Lab 3: Connecting to The Database

This lab will cover the following points:

- Using databases with GraphQL
- Using Sequelize in Node.js
- Writing database models
- Performing database migrations with Sequelize
- Seeding data with Sequelize
- Using Apollo together with Sequelize

In this course, we will use SQL via Sequelize in order to see this feature in a real-world use case. For future purposes, it will also help you to handle problems with existing SQL-based systems.

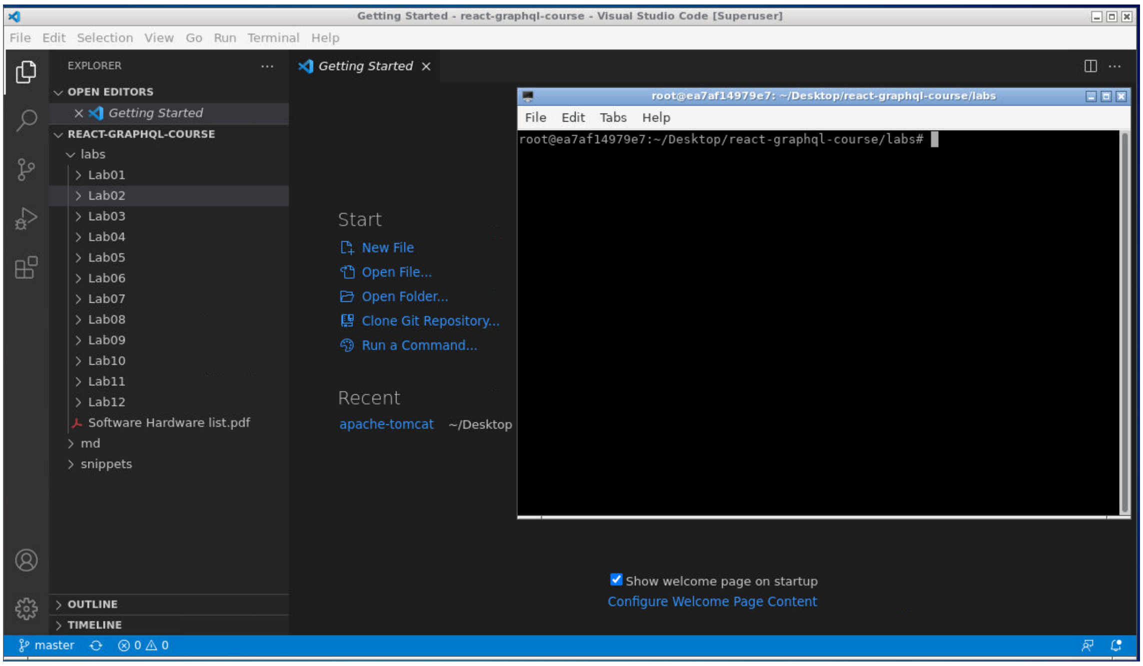
Lab Solution

Complete solution for this lab is available in the following directory:

`cd ~/Desktop/react-graphql-course/labs/Lab03`

Run following command to install all required packages:

`npm install`



Running Solution

Database needs to be setup first as mentioned in next steps before running the application.

Run following commands to run application:

`npm run client:build`

`npm run server`

MySQL and phpMyAdmin

MySQL is already installed and running. Execute the following steps to get MySQL running:

1. Verify that mysql server is running:

```
service mysql status
```

2. We must create a separate user for development, aside from the root and phpMyAdmin user. It is discouraged to use the root user at all. Log in to our MySQL Server with the root user in order to accomplish this:

```
mysql -u root
```

6. Now, run the following SQL command. You can replace the [PASSWORD] string with the password that you want. It is the password that you will use for the database connection in your application, but also when logging in to phpMyAdmin. This command creates a user called [devuser], with root privileges that are acceptable for local development:

