SQL og NoSQL

Opsamling

Videregående Database

ERHVERVSAKADEMI AARHUS
BUSINESS ACADEMY AARHUS

Agenda

1. Opsamling
    1. SQL og NoSQL
    2. ORM og ODM
    3. Schema Design og Validering
    4. MongoDB Client vs Mongoose
    5. Indeksering
2. Eksamen, eksamensopgave og vejledning

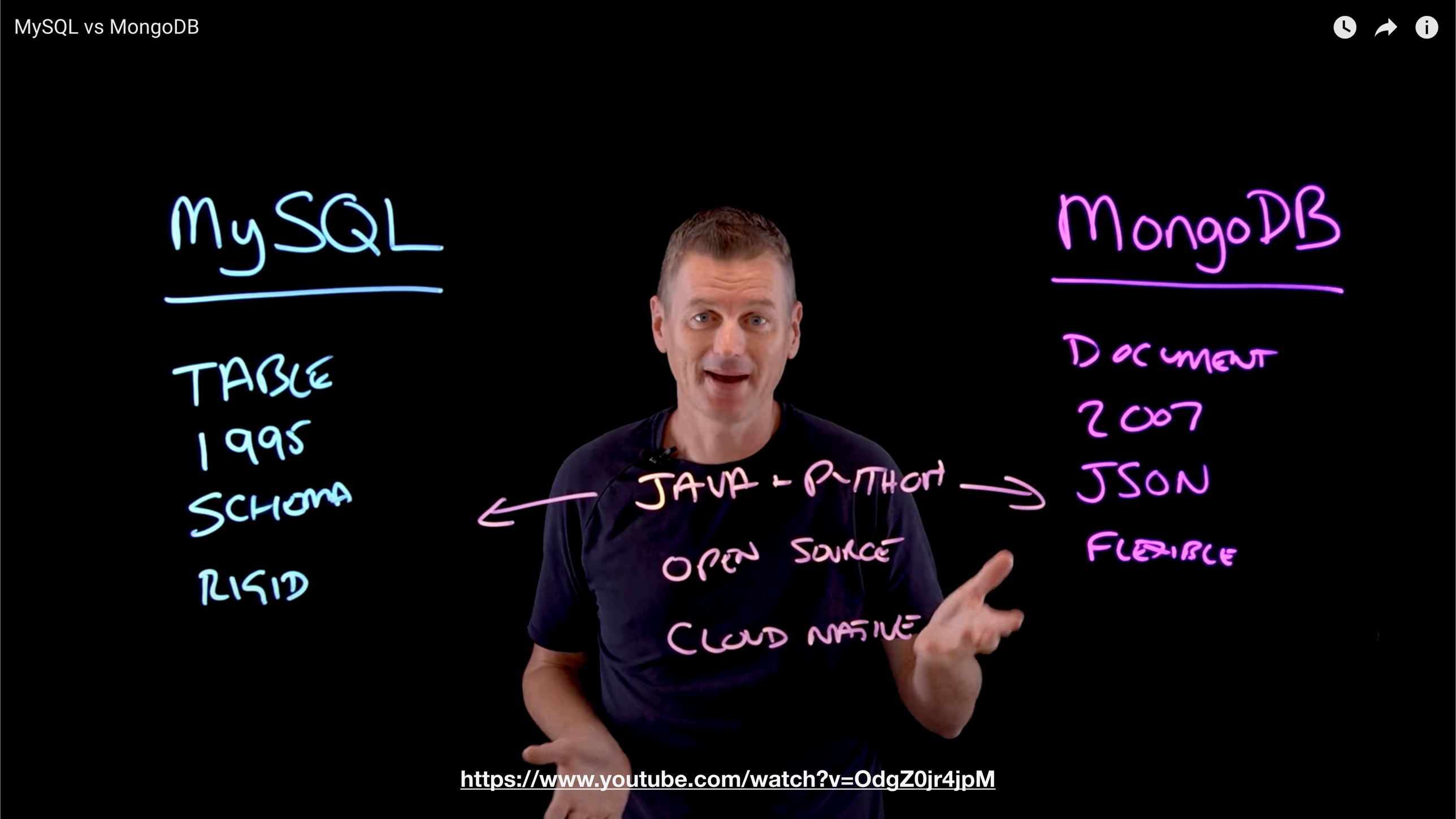

MySQL™


mongoDB

Most Popular Databases

https://survey.stackoverflow.co/2023/#section-most-popular-technologies-databases

MySQL vs MongoDB



https://www.youtube.com/watch?v=OdgZ0jr4jpM

Differences between SQL and NoSQL

	SQL Databases	NoSQL Databases
Data Storage Model	Tables with fixed rows and columns	Document: JSON documents, Key-value: key-value pairs, Wide-column: tables with rows and dynamic columns, Graph: nodes and edges
Development History	Developed in the 1970s with a focus on reducing data duplication	Developed in the late 2000s with a focus on scaling and allowing for rapid application change driven by agile and DevOps practices.
Examples	Oracle, MySQL, Microsoft SQL Server, and PostgreSQL	Document: MongoDB and CouchDB, Key-value: Redis and DynamoDB, Wide-column: Cassandra and HBase, Graph: Neo4j and Amazon Neptune
Primary Purpose	General purpose	Document: general purpose, Key-value: large amounts of data with simple lookup queries, Wide-column: large amounts of data with predictable query patterns, Graph: analyzing and traversing relationships between connected data
Schemas	Rigid	Flexible
Scaling	Vertical (scale-up with a larger server)	Horizontal (scale-out across commodity servers)
Multi-Record ACID Transactions	Supported	Most do not support multi-record ACID transactions. However, some – like MongoDB – do.
Joins	Typically required	Typically not required
Data to Object Mapping	Requires ORM (object-relational mapping)	Many do not require ORMs. MongoDB documents map directly to data structures in most popular programming languages.

https://www.mongodb.com/nosql-explained/nosql-vs-sql

Features: SQL vs NoSQL

Feature	SQL Databases	NoSQL Databases
Data Structure	Structured	Flexible (Document, Key-Value, Graph, Wide-Column)
Data Types	Structured	Structured, Semi-structured, Unstructured
Scalability	Vertical (increasing resources on a single server)	Horizontal (adding more servers to a cluster)
ACID Compliance	Yes	No (may support eventual consistency)
Query Language	Structured Query Language (SQL)	Less structured query languages or no specific query language
Applications	E-commerce, Financial Systems, Enterprise Applications	Web Applications, Social Media Platforms, Mobile Apps
Strengths	Data organization, Complex queries, ACID compliance	Flexibility, Scalability, Handling unstructured data
Weaknesses	Rigid schema, Slow performance for large data	Less mature technology, Less standardized query syntax

Export to Sheets

https://g.co/bard/share/9a4c7d0aa722

Features: MySQL vs MongoDB

Feature	MySQL	MongoDB
Data Structure	Relational (tables, rows, columns)	Document (JSON-like documents)
Schema	Rigid, requires predefined schema	No schema, flexible data structure
Data Types	Structured	Structured, Semi-structured, Unstructured (JSON, XML, binary data)
Scalability	Vertical (increasing resources on a single server)	Horizontal (adding more servers to a cluster)
ACID Compliance	Yes	Eventual consistency
Query Language	Structured Query Language (SQL)	MongoDB Query Language (MongoDBQL)
Applications	E-commerce, Financial Systems, Enterprise Applications	Web Applications, Social Media Platforms, Mobile Apps, Real-time applications
Strengths	Data organization, Complex queries, ACID compliance, Mature technology	Flexibility, Scalability, Handling unstructured data, Real-time data handling
Weaknesses	Rigid schema, Slow performance for large data	Less mature technology, Less standardized query syntax, May not support complex queries

Export to Sheets

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Best For: MySQL vs MongoDB

Feature	MySQL	MongoDB
Best for	Applications with structured data, complex queries, and strict data integrity	Applications with unstructured or evolving data, high scalability, and real-time data handling

Export to Sheets

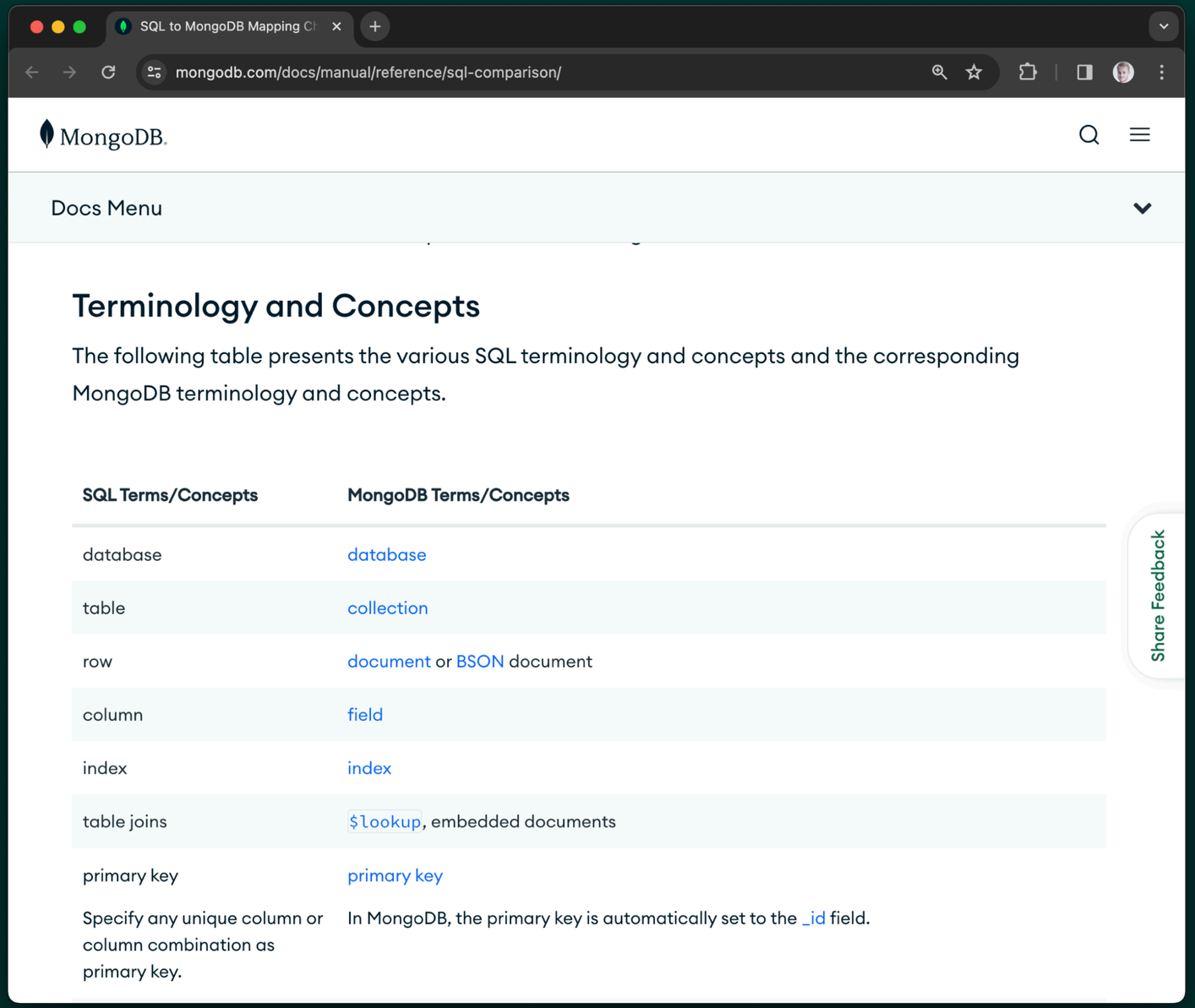
https://g.co/bard/share/1233c9c2da05

Why NoSQL?

https://www.youtube.com/watch?v=0X43QfCfyk0&t=35s&ab_channel=MongoDB

- **Flexibility:** NoSQL databases do not require a predefined schema, which means that the data structure can be easily changed as the application evolves. This makes them well-suited for applications that handle unstructured or semi-structured data.
- **Scalability:** NoSQL databases are typically horizontally scalable, which means that they can be easily added to more servers to handle increasing data and workloads. This makes them ideal for applications that need to support large amounts of data or that experience sudden spikes in traffic.
- **Performance:** NoSQL databases can often outperform SQL databases for certain types of workloads, such as read-heavy applications or applications that require low latency. This is because they are designed to store and retrieve data efficiently, without the overhead of maintaining a rigid schema.
- **Ease of use:** NoSQL databases can be easier to use than SQL databases, especially for developers who are not familiar with traditional relational databases. They often have simpler APIs and data models, which can make it easier to develop and maintain applications.

