongoDB as a Windows service.

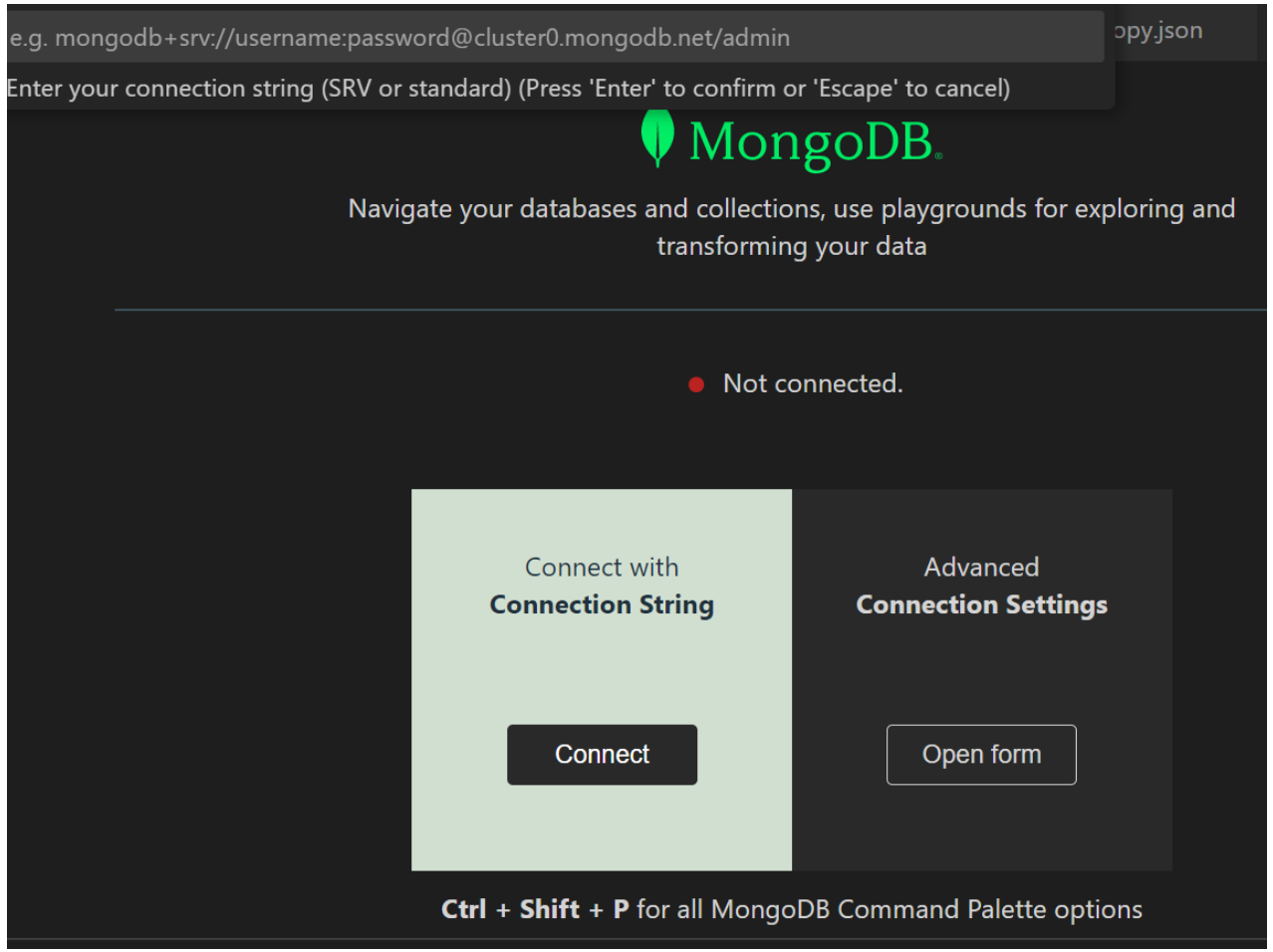
- Specify a directory for your db files and start Mongodb server.

```
mkdir db

mongod -dbpath db
```