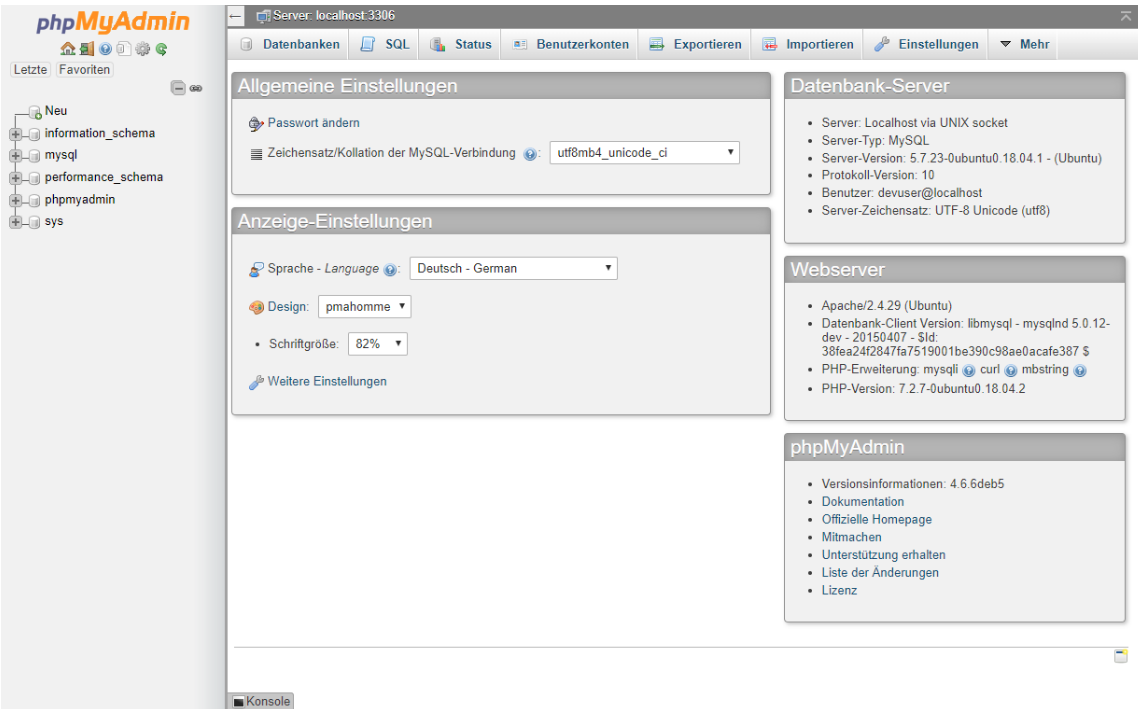
```
CREATE USER 'devuser'@'%' IDENTIFIED BY 'PASSWORD';

GRANT ALL PRIVILEGES ON *.* TO 'devuser'@'%';

FLUSH PRIVILEGES;

ALTER USER 'devuser'@'%' IDENTIFIED WITH mysql_native_password BY 'PASSWORD';
```

phpMyAdmin

1. Verify that apache server is running:

```
service apache2 status
```

We can now visit phpMyAdmin under [http://localhost:81/phpmyadmin] and log in with the newly created user. It should look like the following screenshot:



Creating a database in MySQL

Before we begin with the implementation of our back end, we need to add a new database that we can use.