SQL vs MQL



https://www.mongodb.com/docs/manual/reference/sql-comparison/

SQL Schema Statements

```
CREATE TABLE people (
    id MEDIUMINT NOT NULL
        AUTO_INCREMENT,
    user_id Varchar(30),
    age Number,
    status char(1),
    PRIMARY KEY (id)
)
```

MongoDB Schema Statements

Implicitly created on first `insertOne()` or `insertMany()` operation. The primary key `_id` is automatically added if `_id` field is not specified.

```
db.people.insertOne( {
    user_id: "abc123",
    age: 55,
    status: "A"
} )
```

https://www.mongodb.com/docs/manual/reference/sql-comparison/

SQL INSERT Statements	MongoDB insertOne() Statements

```
INSERT INTO people(user_id,
                   age,
                   status)
VALUES ("bcd001",
        45,
        "A")
```

```
db.people.insertOne(
   { user_id: "bcd001", age: 45, status: "A"
)
```

https://www.mongodb.com/docs/manual/reference/sql-comparison/

SQL SELECT Statements	MongoDB find() Statements
`SELECT *` `FROM people`	`db.people.find()`

`SELECT id,`
`user_id,`
`status`
`FROM people`
	`db.people.find(`
	`{ },`
	`{ user_id: 1, status: 1 }`
	`)`

`SELECT user_id, status`
`FROM people`
	`db.people.find(`
	`{ },`
	`{ user_id: 1, status: 1, _id: 0 }`
	`)`

`SELECT *`
`FROM people`
`WHERE status = "A"`
	`db.people.find(`
	`{ status: "A" }`
	`)`

SQL Update Statements	MongoDB updateMany() Statements

```
UPDATE people
SET status = "C"
WHERE age > 25
```

```
db.people.updateMany(
   { age: { $gt: 25 } },
   { $set: { status: "C" } }
)
```

```
UPDATE people
SET age = age + 3
WHERE status = "A"
```

```
db.people.updateMany(
   { status: "A" } ,
   { $inc: { age: 3 } }
)
```

https://www.mongodb.com/docs/manual/reference/sql-comparison/

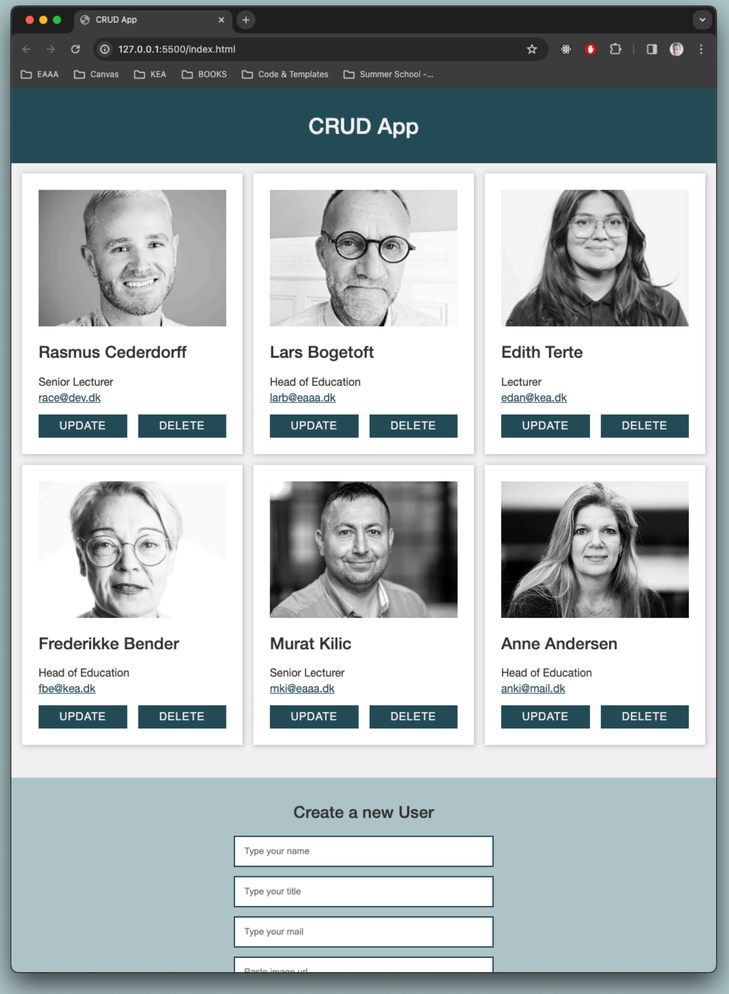
Mapping

Object Relational Mapping (ORM)

&

Object Document Mapping (ODM)

Web App



Database

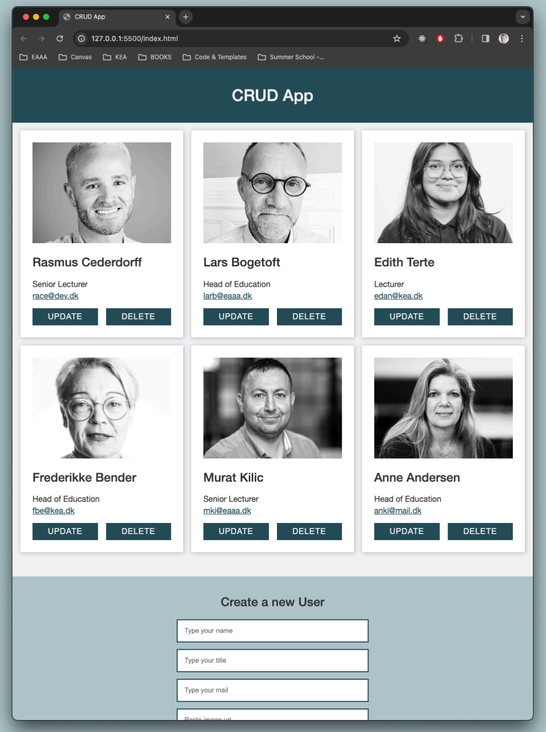
id	name	mail	title	image
1	Peter Lind	petl@kea.dk	Senior Lecturer	https://
2	Rasmus Cederdorff	race@dev.dk	Senior Lecturer	https://
3	Lars Bogetoft	larb@eaaa.dk	Head of Education	https://
4	Edith Terte	edan@kea.dk	Lecturer	https://
5	Frederikke Bender	fbe@kea.dk	Head of Education	https://
6	Murat Kilic	mki@eaaa.dk	Senior Lecturer	https://
7	Anne Kirketerp	anki@eaaa.dk	Head of Education	https://

Hvordan “mapper” vi det her?

Frontend

REST API med Node.js

Database



id	name	mail	title
1	Peter Lind	petl@kea.dk	Senior Lectu
2	Rasmus Cederdorff	race@dev.dk	Senior Lectu
3	Lars Bogetoft	larb@eaaa.dk	Head of Educ
4	Edith Terte	edan@kea.dk	Lecturer
5	Frederikke Bender	fbe@kea.dk	Head of Educ
6	Murat Kilic	mki@eaaa.dk	Senior Lectu
7	Anne Kirketerp	anki@eaaa.dk	Head of Educ

Web App
(Client)

REST API
(Udveksler JSON)

Backend App
(Server)

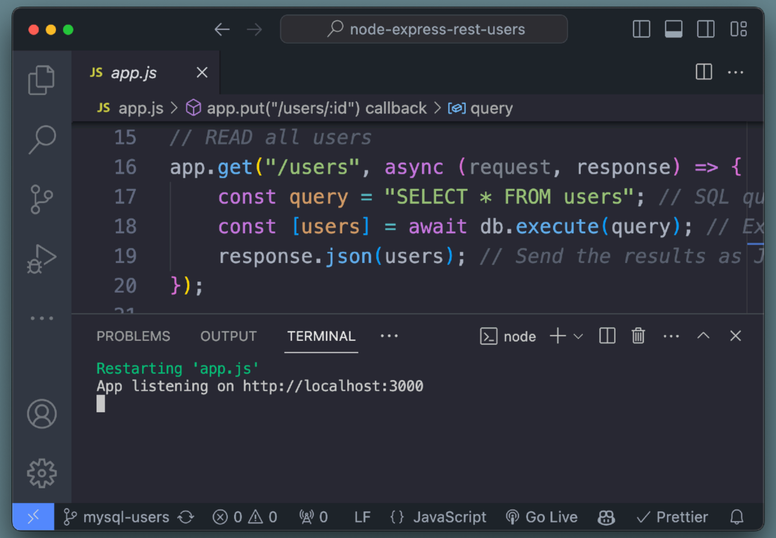
MySQL Database
(Database Server)

BACKEND

REQUEST

JSON

RESPONSE



SQL

	id	name	mail
1	1	Maria Louise Bendixen	mlbe@eaaa.dk
2	2	Rasmus Cederdorff	race@eaaa.dk
3	3	Anne Kirketerp	anki@eaaa.dk
4	4	Line Skjødt	lskj@eaaa.dk
5	5	Dan Okkels Brendstrup	dob@eaaa.dk

CLIENT

SERVER

Object Relational Mapping

ORM

id	name	mail	title	image
1	Peter Lind	petl@kea.dk	Senior Lecturer	https://share.cederdorff.com/images/pe…
2	Rasmus Cederdorff	race@dev.dk	Senior Lecturer	https://share.cederdorff.com/images/ra…
3	Lars Bogetoft	larb@eaaa.dk	Head of Education	https://kea.dk/slir/w200-c1x1/images/u…
4	Edith Terte	edan@kea.dk	Lecturer	https://media.licdn.com/dms/image/C4E0…
5	Frederikke Bender	fbe@kea.dk	Head of Education	https://kea.dk/slir/w200-c1x1/images/u…
6	Murat Kilic	mki@eaaa.dk	Senior Lecturer	https://www.eaaa.dk/media/llyavasj/mur…
7	Anne Kirketerp	anki@eaaa.dk	Head of Education	https://www.eaaa.dk/media/5buh1xeo/ann…

```
const user = {
    id: 6,
    name: "Murat Kilic",
    mail: "mki@eaaa.dk",
    title: "Senior Lecturer",
    image: "https://www.eaaa.dk/media/ll
};
```