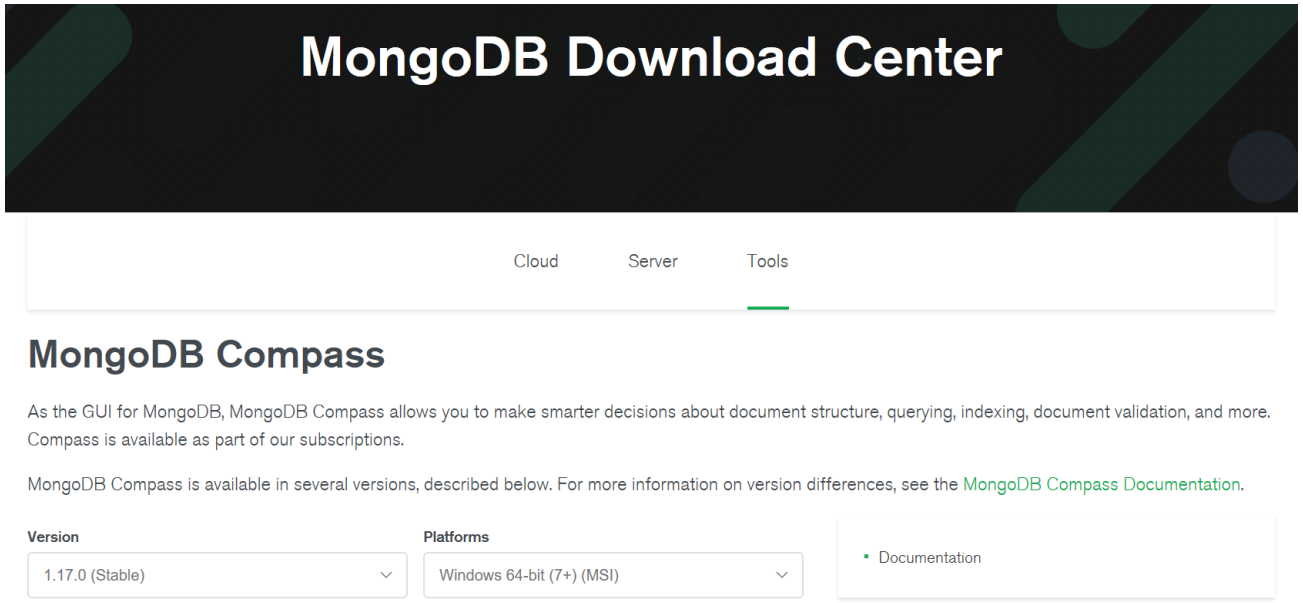
Getting Started (locally)

- Install Mongo DB Extension for VS Code
  - Never have to leave your VS Code environment!!!
  - Navigate your DBs and Collections



Getting Started (locally)

- Install Mongo Compass, Graphical User Interface for managing MongoDB.
  - For windows, comes as part of mongodb install
  - Other platforms can get it here:



Mongo with Node.js

MONGOOSE

Mongoose Overview

- Mongoose is a object-document model module in Node.js for MongoDB
  - Wraps the functionality of the native MongoDB driver
  - Exposes models to control the records in a doc
  - Supports validation on save
  - Extends the native queries

mongoose

elegant mongodb object modeling for node.js

read the docs | discover plugins

Star 18,205 Version 5.4.19 Fork 2,570

Let's face it, **writing MongoDB validation, casting and business logic boilerplate is a drag**. That's why we wrote Mongoose.

Mongoose first?

- Shortcut to understanding the basics
- Similar to Object Relational Mapping libraries like JPA/Hibernate
- Easier concept if coming from relational DB background.