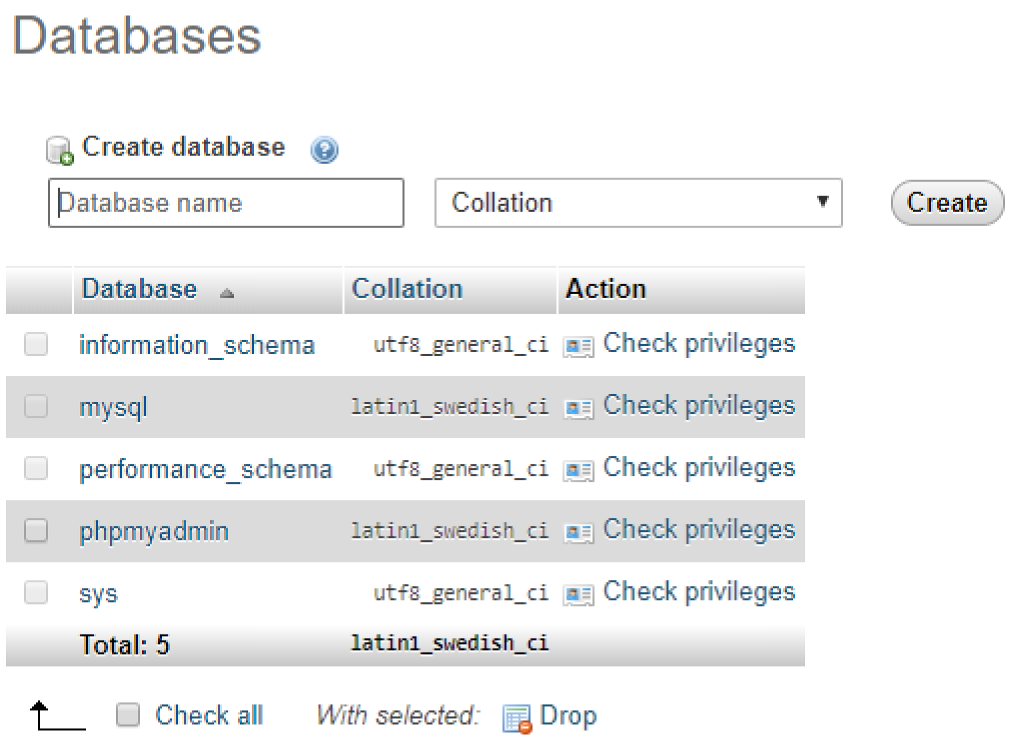
You are free to do this via the command line or phpMyAdmin. As we have just installed phpMyAdmin, we are going to use it, of course.

You can run raw SQL commands in the [SQL] tab of phpMyAdmin. The corresponding command to create a new database looks as follows:

```
CREATE DATABASE graphbook_dev CHARACTER SET utf8 COLLATE utf8_general_ci;
```

Otherwise, you can follow the next steps to use the graphical method. In the left-hand panel, click on the [New] button.

You will be presented with a screen like the following. It shows all databases including their collation of your MySQL server:



Enter a database name, such as [graphbook_dev], and then choose the [uft8_general_ci] collation. After doing so, click on [Create].

You will see a page that says, [No tables found in database], which is correct (for now). This will change later, when we have implemented our database models, such as posts and users.

Integrating Sequelize into our stack

Sequelize is an ORM for Node.js. It supports the PostgreSQL, MySQL, SQLite, and MSSQL standards.

Install Sequelize in your project via [npm]. We will also install a second package, called [mysql2]:

```
npm install --save sequelize mysql2
```

The `mysql2` package allows Sequelize to speak with our MySQL server. Sequelize is just a wrapper around the various libraries for the different database systems.

Let's start by setting Sequelize up in our backend.

Connecting to a database with Sequelize

The first step is to initialize the connection from Sequelize to our MySQL server. To do this, we will create a new folder and file, as follows:

```
mkdir src/server/database
touch src/server/database/index.js
```

Inside of the `index.js` database, we will establish a connection to our database with Sequelize. Internally, Sequelize relies on the [mysql2] package, but we do not use it on our own, which is very convenient:

```
import Sequelize from 'sequelize';

const sequelize = new Sequelize('graphbook_dev', 'devuser', 'PASSWORD', {
 host: 'localhost',
  dialect: 'mysql',
  operatorsAliases: false,
  pool: {
    max: 5,
    min: 0,
    acquire: 30000,
    idle: 10000,
  },
});

export default sequelize;
```

As you can see, we require Sequelize from the [node_modules], and then create an instance of it.

Using a configuration file with Sequelize

The previous setup for our database connection with Sequelize is fine, but it is not made for later deployment. The best option is to have a separate configuration file that is read and used according to the environment that the server is running in.