From database row to object

Object Relational Mapping

ORM

id	name	mail	title	image
1	Peter Lind	petl@kea.dk	Senior Lecturer	https://share.cederdorff.com/images/pe…
2	Rasmus Cederdorff	race@dev.dk	Senior Lecturer	https://share.cederdorff.com/images/ra…
3	Lars Bogetoft	larb@eaaa.dk	Head of Education	https://kea.dk/slir/w200-c1x1/images/u…
4	Edith Terte	edan@kea.dk	Lecturer	https://media.licdn.com/dms/image/C4E0…
5	Frederikke Bender	fbe@kea.dk	Head of Education	https://kea.dk/slir/w200-c1x1/images/u…
6	Murat Kilic	mki@eaaa.dk	Senior Lecturer	https://www.eaaa.dk/media/llyavasj/mur…
7	Anne Kirketerp	anki@eaaa.dk	Head of Education	https://www.eaaa.dk/media/5buh1xeo/ann…

```
const users = [
    {
        id: 2,
        name: "Rasmus Cederdorff",
        mail: "race@dev.dk",
        title: "Senior Lecturer",
        image: "https://share.cederdorff.com/images/race.jpg"
    },
    {
        id: 3,
        name: "Lars Bogetoft",
        mail: "larb@eaaa.dk",
        title: "Head of Education",
        image: "https://kea.dk/slir/w200-c1x1/images/user-profile/chefer/larb.jpg"
    },
    {
        id: 4,
        name: "Edith Terte",
        mail: "edan@kea.dk",
        title: "Lecturer",
        image: "https://media.licdn.com/dms/image/C4E03AQE6nx7oUPqo_g/profile-displayphoto-shrink_800_800/
    },
    {
        id: 5,
        name: "Frederikke Bender",
        mail: "fbe@kea.dk",
        title: "Head of Education",
        image: "https://kea.dk/slir/w200-c1x1/images/user-profile/chefer/fbe.jpg"
    },
    {
        id: 6,
        name: "Murat Kilic",
        mail: "mki@eaaa.dk",
        title: "Senior Lecturer",
        image: "https://www.eaaa.dk/media/llyavasj/murat-kilic.jpg?width=800&height=450&rnd=133401946552600
    },
    {
        id: 7,
        name: "Anne Andersen",
        mail: "anki@mail.dk",
        title: "Head of Education",
        image: "https://www.eaaa.dk/media/5buh1xeo/anne-kirketerp.jpg?width=800&height=450&rnd=133403878321
    }
];
```

From database table to array of objects

Object Relational Mapping

ORM

- **Simplifies Database Interaction:** Allows using objects in code to interact with a relational database.
- **Maps Objects to Tables**: Links object-oriented language structures to relational database tables.
- **Abstraction Layer**: Abstracts database operations, reducing manual SQL coding.
- **Automates Queries**: Generates and executes SQL queries based on object interactions.
- **Saves Development Time**: Reduces the need for low-level database code, streamlining development.

Object Relational Mapping

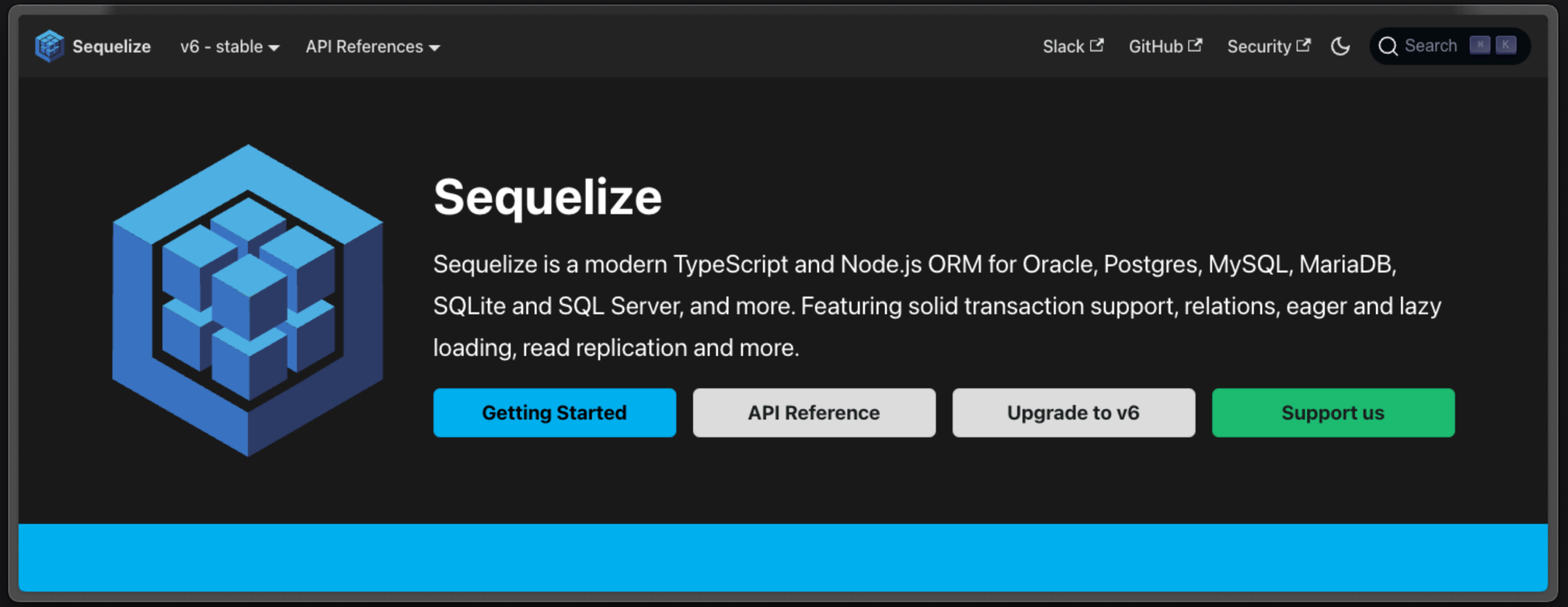
Pros

- **Simplifies the development of database applications:** ORMs can simplify the development of database applications by abstracting away database-specific details. This makes it easier for developers to focus on the business logic of their applications.
- **Increases productivity:** ORMs can increase productivity by automating repetitive tasks, such as creating and updating tables and columns. This can free up developers to focus on more complex tasks.
- **Improves maintainability:** ORMs can improve the maintainability of database applications by making it easier to change the database structure. This is because ORMs can generate code compatible with the new database structure.

Object Relational Mapping

Cons

- **May reduce performance:** ORMs can reduce the performance of database applications by introducing an extra layer between the application and the database. This is because ORMs need to convert data between the application's data model and the database's data model.
- **May make it harder to understand the database:** ORMs can make it harder to understand the database by abstracting away database-specific details. This is because developers need to understand how the ORM works to understand how the data is stored in the database.
- **May be difficult to learn:** ORMs can be difficult to learn, especially for developers who don't have experience with databases. This is because ORMs introduce a new paradigm for interacting with databases.


Sequelize
v6 - stable
API References
Slack
GitHub
Security
Search
Sequelize
Sequelize is a modern TypeScript and Node.js ORM for Oracle, Postgres, MySQL, MariaDB, SQLite and SQL Server, and more. Featuring solid transaction support, relations, eager and lazy loading, read replication and more.
Getting Started
API Reference
Upgrade to v6
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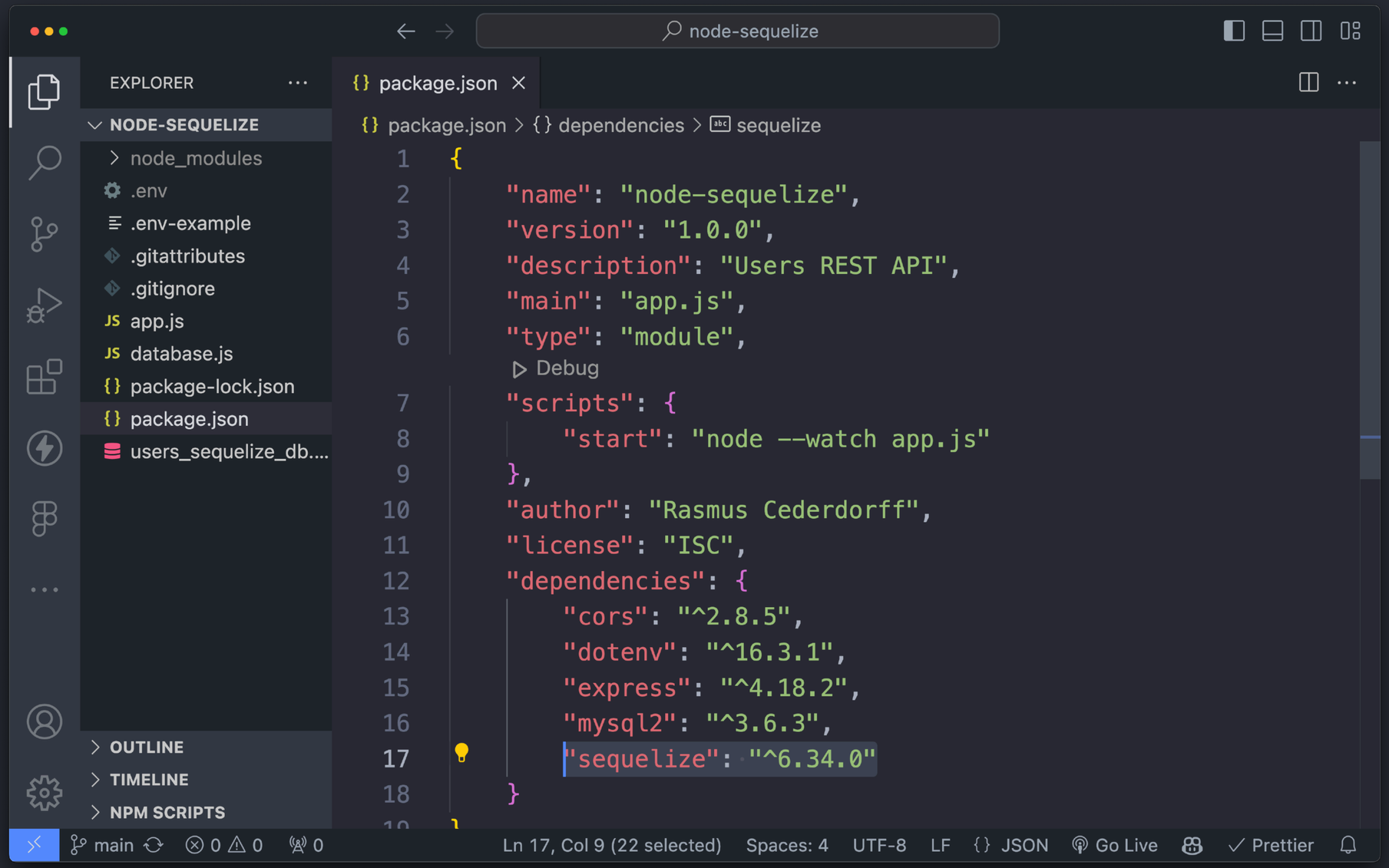
... npm package