Installing & Using Mongoose

1. Run the following from the CMD/Terminal

```
npm install --save mongoose
```

2. Import the module

```
import mongoose from 'mongoose';
```

3. Connect to the database

```
mongoose.connect(process.env.mongoDB);
```

Mongoose Schemas and Models

- A Mongoose schema defines the structure of the document
  - Properties, default values, validation etc.
- A Mongoose model is a “wrapper” on the Mongoose schema.
  - provides an interface to the database for creating, querying, updating, deleting records, etc

```
import mongoose from 'mongoose';

const Schema = mongoose.Schema;

const UserSchema = new Schema({
  username: { type: String, unique: true, required: true},
  password: {type: String, required: true }
});

export default mongoose.model('User', UserSchema);
```

Demo

- Contacts API: Manage contact details…

Contacts Schema:

```
name: String
address: String
age: Number
email: String
updated: Date
```

Solution in Code Examples…

Mongoose Schemas – Arrays & sub-documents

Example: Data Model for supports user Posts on a web site:

Comments property is an Array of CommentSchemas

Title: Check the Dune movie trailer
Link: http://dunethemovie.com
username:fxwalsh
upvotes:20
comments:

body: Wow Looks Great!!!
author: JPrithet
upvotes: 0

body: When is it out?
author: BHope
upvotes: 0

body: Original is better!
author: MPower
upvotes: 0

```
1  const mongoose = require('mongoose'),
2  Schema = mongoose.Schema;
3
4  const CommentSchema = new Schema({
5    body: {type: String, required:true},
6    author: {type: String, required:true},
7    upvotes:Number
8    });
9
10  const PostSchema = new Schema({
11     title: {type: String, required:true},
12     link:  {type: String, optional:true},
13     username:  {type: String, required:true},
14     comments: [CommentSchema],
15   upvotes: { type: Number, min: 0, max: 100 }
16  });
17
18 export default mongoose.model('posts', PostSchema);
```

Mongoose Queries

- Mongoose supports many queries:
  - For equality/non-equality
  - Selection of some properties
  - Sorting
  - Limit & skip
- Mongoose models provide several static helper functions for CRU operations.
  - Model.findOne() returns a single document, the first match
  - Model.find() returns all
  - Model.findById() queries on the _id field.

- `Model.deleteMany()`
- `Model.deleteOne()`
- `Model.find()`
- `Model.findById()`
- `Model.findByIdAndDelete()`
- `Model.findByIdAndRemove()`
- `Model.findByIdAndUpdate()`
- `Model.findOne()`
- `Model.findOneAndDelete()`
- `Model.findOneAndRemove()`
- `Model.findOneAndReplace()`
- `Model.findOneAndUpdate()`
- `Model.replaceOne()`
- `Model.updateMany()`
- `Model.updateOne()`

Mongoose Queries

- Can build complex queries and execute them later

```
1  const query = ContactModel.where('age').gt(17).lt(66)
2                            .where('county').in(['Waterford','Wexford','Kilkenny']);
3
4  query.exec((err,contacts)=>{...})
5
6
```

- The above finds all contacts where age >17 and <66 and living in either Waterford, Kilkenny or Wexford

Sub Documents

Validators

Queries

Object Refs.

LECTURE 2

Mongoose Schemas - Arrays

```
import mongoose from 'mongoose';

const Schema = mongoose.Schema;

const MovieReviewSchema = {
  userName : { type: String},
  review : {type: String}
}

const MovieSchema = new Schema({
    adult: { type: Boolean},
    id: { type: Number, required: true, unique: true },
    poster_path: { type: String},
    overview: { type: String},
    release_date: { type: String},
    reviews : [ MovieReviewSchema],
    original_title: { type: String},
    genre_ids: [{type: Number}],
```

Review property is an Array of MovieReviewSchema

Mongoose Schema – Built-in Validation

constraints on properties :

```
import mongoose from 'mongoose';
const Schema = mongoose.Schema;

const ContactSchema = new Schema({
  name: {type: String, required:[true, 'Name is a required property']},
  address: String,
  age: {
    type: Number,
    min: 0,
    max: 120,required: true
  },
  email: String,
  updated: {
    type: Date,
    default: Date.now,
  },
});

export default mongoose.model('Contact', ContactSchema);
```

```
import mongoose from 'mongoose';

const Schema = mongoose.Schema;

const UserSchema = new Schema({
  username: { type: String, unique: true, required: true},
  password: {type: String, required: true }
});

export default mongoose.model('User', UserSchema);
```

https://mongoosejs.com/docs/validation.html

Mongoose Custom Validation

- Developers can define custom validation on their properties (e.g. validate name field is correct format)

```
//Make sure name starts with capital letter,
const nameValidator = (name) => {
    let nameRegEx = /\b([A-ZÀ-ÿ][-,a-z. ']+[ ]*)+/;
    return nameRegEx.test(name);
};

ContactSchema.path('name').validate(nameValidator);
```