For this, create a new `index.js` file inside a separate folder (called [config]), next to the [database] folder:

```
mkdir src/server/config
touch src/server/config/index.js
```

Your sample configuration should look like the following code, if you have followed the instructions for creating a MySQL database. The only thing that we did here was to copy our current configuration into a new object indexed with the [development] or [production] environment:

```
module.exports = {
  "development": {
    "username": "devuser",
    "password": "PASSWORD",
    "database": "graphbook_dev",
    "host": "localhost",
    "dialect": "mysql",
    "operatorsAliases": false,
    "pool": {
      "max": 5,
      "min": 0,
      "acquire": 30000,
      "idle": 10000
    }
  },
  "production": {
    "host": process.env.host,
```

```
    "username": process.env.username,
    "password": process.env.password,
    "database": process.env.database,
    "logging": false,
    "dialect": "mysql",
    "operatorsAliases": false,
    "pool": {
      "max": 5,
      "min": 0,
      "acquire": 30000,
      "idle": 10000
    }
  }
}
```

Sequelize expects a [config.json] file inside of this folder by default, but this setup will allow us a more custom approach in later chapters. The [development] environment directly store the credentials for your database whereas the [production] configuration uses environment variables to fill them.

We can remove the configuration that we hardcoded earlier and replace the contents of our `index.js` database file to require our [configFile], instead.

This should look like the following code snippet:

```
import Sequelize from 'sequelize';
import configFile from '../config/';

const env = process.env.NODE_ENV || 'development';
const config = configFile[env];

const sequelize = new Sequelize(config.database, config.username,
 config.password, config);

const db = {
  sequelize,
};

export default db;
```

In the preceding code, we are using the [NODE_ENV] environmental variable to get the environment that the server is running in. We read the [config] file and pass the correct configuration to the Sequelize instance.

The Sequelize instance is then exported for use throughout our application. We use a special [db] object for this. You will see why we are doing this later on.

Next, you will learn how to generate and write models and migrations for all of the entities that our application will have.

Writing database models

After creating a connection to our MySQL server via Sequelize, we want to use it. However, our database is missing a table or structure that we can query or manipulate. Creating those is the next thing that we need to do.

Currently, we have two GraphQL entities: [User] and [Post].

Sequelize lets us create a database schema for each of our GraphQL entities. The schema is validated when inserting or updating rows in our database. We already wrote a schema for GraphQL in the [schema.js] file used by Apollo Server, but we need to create a second one for our database. The field types, as well as the fields themselves, can vary between the database and the GraphQL schema.

GraphQL schemas can have more fields than our database model, or vice versa. Perhaps you do not want to export all data from your database through the API, or maybe you generate data for your GraphQL API on the fly, when requesting data.

Let's create the first model for our posts. Create two new folders (one called [models], and the other, [migrations]) next to the [database] folder:

```
mkdir src/server/models
mkdir src/server/migrations
```

Creating each model in a separate file is much cleaner than having one big file for all models.

Your first database model

Sequelize CLI is already installed globally. allows us to generate the model automatically. This can be done by running the following command:

```
sequelize model:generate --models-path src/server/models --migrations-path
src/server/migrations --name Post --attributes text:text
```

Note: Lab solution already has migrations created. You will get an error if you are running command from solution folder. This error can be ignored.

Sequelize expects us to run the command in the folder in which we have run [sequelize init], by default. Our file structure is a bit different, because we have two layers with [src/server]. For this reason, we specify the path manually, with the first two parameters: [--models-path] and [--migrations-path].

The [--name] parameter gives our model a name under which it can be used. The [--attributes] option specifies the fields that the model should include.

This command creates a [post.js] model file in your [models] folder, and a database migration file, named [XXXXXXXXXXXXXX-create-post.js], in your [migrations] folder. The [X] is the timestamp when generating the files with the CLI. You will see how migrations work in the next section.

The following model file was created for us:

```
'use strict';

module.exports = (sequelize, DataTypes) => {
  var Post = sequelize.define('Post', {
    text: DataTypes.TEXT
  }, {});

  Post.associate = function(models) {
    // associations can be defined here
  };
```

```
  return Post;
};
```

We are using the [define] Sequelize function to create a database model:

- The first parameter is the name of the database model.
- The second option is the field configuration for this model.

A post object has the [id], [text], and [user] properties. The user will be a separate model, as seen in the GraphQL schema. Consequently, we only need to configure the [id] and [text] as columns of a post.

The [id] is the key that uniquely identifies a data record from our database. We do not specify this when running the [model:generate] command, because it is generated by MySQL automatically.