Sequelize is a dependency (node module)



Define models to handle the DB interaction

```
// ========== Define Models ========== //
// Define user model
const User = sequelize.define("user", {
    // User model attributes
    name: {
        type: DataTypes.STRING,
        allowNull: false // Name is required
    },
    title: {
        type: DataTypes.STRING
    },
    mail: {
        type: DataTypes.STRING,
        allowNull: false // Email is required
    },
    image: {
        type: DataTypes.TEXT // URL to image
    }
});
```

```
// Sample users
// Sample user 1
const user1 = await User.create({
    name: "Rasmus Cederdorff",
    title: "Senior Lecturer",
    mail: "race@eaaa.dk",
    image: "https://share.cederdorff.com/images/race.jpg"
});

// Sample user 2
const user2 = await User.create({
    name: "Anne Kirketerp",
    title: "Head of Department",
    mail: "anki@eaaa.dk",
    image: "https://www.eaaa.dk/media/5buh1xeo/anne-kirketerp.jpg?wi
});

// Sample user 3
const user3 = await User.create({
    name: "Murat Kilic",
    title: "Senior Lecturer",
    mail: "mki@eaaa.dk",
    image: "https://www.eaaa.dk/media/llyavasj/murat-kilic.jpg?width=
});
```

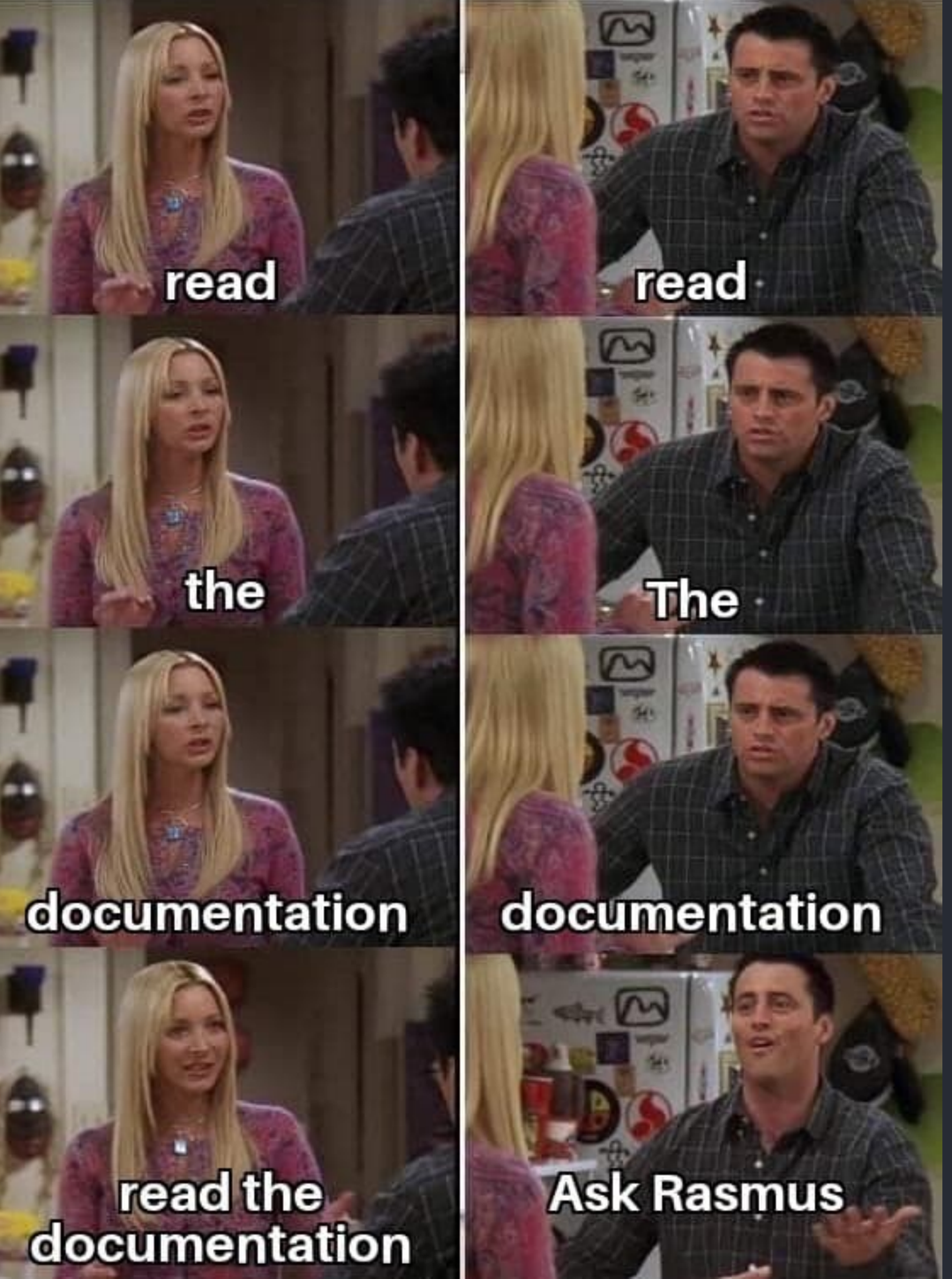
Creates users table with entities

```
// ========== Define Models ========== //
// Define user model
const User = sequelize.define("user", {
    // User model attributes
    name: {
        type: DataTypes.STRING,
        allowNull: false // Name is required
    },
    title: {
        type: DataTypes.STRING
    },
    mail: {
        type: DataTypes.STRING,
        allowNull: false // Email is required
    },
    image: {
        type: DataTypes.TEXT // URL to image
    }
});
```

id	name	title	mail	image	createdAt	updatedAt
1	Rasmus Ced…	Senior Lect…	race@eaaa.dk	https://share.cederdo…	2023-11-12 19:0…	2023-11-12 19:0…
2	Anne Kirke…	Head of Dep…	anki@eaaa.dk	https://www.eaaa.dk/m…	2023-11-12 19:0…	2023-11-12 19:0…
3	Murat Kilic	Senior Lect…	mki@eaaa.dk	https://www.eaaa.dk/m…	2023-11-12 19:0…	2023-11-12 19:0…

Methods (SQL Queries)

```
const users = await User.findAll(); // SELECT * FROM users;

const users = await User.findByPk(id); // SELECT * FROM users WHERE id = id;

const newUser = await User.create(user); // INSERT INTO users (name, title, mail, image) VAL

const [result] = await User.update(user, { where: { id: id } }); // UPDATE users SET name =

const result = await User.destroy({ where: { id: id } }); // DELETE FROM users WHERE id = id
```



Useful Methods (see the docs)

- Core Concepts of Sequelize: https://sequelize.org/docs/v6/category/core-concepts/
- Model Basics: https://sequelize.org/docs/v6/core-concepts/model-basics/
- Model Querying - Basics: https://sequelize.org/docs/v6/core-concepts/model-querying-basics/
- Model Querying - Finders: https://sequelize.org/docs/v6/core-concepts/model-querying-finders/
- Associations: https://sequelize.org/docs/v6/core-concepts/assocs/

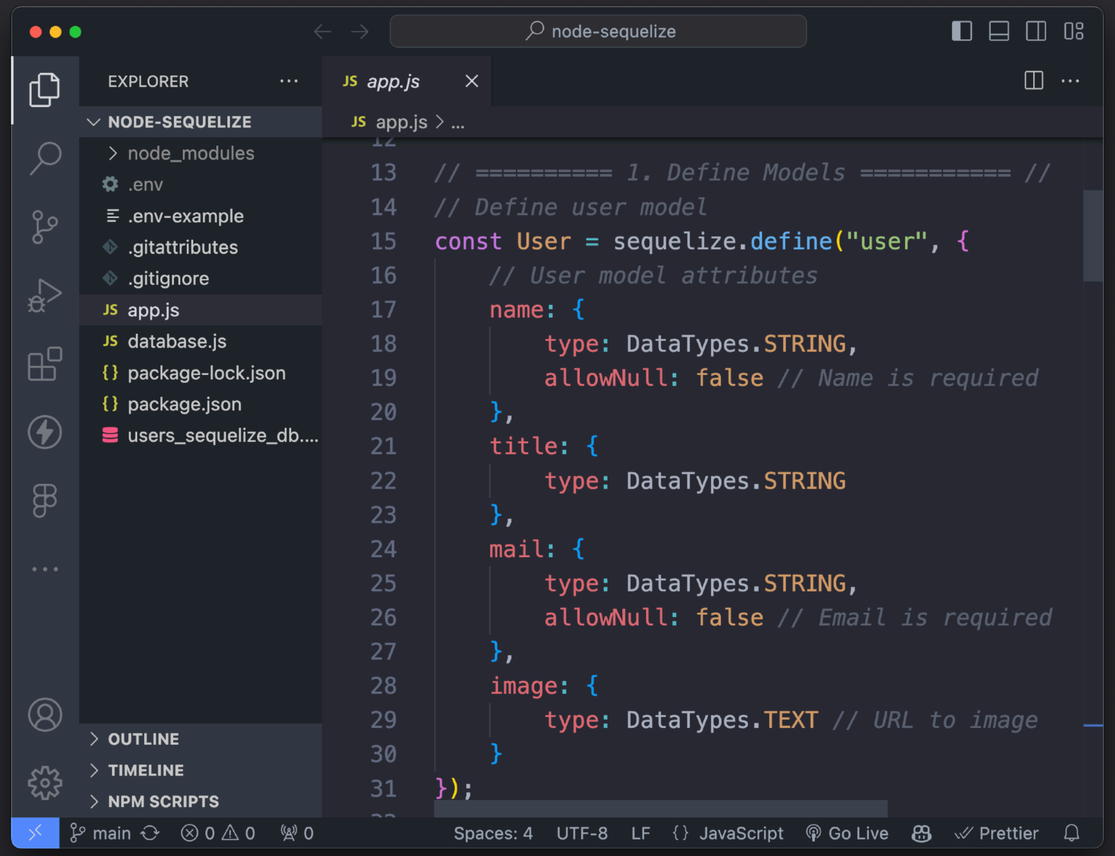
Routes: SQL vs Sequelize

```
// READ all users
app.get("/users", async (request, response) => {
    const query = "SELECT * FROM users"; // SQL query
    const [users] = await db.execute(query); // Execute the query
    response.json(users); // Send the results as JSON
});

// READ one user
app.get("/users/:id", async (request, response) => {
    const id = request.params.id; // grabs the id from the url
    const query = "SELECT * FROM users WHERE id=?;"; // sql query
    const values = [id]; // values to insert into query
    const [results] = await db.execute(query, values); // execute the query
    response.json(results[0]); // send response
});

// CREATE user
app.post("/users", async (request, response) => {
    const user = request.body; // grab the user from the request body
    const query = "INSERT INTO users(name, mail, title, image) values(?,?,?,?);"; /
    const values = [user.name, user.mail, user.title, user.image]; // values to ins
    const [result] = await db.execute(query, values); // execute the query
    response.json(result); // send response
});

// UPDATE user
app.put("/users/:id", async (request, response) => {
    const id = request.params.id; // grabs the id from the url
    const user = request.body; // grab the user from the request body
```

```
// READ all users
app.get("/users", async (request, response) => {
    const users = await User.findAll(); // SELECT * FROM users;
    response.json(users); // send the users as JSON
});

// READ one user by id
app.get("/users/:id", async (request, response) => {
    const id = request.params.id; // use id from url
    const users = await User.findByPk(id); // SELECT * FROM users WHERE id
    response.json(users); // send the users as JSON
});

// CREATE one user
app.post("/users", async (request, response) => {
    const user = request.body; // use request body as user object
    const newUser = await User.create(user); // INSERT INTO users (name, ti
    response.json(newUser); // send the new user as JSON
});

// UPDATE one user by id
app.put("/users/:id", async (request, response) => {
    const id = request.params.id; // use id from url
    const user = request.body; // use request body as user object
    const [result] = await User.update(user, { where: { id: id } }); // UPD
    if (result) {
        response.json({ message: "User updated" }); // send a success messa
    } else {
```