Using Regular Expression (regex) to test for a valid name format, for example begins with a capital letter. If you've not come across them before check out https://www.w3schools.com/jsref/jsref_obj_regexp.asp

https://mongoosejs.com/docs/validation.html

Data Manipulation Mongoose

- Mongoose supports all the CRUD operations:
  - **Create** –> Model.create(docs) or new Model(doc).save()
  - **Read** –> Model.find(conditions)
  - **Update** –> Model.update(conditions, props)
  - **Remove** –> Model.remove(conditions)
- Can operate with "*error first*" callbacks, promises, pr async-await

Create with Mongoose (async-await)

```
import mongoose from 'mongoose';
const Schema = mongoose.Schema;

const ContactSchema = new Schema({
    name: { type: String, required: true },
    address: String,
    age: {
        type: Number,
        min: 0,
        max: 120,
        required: true
    },
    email: String,
    updated: {
        type: Date,
        default: Date.now
    }
});

export default mongoose.model('Contact', ContactSchema);
```

```
api \ contacts
JS contactModel.js
JS index.js
```

```
import express from 'express';
import Contact from './contactModel';

const router = express.Router();

// add a contact (simple - no validation or body checking)
router.post('/', async (req, res) => {
  const newContact = await new Contact(req.body).save();
  res.status(201).json(newContact);
});
```

Create with Mongoose (promise)

```js
import mongoose from 'mongoose';
const Schema = mongoose.Schema;

const ContactSchema = new Schema({
    name: { type: String, required: true },
    address: String,
    age: {
        type: Number,
        min: 0,
        max: 120,
        required: true
    },
    email: String,
    updated: {
        type: Date,
        default: Date.now
    }
});

export default mongoose.model('Contact', ContactSchema);
```

```
api \ contacts
JS contactModel.js
JS index.js
```

```js
import express from 'express';
import Contact from './contactModel';

const router = express.Router();

// add a contact (simple - no validation or body checking)
router.post('/', (req, res) => {
  new Contact(req.body).save()
  .then(contact =>res.status(201).json(contact));
});
```

Update with Mongoose

- Async-Await Syntax

```
router.put('/:id', async (req, res, next) => {
  if (req.body._id) delete req.body._id;
  const query = { _id: req.params.id };
  const result = await Contact.update(query, req.body)
  res.status(201).json(result);
});

export default router;
```

- Promise Syntax

```
router.put('/:id', (req, res, next) => {
  if (req.body._id) delete req.body._id;
  const query = { _id: req.params.id };
  Contact.update(query, req.body)
    .then(contact => res.status(201).json(contact));
});
```

Object Referencing

- Can use Object Id to reference documents in other collections
- Similar to ‘foreign keys’ in SQL databases

```
const ContactSchema = new Schema({
    name: { type: String, required: true },
    address: String,
    age: {
        type: Number,
        min: 0,
        max: 120,
        required: true
    },
    email: String,
    updated: {
        type: Date,
        default: Date.now
    },
    productsPurchased: [{type: mongoose.Schema.Types.ObjectId, ref: 'Products'}]
}
);
```