The [text] column is just a MySQL [TEXT] field, which allows us to write pretty long posts. Alternatively, there are other MySQL field types, with [MEDIUMTEXT], [LONGTEXT], and [BLOB], which could save more characters. A regular [TEXT] column should be fine for our use case.

The Sequelize CLI created a model file, exporting a function that, after execution, returns the real database model. You will soon see why this a great way of initializing our models.

Let's take a look at the migration file that is also created by the CLI.

Your first database migration

Our first migration file creates a [Posts] table and adds all required columns, as follows:

```
'use strict';

module.exports = {
  up: (queryInterface, Sequelize) => {
    return queryInterface.createTable('Posts', {
      id: {
        allowNull: false,
        autoIncrement: true,
        primaryKey: true,
        type: Sequelize.INTEGER
      },
      text: {
        type: Sequelize.TEXT
      },
      createdAt: {
        allowNull: false,
        type: Sequelize.DATE
      },
      updatedAt: {
        allowNull: false,
        type: Sequelize.DATE
      }
    });
  },
  down: (queryInterface, Sequelize) => {
    return queryInterface.dropTable('Posts');
  }
};
```

The `id` and `text` column are created, as well as two additional `datetime` columns, to save the creation and update time.

The `id` field has set `autoIncrement` and `primaryKey` to `true`. The `id` will count upward, from one to nearly infinite, for each post in our table. This `id` uniquely identifies posts for us. Passing `allowNull` with `false` disables the feature to insert a row with an empty field value.

To execute this migration, we use the Sequelize CLI again, as follows:

```
sequelize db:migrate --migrations-path src/server/migrations --config
src/server/config/index.js
```

Look inside of phpMyAdmin. Here, you will find the new table, called [Posts]. The structure of the table should look as follows:

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra
1	**id**	int(11)			No	*None*		AUTO_INCREMENT
2	**text**	text	utf8_general_ci		Yes	*NULL*		
3	**createdAt**	datetime			No	*None*		
4	**updatedAt**	datetime			No	*None*		

All of the fields were created as we desired.

Furthermore, two additional fields, [createdAt] and [updatedAt], were created. These two fields are what are called timestamps, and are used to tell when a row was either created or updated. The fields were created by Sequelize automatically. If you do not want this, you can set the [timestamps] property in the model to [false].

Every time that you use Sequelize and its migration feature, you will have an additional table, called [SequelizeMeta]. The contents of the table should look as follows:

←T→	name
Edit Copy Delete	20180812190328-create-post.js

Sequelize saves every migration that has been executed. If we add further fields in development or in a new release cycle, we can write a migration that runs all table alterings for us as an update. Sequelize skips all migrations that are saved inside of the meta table.

One major step is to bind our model to Sequelize. This process can be automated by running [sequelize init], but understanding it will teach us way more than relying on premade boilerplate commands.

Importing models with Sequelize

We want to import all of our database models at once, in a central file. Our database connection instantiator will then use this file on the other side.

Create an `index.js` file in the [models] folder, and fill in the following code:

```
import Sequelize from 'sequelize';
if (process.env.NODE_ENV === 'development' || true) {
  require('babel-plugin-require-context-hook/register')()
}

export default (sequelize) => {
  let db = {};

  const context = require.context('.', true, /^\.\/(?!index\.js).*\.js$/,
   'sync')
  context.keys().map(context).forEach(module => {
    const model = module(sequelize, Sequelize);
    db[model.name] = model;
  });

  Object.keys(db).forEach((modelName) => {
    if (db[modelName].associate) {
      db[modelName].associate(db);
    }
  });

  return db;
};
```

This file will also be generated when running [sequelize init], but we have split up the setup of the database connection and this part into different files. Usually, this would happen in just one file.

To summarize what happens in the preceding code, we search for all files ending with [.js] in the same folder as the current file, and load them all with the [require.context] statement. In development, we must execute the [babel-plugin-require-context-hook/register] hook to load the [require.context] function at the top. This package must be installed with [npm], with the following command:

```
npm install --save-dev babel-plugin-require-context-hook
```

We need to load the plugin with the start of our development server, so, open the [package.json] file and edit the server script, as follows:

```
nodemon --exec babel-node --plugins require-context-hook --watch src/server
src/server/index.js
```

When the plugin is loaded and we run the [require('babel-plugin-require-context-hook/register')()] function, the [require.context] method is available for us.