Øvelse

Node.js & Sequelize



Object Document Mapping

ODM

```
_id: ObjectId('70717a4759314d6e48596d33')
image: "https://www.eaaa.dk/media/14qpfeq4/line-skjodt.jpg?width=800&height=45…"
mail: "lskj@eaaa.dk"
name: "Line Skjødt"
title: "Senior Lecturer & Internship Coordinator"
```

```
_id: ObjectId('66547338344b526f59773570')
image: "https://share.cederdorff.com/images/race.jpg"
mail: "race@eaaa.dk"
name: "Rasmus Cederdorff"
title: "Senior Lecturer"
```

```
_id: ObjectId('666a70525452546a5a487772')
image: "https://www.baaa.dk/media/5buh1xeo/anne-kirketerp.jpg?anchor=center&mo…"
mail: "anki@eaaa.dk"
name: "Anne Kirketerp"
title: "Head of Department"
```

```
_id: ObjectId('486c76524872353843303567')
image: "https://www.eaaa.dk/media/bdojel41/dan-okkels-brendstrup.jpg?anchor=ce…"
mail: "dob@eaaa.dk"
name: "Dan Okkels Brendstrup"
title: "Lecturer"
```

```
const user = {
    _id: "666a70525452546a5a487772",
    image: "https://www.baaa.dk/media/5buh1xeo/anne-kirketerp.jpg?anchor=cen
    mail: "anki@eaaa.dk",
    name: "Anne Kirketerp",
    title: "Head of Department"
};
```

From document to object

Object Document Mapping

ODM

```
_id: ObjectId('70717a4759314d6e48596d33')
image: "https://www.eaaa.dk/media/14qpfeq4/line-skjodt.jpg?width=800&height=45…"
mail: "lskj@eaaa.dk"
name: "Line Skjødt"
title: "Senior Lecturer & Internship Coordinator"

_id: ObjectId('66547338344b526f59773570')
image: "https://share.cederdorff.com/images/race.jpg"
mail: "race@eaaa.dk"
name: "Rasmus Cederdorff"
title: "Senior Lecturer"

_id: ObjectId('666a70525452546a5a487772')
image: "https://www.baaa.dk/media/5buh1xeo/anne-kirketerp.jpg?anchor=center&mo…"
mail: "anki@eaaa.dk"
name: "Anne Kirketerp"
title: "Head of Department"

_id: ObjectId('486c76524872353843303567')
image: "https://www.eaaa.dk/media/bdojel41/dan-okkels-brendstrup.jpg?anchor=ce…"
mail: "dob@eaaa.dk"
name: "Dan Okkels Brendstrup"
title: "Lecturer"
```

```
const users = [
    {
        _id: "5a66505456454d514b663976",
        image: "https://www.baaa.dk/media/b5ahrlra/maria-louise-bendixen.jpg?anchor=center&
        mail: "mlbe@eaaa.dk",
        name: "Maria Louise Bendixen",
        title: "Senior Lecturer"
    },
    {
        _id: "66547338344b526f59773570",
        image: "https://share.cederdorff.com/images/race.jpg",
        mail: "race@eaaa.dk",
        name: "Rasmus Cederdorff",
        title: "Senior Lecturer"
    },
    {
        _id: "666a70525452546a5a487772",
        image: "https://www.baaa.dk/media/5buh1xeo/anne-kirketerp.jpg?anchor=center&mode=cr
        mail: "anki@eaaa.dk",
        name: "Anne Kirketerp",
        title: "Head of Department"
    },
    {
        _id: "70717a4759314d6e48596d33",
        image: "https://www.eaaa.dk/media/14qpfeq4/line-skjodt.jpg?width=800&height=450&rnd
        mail: "lskj@eaaa.dk",
        name: "Line Skjødt",
        title: "Senior Lecturer & Internship Coordinator"
    },
    {
        _id: "486c76524872353843303567",
        image: "https://www.eaaa.dk/media/bdojel41/dan-okkels-brendstrup.jpg?anchor=center&
        mail: "dob@eaaa.dk",
        name: "Dan Okkels Brendstrup",
        title: "Lecturer"
    }
];
```

From collection to array of objects

Mongoose: Schema, Model and Object

```
// ========== SCHEMAS & MODELS ========== //

const artistSchema = new mongoose.Schema({
    name: { type: String, required: true },
    genre: String,
    image: String,
    birthdate: { type: Date, default: Date.now },
    gender: String
});

const Artist = mongoose.model("Artist", artistSchema);
```

```
// ========== CREATE TEST DATA ========== //

const adele = new Artist({
    name: "Adele",
    genre: "Pop",
    image: "https://upload.wikimedia.org/wikipedia/commons/thu
    birthdate: new Date("1988-05-05"),
    gender: "Female"
});
await adele.save();

const beyonce = new Artist({
    name: "Beyoncé",
    genre: "Pop",
    image: "https://upload.wikimedia.org/wikipedia/commons/thu
    birthdate: new Date("1981-09-04"),
    gender: "Female"
});
await beyonce.save();
```

https://github.com/cederdorff/musicbase-mongodb/tree/mongoose

Mongoose: Schema, Model and Object

```
// ========== SCHEMAS & MODELS ========== //

const artistSchema = new mongoose.Schema({
    name: { type: String, required: true },
    genre: String,
    image: String,
    birthdate: { type: Date, default: Date.now },
    gender: String
});

const Artist = mongoose.model("Artist", artistSchema);
```

```
// GET Endpoint "/artists" - get all artists
app.get("/artists", async (request, response) => {
    const artists = await Artist.find();
    response.json(artists);
});

// GET Endpoint "/artists/:id" - get one artist
app.get("/artists/:id", async (request, response) => {
    const artist = await Artist.findById(request.params.id);
    response.json(artist);
});

// POST Endpoint "/artists" - create one artist
app.post("/artists", async (request, response) => {
    const artist = new Artist(request.body);
    const result = await artist.save();
    response.json(result);
});

// PUT Endpoint "/artists/:id" - update one artist
app.put("/artists/:id", async (request, response) => {
    const artist = await Artist.findById(request.params.id);
    artist.set(request.body);
    const result = await artist.save();
    response.json(result);
});

// DELETE Endpoint "/artists/:id" - delete one artist
app.delete("/artists/:id", async (request, response) => {
    const result = await Artist.deleteOne({ _id: request.params.id });
    response.json(result);
});
```

https://github.com/cederdorff/musicbase-mongodb/tree/mongoose

Object Document Mapping

ODM

Object document mapping (ODM) is a software design pattern that maps objects in an object-oriented programming language to documents in a document-oriented database. This pattern allows developers to store and retrieve data in a way that is both flexible and efficient.

Key features:

- **Flexibility:** ODM allows developers to define their data structures, which can be tailored to the specific needs of their application. This is in contrast to relational databases, which have a fixed schema that can be limiting.
- **Efficiency:** ODM can improve the performance of data access by eliminating the need to join tables. In object-oriented languages, objects are naturally related to each other, and ODM can leverage these relationships to efficiently retrieve and store data.
- **Reusability:** ODM can be used to create reusable components that can be shared across multiple applications. This can save developers time and effort, and it can also improve the overall maintainability of their code.

Object Document Mapping

Pros

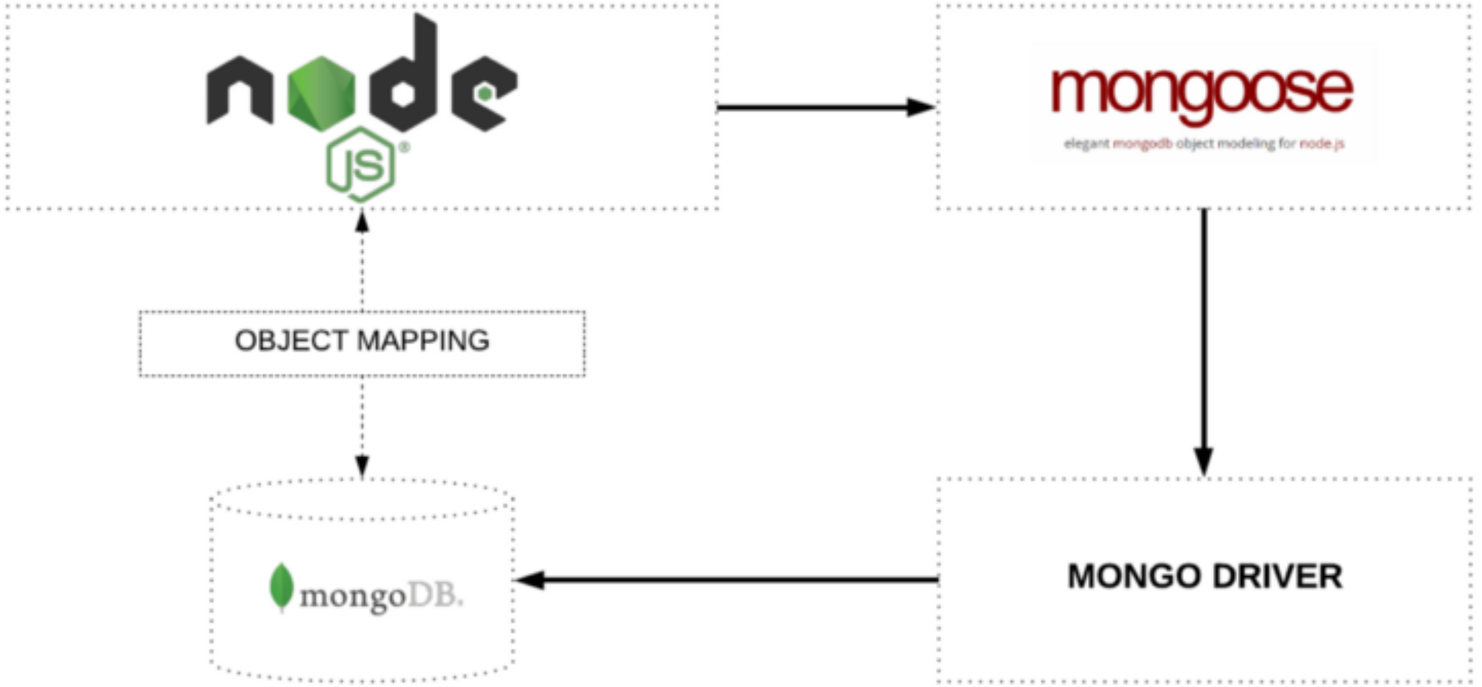
- **Flexibility**: ODM allows developers to define their own data structures, which can be tailored to the specific needs of their application. This is in contrast to relational databases, which have a fixed schema that can be limiting.
- **Efficiency**: ODM can improve the performance of data access by eliminating the need to join tables. In object-oriented languages, objects are naturally related to each other, and ODM can leverage these relationships to efficiently retrieve and store data.
- **Reusability**: ODM can be used to create reusable components that can be shared across multiple applications. This can save developers time and effort, and it can also improve the overall maintainability of their code.
- **Ease of use**: ODM can make it easier for developers to learn and use document-oriented databases. This is because ODM provides a high-level abstraction that hides the complexity of the underlying database.
- **No need for SQL**: ODM (and NoSQL) can eliminate the need for developers to write SQL queries. This can be a significant benefit for developers who are not familiar with SQL.