Using Object ID to reference a document in Products

Query Population using Refs

https://github.com/fxwalsh/ewd-examples-2020.git

- Allows you to automatically replace the specified paths in the document with document(s) from other collection(s).

```javascript
//Demo of Referencing in Mongoose: Error handling left out to simplify code.
//to run, type npx babel-node ref_example.js at the command line.

const createData = async () => {

    //Create a product
    const product1 = await new Product({
        productName: "PS5",
        productCode: "X123456"
    }).save();

    //Create contact and add product IDs
    const contact1 = await new Contact({
        name: "Frank Walsh",
        age: 22,
        productsPurchased: [product1._id]
    }).save();

    //query db for contact and populate user field
    const contact = await Contact.findById(contact1._id).populate('productsPurchased');
    console.log(JSON.stringify(contact, null, "\t"));
```

output

```json
{
        "productsPurchased": [
                {
                        "_id": "5fc8d72bdf5a440d7c003be4",
                        "productName": "PS5",
                        "productCode": "X123456",
                        "__v": 0
                }
        ],
        "_id": "5fc8d72bdf5a440d7c003be5",
        "name": "Frank Walsh",
        "age": 22,
        "updated": "2020-12-03T12:16:43.336Z",
        "__v": 0
}
```

SCHEMA METHODS

Example: Using Schema Methods for Simple Authentication

- Restrict access to API (require authentication):
  - Create users schema with methods for
    - Finding users
    - Checking password
  - Use **express-session** middleware to create and manage user session (using cookies)
  - Create an authentication route to set up “session”
  - Create your own authentication middleware and place it on /api/movies route

Aside: Sessions

- Requests to Express apps are stand-alone by default
  - no request can be linked to another.
  - By default, no way to know if this request comes from client that already performed a request previously.
- Sessions are a mechanism that makes it possible to “know” who sent the request and to associate requests.
- Using Sessions, every user of you API is assigned a unique session:
  - Allows you to store state.
- The express-session module is middleware that provides sessions for Express apps.

express-session

1.15.6 • Public • Published a year ago

Readme 9 Depen

express-session

npm v1.15.6 downloads 3M/m build passing coverage 100%

nstallation

a Node.js module available through the npm reg

command:

```
express-session
```

1. User Schema with Static & Instance Methods

```
const UserSchema = new Schema({
  username: { type: String, unique: true, required: true},
  password: {type: String, required: true },
});

UserSchema.statics.findByUserName = function(username) {
  return this.findOne({ username: username});
};

UserSchema.methods.comparePassword = function (candidatePassword) {
  const isMatch = this.password === candidatePassword;
  if (!isMatch) {
    throw new Error('Password mismatch');
  }
  return this;
};

export default mongoose.model('User', UserSchema);
```

Static Method: belongs to schema. Independent of any document instance

Instance Method: belongs to a specific document instance.

2. express-session middleware

- Session middleware that stores session data on server-side
  - Puts a unique ID on client

```
npm install --save express-session
```

- Add to Express App middleware stack:

```
//session middleware
app.use(session({
  secret: 'ilikecake',
  resave: true,
  saveUninitialized: true
}));
```

3. Use User Route to authenticate

- Use **/api/user** to authenticate, passing username and password in HTTP body

/api/users/index.js

```
// authenticate a user, using async handler
router.post('/', asyncHandler(async (req, res) => {
    if (!req.body.username || !req.body.password) {
        res.status(401).send('authentication failed');
    } else {
        const user = await User.findByUserName(req.body.username);
        if (user.comparePassword(req.body.password)) {
            req.session.user = req.body.username;
            req.session.authenticated = true;
            res.status(200).end("authentication success!");
        } else {
            res.status(401).end('authentication failed');
        }

    }
}));
```

Using static method to find User document

Using instance method to check password

/index.js

```
app.use('/api/users', usersRouter);
```

4. Add Authentication Middleware

authenticate.js

```
import User from './api/users/userModel';
// Authentication and Authorization Middleware
export default async (req, res, next) => {
  if (req.session) {
    let user = await User.findByUserName(req.session.user);
    if (!user)
      return res.status(401).end('unauthorised');
    next();
  } else {
    return res.status(401).end('unauthorised');
  }
};
```

Checks for user ID in session object.
If exists, called next middleware function, otherwise end req/res cycle with 401

index.js

```
import authenticate from './authenticate';
```

```
app.use('/api/movies', authenticate, moviesRouter);
```

Authentication middleware applied on /api/movies route.