Now, we want to use our models. Go back to the `index.js` database file and import all models through the aggregation `index.js` file that we just created:

```
import models from '../models';
```

Before exporting the [db] object at the end of the file, we need to run the [models] wrapper to read all model [.js] files. We pass our Sequelize instance as a parameter, as follows:

```
const db = {
  models: models(sequelize),
```

```
  sequelize,
};
```

The new database object in the preceding command has [sequelize] and [models] as a property. Under [models], you can find the [Post] model, and every new model that we are going to add later.

The database `index.js` file is ready, and can be used now. You should import this file only once, because it can get messy when creating multiple instances of Sequelize. The pool functionality won't work correctly, and we will end up with more connections than the maximum of five that we specified earlier.

We create the global database instance in the `index.js` file of the root server folder. Add the following code:

```
import db from './database';
```

We require the [database] folder and the `index.js` file inside this folder. Loading the file instantiates the Sequelize object, including all database models.

Going forward, we want to query some data from our database via the GraphQL API that we implemented in Lab 2.

Seeding data with Sequelize

We should fill the empty [Posts] table with our fake data. To accomplish this, we will use Sequelize's feature for seeding data to our database.

Create a new folder, called [seeders]:

```
mkdir src/server/seeders
```

Now, we can run our next Sequelize CLI command, in order to generate a boilerplate file:

```
sequelize seed:generate --name fake-posts --seeders-path src/server/seeders
```

Seeders are great for importing test data into a database for development. Our [seed] file has the timestamp and the words [fake-posts] in the name, and should look as follows:

```
'use strict';

module.exports = {
  up: (queryInterface, Sequelize) => {
    /*
      Add altering commands here.
      Return a promise to correctly handle asynchronicity.

      Example:
      return queryInterface.bulkInsert('Person', [{
        name: 'John Doe',
        isBetaMember: false
      }], {});
    */
  },
  down: (queryInterface, Sequelize) => {
    /*
      Add reverting commands here.
```

```
      Return a promise to correctly handle asynchronicity.

      Example:
      return queryInterface.bulkDelete('Person', null, {});
    */
  }
};
```

As you can see in the preceding code snippet, nothing is done here. It is just an empty boilerplate file. We need to edit this file to create the fake posts that we already had in our backend. This file looks like our migration from the previous section. Replace the contents of the file with the following code:

```
'use strict';

module.exports = {
  up: (queryInterface, Sequelize) => {
    return queryInterface.bulkInsert('Posts', [{
      text: 'Lorem ipsum 1',
      createdAt: new Date(),
      updatedAt: new Date(),
    },
    {
      text: 'Lorem ipsum 2',
      createdAt: new Date(),
      updatedAt: new Date(),
    }],
    {});
  },
  down: (queryInterface, Sequelize) => {
    return queryInterface.bulkDelete('Posts', null, {});
  }
};
```

In the [up] migration, we are bulk inserting two posts, through the [queryInterface] and its [bulkInsert] command. For this, we pass an array of posts, excluding the [id] and the associated user. The [id] is created automatically, and the user is saved in a separate table later on. The [QueryInterface] of Sequelize is the general interface that Sequelize uses to talk to all databases.

In our seed file, we need to add the [createdAt] and [updatedAt] field, since Sequelize does not set up default values for the timestamp columns in MySQL. In reality, Sequelize takes care of the default values of those fields by itself, but not when seeding data. If you do not provide these values, the seed will fail, because [NULL] is not allowed for [createdAt] and [updatedAt].

The [down] migration bulk deletes all rows in the table, since this is the apparent reverse action of the [up] migration.

Execute all of the seeds from the [seeders] folder with the following command:

```
sequelize db:seed:all --seeders-path src/server/seeders --config
src/server/config/index.js
```

Sequelize does not check or save if a seed has been run already, as we are doing it with the preceding command. This means that you can run seeds multiple times if you want to.