Object Document Mapping

Cons

- **Performance overhead:** ODM can introduce some performance overhead compared to directly writing SQL queries. This is because ODM must translate object-oriented data structures into the format that the database understands.
- **Potential for data integrity issues:** ODM can make it more difficult to enforce data integrity rules. This is because ODM is not as strict as SQL about data types and relationships.
- **Complexity:** ODM can add some complexity to the development process. This is because developers must learn how to use the ODM API and how to map object-oriented data structures to the database.
- **Lack of standardization:** There is no single standard for ODM, which can make it difficult to choose an ODM and to move between ODMs.

elegant mongodb object modeling for node.js



https://www.freecodecamp.org/news/introduction-to-mongoose-for-mongodb-d2a7aa593c57/

Mongoose

ODM for MongoDB

Mongoose is an ODM (object document mapper) for MongoDB. It is a popular and widely used ODM that provides a high-level abstraction layer on top of MongoDB, making it easier for developers to work with document-oriented data. Mongoose provides several features that make it a powerful tool for developing applications with MongoDB, including:

- **Object modelling:** Mongoose provides a schema-based approach to modelling data, allowing developers to define their data structures in an object-oriented way. This makes it easier to work with data in a way that is familiar to developers who are accustomed to working with object-oriented programming languages.
- **Data validation:** Mongoose provides built-in data validation features that can help to ensure that data is always in a consistent and valid state. This can help to prevent errors and improve the overall reliability of applications.
- **Query building:** Mongoose provides a fluent query builder that makes it easy to construct complex queries to retrieve and manipulate data. This can help to reduce the amount of code that developers need to write and improve the overall clarity of their code.
- **Relationship management:** Mongoose provides built-in support for managing relationships between documents, which can help to model complex data structures and improve the efficiency of data access.

Is MongoDB (client) an ORM?

View other drafts

PaLM2

No, MongoDB is a NoSQL database management system (DBMS) that stores data in documents, which are JSON-like objects. It is not an ODM itself, but it supports ODMs like Mongoose. ODMs provide a higher-level abstraction layer on top of MongoDB, making it easier for developers to work with document-oriented data.

Here's a table summarizing the difference between MongoDB and ODMs:

Feature	MongoDB	ODM
Type	NoSQL database	Object document mapper
Purpose	Stores data in documents	Manages data access and relationships in MongoDB
Functionality	Stores, retrieves, and manages data	Provides abstraction layer for developers
Popularity	Widely used, but requires some SQL knowledge	Less common, but easier for developers to use

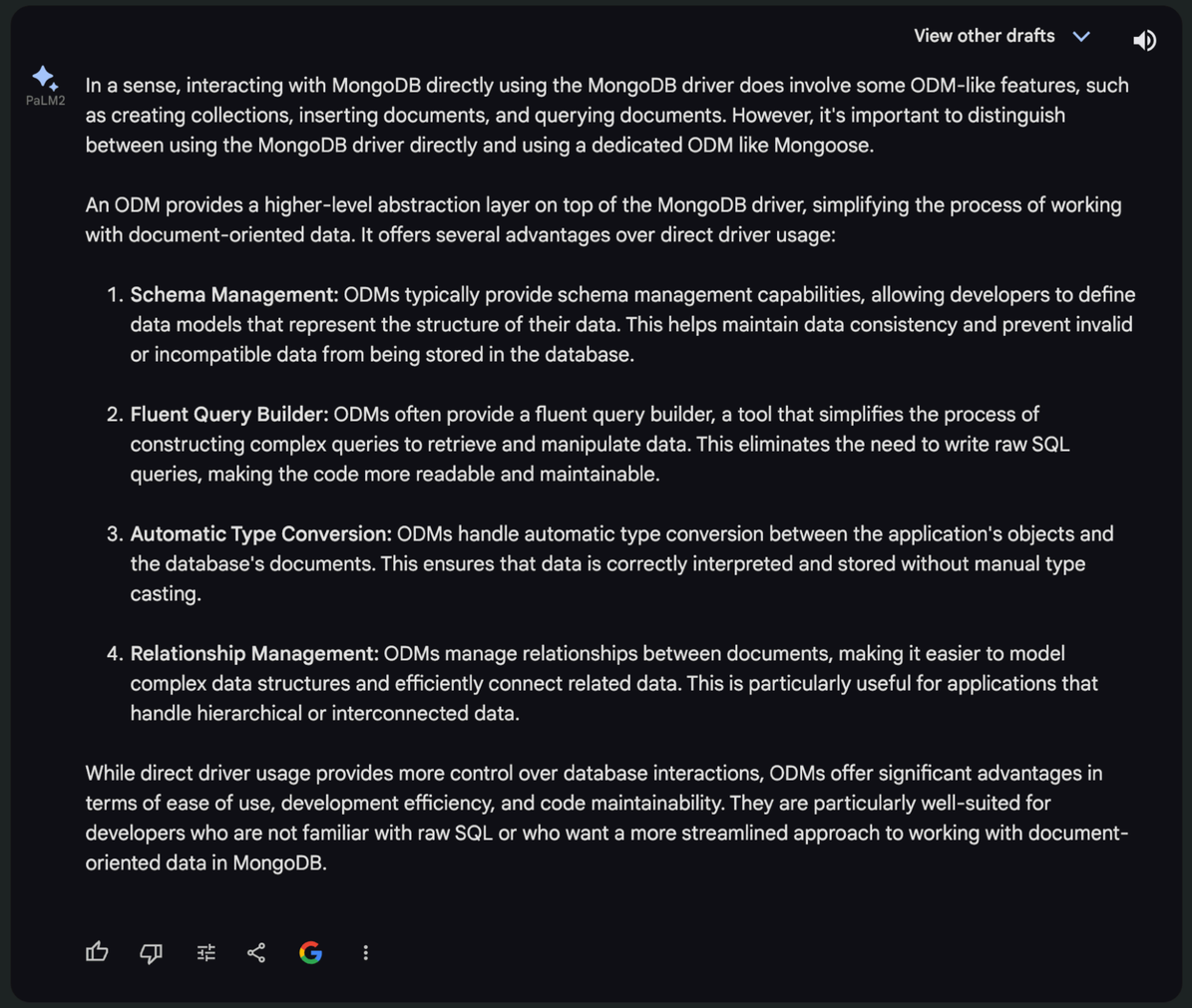
Export to Sheets

In summary, MongoDB is the underlying database that stores data, while ODMs are libraries that simplify working with that data. ODMs are particularly useful for developers who are not familiar with SQL or who want to focus on application logic instead of database interactions.

```
const collection = database.collection("myCollection");

const document = { name: "John Doe", age: 30 };

await collection.insertOne(document);
```

https://g.co/bard/share/66bd5b2397b0

Well, what's the difference?



https://g.co/bard/share/27290e7ec30d

Well, what's the difference?

Feature	Directly Using MongoDB Driver	Using an ODM
Schema management	Manual definition using JSON documents	Built-in schema management using data models
Query building	Constructing SQL queries manually	Using a fluent query builder for more concise and readable queries
Type conversion	Manual type casting required	Automatic type conversion between application objects and database documents
Relationship management	Managing relationships manually	Automating relationship management for complex data structures
Ease of use	More complex and requires manual coding	Easier to use and more developer-friendly
Development efficiency	Less efficient for complex data handling	More efficient for rapid development and code maintainability

Export to Sheets

```
// Create a Mongoose schema for the "artists" collection
const artistSchema = new mongoose.Schema({
    name: {
        type: String,
        required: [true, "Name of the artist is required and must be a string"],
        minlength: [1, "Name must be at least 1 character long"],
        maxlength: [255, "Name cannot exceed 255 characters"]
    },
    genre: {
        type: String,
        required: [true, "Genre of the artist is required and must be a string"],
        enum: {
            values: ["Pop", "Rock", "Hip-Hop", "Country", "Other"],
            message: "Invalid genre. Must be one of: Pop, Rock, Hip-Hop, Country, Other"
        }
    },
    image: {
        type: String,
        required: [true, "Image of the artist is required and must be a string"],
        minlength: [4, "Image must be at least 4 character long"]
    },
    birthdate: {
        type: Date,
        required: [true, "Birthdate of the artist is required and must be a date"]
    },
    gender: {
        type: String,
        required: [true, "Gender of the artist is required and must be a string"],
        enum: {
            values: ["Male", "Female", "Non-Binary", "Other"],
            message: "Invalid gender. Must be one of: Male, Female, Non-Binary, Other"
        }
    }
});

const Artist = mongoose.model("Artist", artistSchema);
```

https://g.co/bard/share/822c562bab0e

MongoDB versus Mongoose

```
// GET Endpoint "/artists" - get all artists
app.get("/artists", async (request, response) => {
    const artistsCollection = db.collection("artists");
    const artists = await artistsCollection.find().toArray(); // Use toArray() to retrieve documents as an array
    response.json(artists);
});

// GET Endpoint "/artists/:id" - get one artist
app.get("/artists/:id", async (request, response) => {
    const id = request.params.id;
    const artistsCollection = db.collection("artists");
    const artists = await artistsCollection.findOne({
        _id: new ObjectId(id)
    });
    response.json(artists);
});

// POST Endpoint "/artists" - create one artist
app.post("/artists", async (request, response) => {
    const artist = request.body;
    const result = await db.collection("artists").insertOne(artist);
    response.json(result);
});

// PUT Endpoint "/artists/:id" - update one artist
app.put("/artists/:id", async (request, response) => {
    const id = request.params.id;
    const artist = request.body;
    const result = await db.collection("artists").updateOne({ _id: new ObjectId(id) }, { $set: artist });
    response.json(result);
});

// DELETE Endpoint "/artists/:id" - delete one artist
app.delete("/artists/:id", async (request, response) => {
    const id = request.params.id;
    const result = await db.collection("artists").deleteOne({ _id: new ObjectId(id) });
    response.json(result);
});
```