The following screenshot shows a filled [Posts] table:

	id	text	createdAt	updatedAt
Edit Copy Delete	1	Lorem ipsum 1	2018-08-13 15:28:40	2018-08-13 15:28:40
Edit Copy Delete	2	Lorem ipsum 2	2018-08-13 15:28:40	2018-08-13 15:28:40

The demo posts are now inside of our database.

We will cover how to use Sequelize with our Apollo Server, and how to add the relationship between the user and their posts, in the next section.

Using Sequelize with Apollo

The database object is initialized upon starting the server within the root `index.js` file. We pass it from this global location down to the spots where we rely on the database. This way, we do not import the database file repeatedly, but have a single instance that handles all database queries for us.

The services that we want to publicize through the GraphQL API need access to our MySQL database. The first step is to implement the posts into our GraphQL API. It should respond with the fake posts from the database we just inserted.

Global database instance

To pass the database down to our GraphQL resolvers, we create a new object in the server `index.js` file:

```
import db from './database';

const utils = {
  db,
};
```

We create a [utils] object directly under the [import] statement of the [database] folder.

The [utils] object holds all of the utilities that our services might need access to. This can be anything, from third-party tools, to our MySQL, or any other database, such as in the preceding code.

Replace the line where we import the [services] folder, as follows:

```
import servicesLoader from './services';
const services = servicesLoader(utils);
```

The preceding code might look weird to you, but what we are doing here is executing the function that is the result of the [import] statement, and passing the [utils] object as a parameter. We must do this in two separate lines, as the [import] syntax does not allow it in just one line; so, we must first import the function exported from the [services] folder into a separate variable.

Until now, the return value of the [import] statement was a simple object. We have to change this to match our requirements.

To do this, go to the services `index.js` file and change the contents of the file, as follows:

```
import graphql from './graphql';

export default utils => ({
  graphql: graphql(utils),
});
```

We surrounded the preceding [services] object with a function, which was then exported. That function accepts only one parameter, which is our [utils] object.

That object is then given to a new function, called `graphql`. Every service that we are going to use has to be a function that accepts this parameter. It allows us to hand over any property that we want to the deepest point in our application.

When executing the preceding exported function, the result is the regular [services] object we used before. We only wrapped it inside of a function to pass the [utils] object.

The `graphql` import that we are doing needs to accept the [utils] object.

Open the `index.js` file from the `graphql` folder and replace everything but the [require] statements at the top with the following code:

```
export default (utils) => {
  const executableSchema = makeExecutableSchema({
    typeDefs: Schema,
    resolvers: Resolvers.call(utils),
  });

  const server = new ApolloServer({
    schema: executableSchema,
    context: ({ req }) => req,
  });

  return server;
};
```

Again, we surrounded everything with a function that accepts the [utils] object. The aim of all this is to have access to the database within our GraphQL resolvers.

To accomplish this, we are using the [Resolvers.call] function of JavaScript. The function allows us to set the owner object of the exported [Resolvers] function. What we are saying here is that the scope of the [Resolvers] is the [utils] object.

So, within the [Resolvers] function, accessing [this] now gives us the [utils] object. At the moment, the [Resolvers] are just a simple object, but because we use the [call] method, we must also return a function from the [resolvers.js] file.

Surround the [resolvers] object in this file with a function, and return the [resolvers] object from inside of the function:

```
export default function resolver() {
  ...
  return resolvers;
}
```

We cannot use the arrow syntax, as before. ES6 arrow syntax would automatically take a scope, but we want the [call] function to take over here.

An alternative way of doing this would be to also hand over the [utils] object as a parameter. I think the way that we have chosen is a bit cleaner, but handle it as you like.

Running the first database query

Now, we want to finally use the database. Add the following code to the top of the [export default function resolver] statement:

```
const { db } = this;
const { Post } = db.models;
```

The [this] keyword is the owner of the current method, and holds the [db] object, as stated previously. We extract the database models from the [db] object that we built in the previous section.