https://github.com/cederdorff/musicbase-mongodb/tree/mongodb-schema-validation

```
// GET Endpoint "/artists" - get all artists
app.get("/artists", async (request, response) => {
    const artists = await Artist.find();
    response.json(artists);
});

// GET Endpoint "/artists/:id" - get one artist
app.get("/artists/:id", async (request, response) => {
    const artist = await Artist.findById(request.params.id);
    response.json(artist);
});

// POST Endpoint "/artists" - create one artist
app.post("/artists", async (request, response) => {
    const artist = new Artist(request.body);
    const result = await artist.save();
    response.json(result);
});

// PUT Endpoint "/artists/:id" - update one artist
app.put("/artists/:id", async (request, response) => {
    const artist = await Artist.findById(request.params.id);
    artist.set(request.body);
    const result = await artist.save();
    response.json(result);
});

app.delete("/artists/:id", async (request, response) => {
    const result = await Artist.deleteOne({ _id: request.params.id });
    response.json(result);
});
```

https://github.com/cederdorff/musicbase-mongodb/tree/mongoose-schema-validation

MongoDB: JSON Schema Validation

- Schema validation in MongoDB refers to the process of ensuring that documents stored in collections adhere to a predefined schema.
- This ensures data consistency and prevents invalid or incompatible data from being inserted into the database.
- JSON Schema is a standard for defining the structure of JSON documents. It defines properties, their data types, and validation rules for each property.
- By defining a JSON Schema for a collection, developers can enforce data consistency and prevent invalid or incompatible documents from being inserted.

```
await db.createCollection("artists", {
    validator: {
        $jsonSchema: {
            bsonType: "object",
            required: ["name", "genre", "image", "birthdate", "gender"],
            properties: {
                name: {
                    bsonType: "string",
                    description: "Name of the artist is required and must be a string",
                    minLength: 1,
                    maxLength: 255
                },
                genre: {
                    bsonType: "string",
                    description: "Genre of the artist is required and must be a string",
                    enum: ["Pop", "Rock", "Hip-Hop", "Country", "Other"]
                },
                image: {
                    bsonType: "string",
                    description: "Image of the artist is required and must be a string",
                    pattern: "^https?://[a-zA-Z0-9-._~:/?#[\\]@!$&'()*+,;=]+$"
                },
                birthdate: {
                    bsonType: "date",
                    description: "Birthdate of the artist is required and must be a date"
                },
                gender: {
                    bsonType: "string",
                    description: "Gender of the artist is required and must be a string",
                    enum: ["Male", "Female", "Non-Binary", "Other"]
                }
            }
        }
    }
});
```

https://github.com/cederdorff/musicbase-mongodb/tree/mongodb-schema-validation

MongoDB: JSON Schema Validation

Required Properties:

- `name`: A string representing the artist's name, with a minimum length of 1 character and a maximum length of 255 characters.
- `genre`: A string representing the artist's genre, from the specified list of options: "Pop", "Rock", "Hip-Hop", "Country", or "Other".
- `image`: A URL string representing the artist's image. The URL must follow the pattern of a valid URL, starting with "https://" or "http://".
- `birthdate`: A date string representing the artist's birthdate.
- `gender`: A string representing the artist's gender, from the specified list of options: "Male", "Female", "Non-Binary", or "Other".

```
await db.createCollection("artists", {
    validator: {
        $jsonSchema: {
            bsonType: "object",
            required: ["name", "genre", "image", "birthdate", "gender"],
            properties: {
                name: {
                    bsonType: "string",
                    description: "Name of the artist is required and must be a string",
                    minLength: 1,
                    maxLength: 255
                },
                genre: {
                    bsonType: "string",
                    description: "Genre of the artist is required and must be a string",
                    enum: ["Pop", "Rock", "Hip-Hop", "Country", "Other"]
                },
                image: {
                    bsonType: "string",
                    description: "Image of the artist is required and must be a string",
                    pattern: "^https?://[a-zA-Z0-9-._~:/?#[\\]@!$&'()*+,;=]+$"
                },
                birthdate: {
                    bsonType: "date",
                    description: "Birthdate of the artist is required and must be a date"
                },
                gender: {
                    bsonType: "string",
                    description: "Gender of the artist is required and must be a string",
                    enum: ["Male", "Female", "Non-Binary", "Other"]
                }
            }
        }
    }
});
```

https://github.com/cederdorff/musicbase-mongodb/tree/mongodb-schema-validation

Mongoose Schema Validation

- Using ODMs: Object document mappers (ODMs) like Mongoose provide built-in schema validation capabilities.
- ODMs allow developers to define data models that represent the structure of their data, and they automatically validate documents against these models before inserting them into the database.

```
// ========== SCHEMAS & MODELS ========== //

// Create a Mongoose schema for the "artists" collection
const artistSchema = new mongoose.Schema({
    name: {
        type: String,
        required: [true, "Name of the artist is required and must be a string"],
        minlength: [1, "Name must be at least 1 character long"],
        maxlength: [255, "Name cannot exceed 255 characters"]
    },
    genre: {
        type: String,
        required: [true, "Genre of the artist is required and must be a string"],
        enum: {
            values: ["Pop", "Rock", "Hip-Hop", "Country", "Other"],
            message: "Invalid genre. Must be one of: Pop, Rock, Hip-Hop, Country, Other"
        }
    },
    image: {
        type: String,
        required: [true, "Image of the artist is required and must be a string"],
        minlength: [4, "Image must be at least 4 character long"]
    },
    birthdate: {
        type: Date,
        required: [true, "Birthdate of the artist is required and must be a date"]
    },
    gender: {
        type: String,
        required: [true, "Gender of the artist is required and must be a string"],
        enum: {
            values: ["Male", "Female", "Non-Binary", "Other"],
            message: "Invalid gender. Must be one of: Male, Female, Non-Binary, Other"
        }
    }
});

const Artist = mongoose.model("Artist", artistSchema);
```

https://github.com/cederdorff/musicbase-mongodb/tree/mongoose-schema-validation

Mongoose Schema Validation

Similar to the JSON Schema definition, the Mongoose code defines the required and optional properties for an artist document, along with their data types and validation rules.

Required Properties:

- `name`: A string representing the artist's name, ensuring it is not null or an empty string.
- `genre`: A string representing the artist's genre, ensuring it is not null or an empty string and belongs to the specified list of options: "Pop", "Rock", "Hip-Hop", "Country", or "Other".
- `image`: A string representing the artist's image URL, ensuring it is not null or an empty string and has a minimum length of 4 characters.
- `birthdate`: A date representing the artist's birthdate, ensuring it is not null or an empty string and follows the date format expected by MongoDB.
- `gender`: A string representing the artist's gender, ensuring it is not null or an empty string and belongs to the specified list of options: "Male", "Female", "Non-Binary", or "Other".

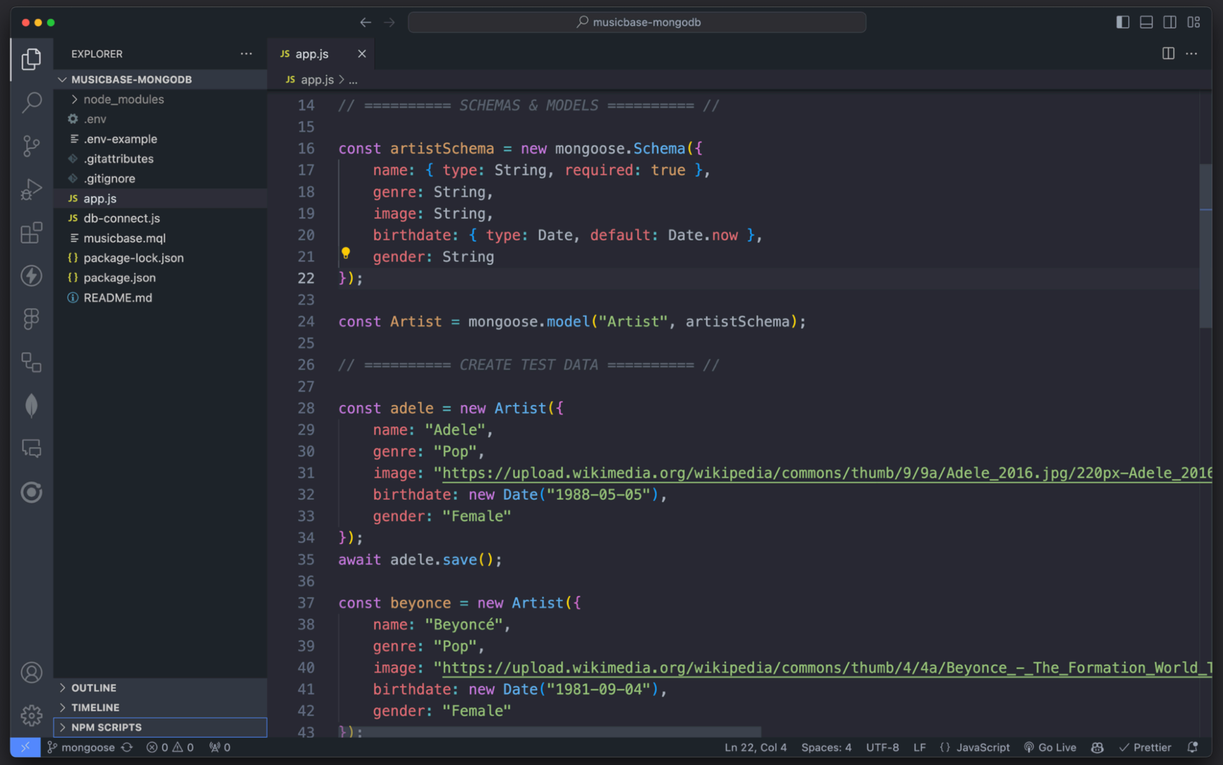
By defining the schema using Mongoose, developers can create, update, and retrieve artist documents with confidence, knowing that they adhere to the specified validation rules. This helps maintain data integrity and ensures that only valid and consistent artist data is stored in the database.

```
// ========== SCHEMAS & MODELS ========== //

// Create a Mongoose schema for the "artists" collection
const artistSchema = new mongoose.Schema({
    name: {
        type: String,
        required: [true, "Name of the artist is required and must be a string"],
        minlength: [1, "Name must be at least 1 character long"],
        maxlength: [255, "Name cannot exceed 255 characters"]
    },
    genre: {
        type: String,
        required: [true, "Genre of the artist is required and must be a string"],
        enum: {
            values: ["Pop", "Rock", "Hip-Hop", "Country", "Other"],
            message: "Invalid genre. Must be one of: Pop, Rock, Hip-Hop, Country, Other"
        }
    },
    image: {
        type: String,
        required: [true, "Image of the artist is required and must be a string"],
        minlength: [4, "Image must be at least 4 character long"]
    },
    birthdate: {
        type: Date,
        required: [true, "Birthdate of the artist is required and must be a date"]
    },
    gender: {
        type: String,
        required: [true, "Gender of the artist is required and must be a string"],
        enum: {
            values: ["Male", "Female", "Non-Binary", "Other"],
            message: "Invalid gender. Must be one of: Male, Female, Non-Binary, Other"
        }
    }
});

const Artist = mongoose.model("Artist", artistSchema);
```

https://github.com/cederdorff/musicbase-mongodb/tree/mongoose-schema-validation

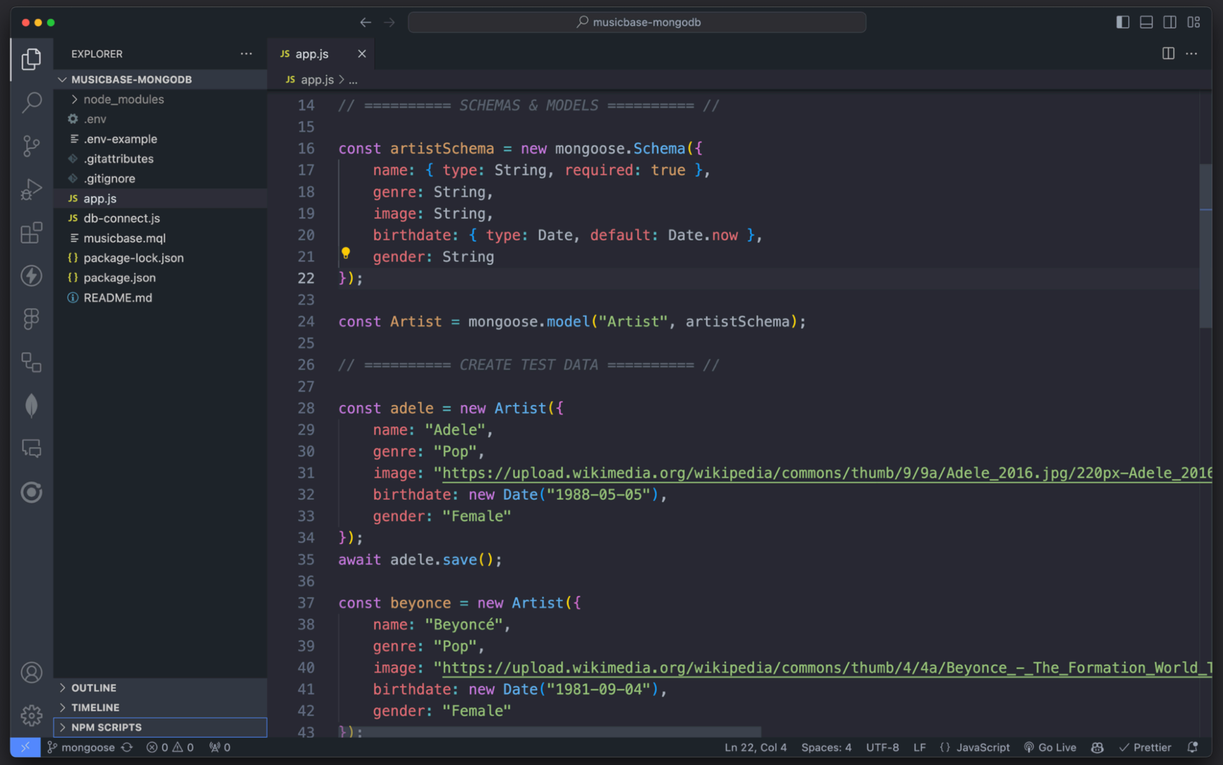
Øvelse

Node.js, MongoDB og Mongoose



Øvelse

MongoDB Musicbase

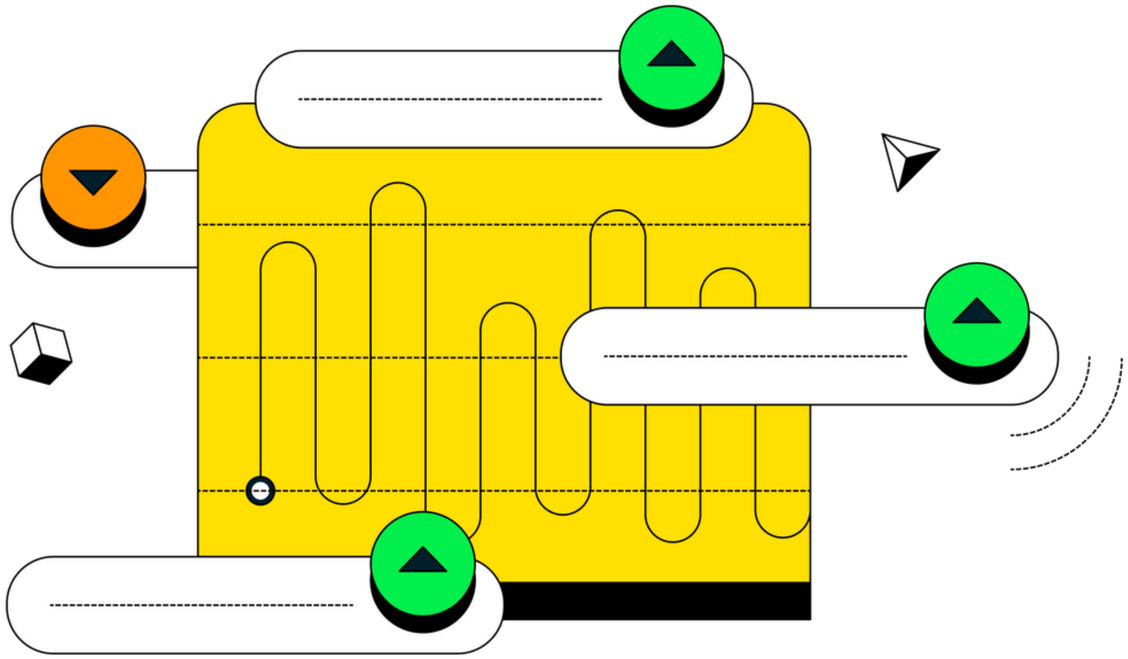


Indexes and search

What is an Index in MongoDB?

Indexes hold a small portion of the collection's data in a form that's easy to traverse. They are used to:

- Speed up queries and updates
- Avoid disk I/O as queries eliminating the need for slow collection scans
- Reduce overall computation



Search Index

https://www.mongodb.com/basics/search-index

Index - example

- This code creates an index on the uid field in the posts collection.
- An index is a data structure that improves the performance of queries that filter or sort based on the indexed field. In this case, the index will improve the performance of queries that filter posts based on the user ID.
- The query `db.posts.find({uid: ObjectId("ZfPTVEMQKf9v")})` will be much faster if there is an index on the uid field, as MongoDB can directly identify the documents associated with the specified user ID. This is in contrast to a scenario where there is no index on the uid field, where MongoDB would have to scan the entire collection to locate the matching documents.

```
db.posts.insertMany(
[
    {
      caption: "A beautiful morning in Aarhus",
      createdAt: new Date("2023-04-06T09:10:54Z"),
      image: "https://images.unsplash.com/photo-1573997953524-ef
      uid: ObjectId("HlvRHr58C05g")
    },
    {
      caption: "Rainbow reflections of the city of Aarhus",
      createdAt: new Date("2023-04-02T20:25:34Z"),
      image: "https://images.unsplash.com/photo-1558443336-dbb3c
      uid: ObjectId("fjpRTRTjZHwr")
    }
  ]
)

 // create index
db.posts.createIndex({ uid: 1 });
// posts with specific user
db.posts.find({uid: ObjectId("ZfPTVEMQKf9v")})
```

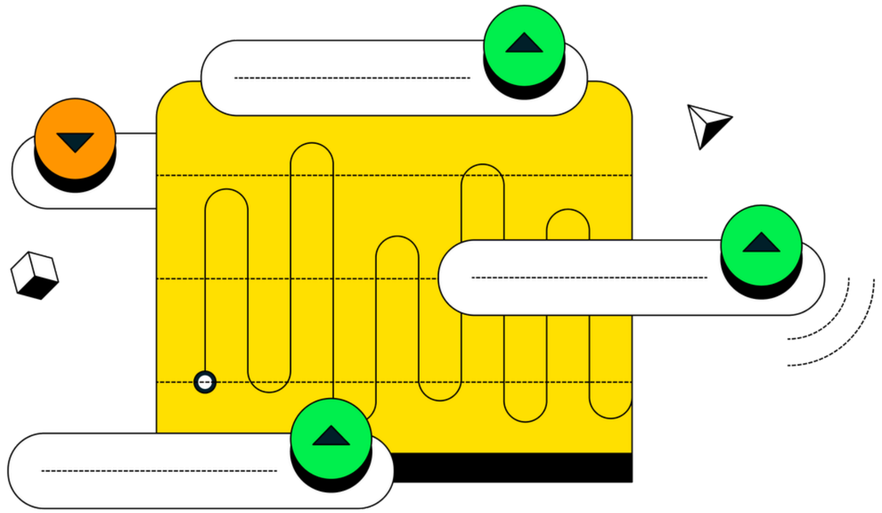
MQL Script: Posts and users

When to Use Indexes

Developers should use an index when querying data in a collection, especially for frequently run queries.

When determining if an index should be used, consider:

- Four indexes is a good rule of thumb for the ideal number for a given collection.
- Sixty-four indexes are the maximum per collection, however, above 20 and performances renders the system almost unusable for workloads.



Considerations When Using Indexes

Indexes require RAM.

Avoid unnecessary indexes at all cost, otherwise the write. performance will suffer. Each index adds 10% overhead.

When does an index entry get modified?

- Data is inserted (applies to all indexes).
- Data is deleted (applies to all indexes).
- Data is updated in such a way that its indexed field changes.

Types of Indexes Available

Most common indexes:

- Single Field
- Compound Index

Other types of specialized indexes including:

- Multikey Index
- Geospatial Index
- Text Index
- Hashed Index
- Time-To-Live (TTL) Index
- Hidden Index
- Partial Index
- Wildcard Index

Eksamensbeskrivelse

Introduktion

I denne eksamensopgave skal du udvikle en databaseapplikation (serverapplikation), der kan handtere en større mængde data. Applikationen skal kunne udføre CRUD-operationer (Create, Read, Update, Delete) på dataene og muliggøre søgning baseret på forskellige kriterier.

Løsning skal bestå af

1. en database (MySQL eller MongoDB) efter eget valg, og
2. en serverapplikation implementeret med Node.js eller Python, der interagerer med databasen.

Disposition

Du skal udarbejde en disposition, der beskriver den teoretiske baggrund for applikationen.

Dispositionen ***kan*** fx indeholde følgende elementer:

- Introduktion til databaser og deres anvendelse
- Argumentation for valgt database og valgte teknologier samt deres fordele og ulemper
- Databasearkitektur og databasemodel samt deres fordele og ulemper
- Designmønstre og deres fordele og ulemper
- Databaseklientapp og hvordan den interagerer med database
- Beskrivelse og argumentation for anvendelse af forskellige databasetyper
- Performanceoptimering i valgt database og evt sammenligning til anden type

Mundtlig eksamen

Den mundtlige eksamen har i alt en varighed pa 30 minutter og består af :

- et mundtligt oplæg (maks 10 min)
- eksaminationssamtale (15 min)
- votering og tilbagemelding af karakter (5 min)

Dit mundtlige oplæg skal inkludere en demonstration af din løsning. Eksaminationssamtalen vil tage udgangspunkt i dispositionen og det praktiske produkt. Der er intern censur ved den mundtlige prøve.

Den mundtlige eksamen afholdes d. 19. december 2023. Eksamensplan følger.

Bedømmelse

Bedømmelsen vil tage udgangspunkt i en samlet helhedsvurdering af det praktiske produkt, dispositionen og den mundtlige præstation. Der gives en samlet karakter efter 7-trinsskalaen.

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Code Every Day