We can query all posts through the Sequelize model, instead of returning the fake posts from before. Replace the [posts] property within the [RootQuery] with the following code:

```
posts(root, args, context) {
  return Post.findAll({order: [['createdAt', 'DESC']]});
},
```

In the preceding code, we search and select all of the posts that we have in our database. We are using the Sequelize [findAll] method and returning the result of it. The return value will be a JavaScript promise, which automatically gets resolved when the database is finished collecting the data.

A typical news feed, such as on Twitter or Facebook, orders the posts according to the creation date. That way, you have the newest posts at the top and the oldest at the bottom. Sequelize expects an array of arrays as a parameter of the order property that we pass as the first parameter to the [findAll] method. The results are ordered by the creation date.

As we are not using the demo [posts] array anymore, you can remove it from the [resolvers.js] file.

You can start the server with `npm run server` and execute the GraphQL posts query from Lab 2 again. The output will look as follows:

```
{
  "data": {
    "posts": [{
      "id": 1,
      "text": "Lorem ipsum 1",
      "user": null
    },
    {
      "id": 2,
      "text": "Lorem ipsum 2",
      "user": null
    }]
  }
}
```

The [id] and [text] fields look fine, but the [user] object is [null]. This happened because we did not define a user model or declare a relationship between the user and the post model. We will change this in the next section.

One-to-one relationships in Sequelize

We need to associate each post with a user, to fill the gap that we have created in our GraphQL response. A post has to have an author. It would not make sense to have a post without an associated user.

First, we will generate a [User] model and migration. We will use the Sequelize CLI again, as follows:

```
sequelize model:generate --models-path src/server/models --migrations-path
src/server/migrations --name User --attributes avatar:string,username:string
```

The migration file creates the `Users` table and adds the `avatar` and `username` column. A data row looks like a post in our fake data, but it also includes an autogenerated ID and two timestamps, as you have seen before.

What every post needs, of course, is an extra field, called `userId`. This column acts as the foreign key to reference a unique user. Then, we can join the user relating to each post.

Updating the table structure with migrations

We have to write a third migration, adding the [userId] column to our [Post] table, but also including it in our database [Post] model.

Generating a boilerplate migration file is very easy with the Sequelize CLI:

```
sequelize migration:create --migrations-path src/server/migrations --name add-userId-
to-post
```

You can directly replace the content, as follows:

```
'use strict';

module.exports = {
  up: (queryInterface, Sequelize) => {
    return Promise.all([
      queryInterface.addColumn('Posts',
        'userId',
        {
          type: Sequelize.INTEGER,
        }),
      queryInterface.addConstraint('Posts', ['userId'], {
        type: 'foreign key',
        name: 'fk_user_id',
        references: {
          table: 'Users',
          field: 'id',
        },
        onDelete: 'cascade',
        onUpdate: 'cascade',
      }),
    ]);
  },

  down: (queryInterface, Sequelize) => {
```

```
    return Promise.all([
      queryInterface.removeColumn('Posts', 'userId'),
    ]);
  }
};
```

This migration is a bit more complex, and I will explain it on a step-by-step basis.

In the [up] migration, we are using the [queryInterface] to first add the [userId] column to the [Posts] table.

Secondly, we add a foreign key constraint, with the [addConstraint] function. The constraint represents the relationship between both the user and the post entities. The relationship is saved in the [userId] column of the Post table.

I experienced some issues when running the migrations without using [Promise.all], which ensures that all promises in the array are resolved. Returning only the array did not run both the [addColumn] and [addConstraint] methods.

The preceding [addConstraint] function receives the [foreign key] string as a [type] which says that the data type is the same as the corresponding column in the [Users] table. We want to give our constraint the custom name [fk_user_id], in order to identify it later.

Then, we specify the [references] field for the [userId] column. Sequelize requires a table, which is the [Users] table, and the field that our foreign key relates to, which is the [id] column of the [User] table. This is everything that is required to get a working database relationship.

Furthermore, we change the [onUpdate] and [onDelete] constraints to [cascade]. What this means is that, when a user either gets deleted or has their user ID updated, the change is reflected in the user's posts. Deleting a user results in deleting all posts of a user, and updating a user's ID updates the ID on all of the user's posts. We do not need to handle all of this in our application code, which would be inefficient.

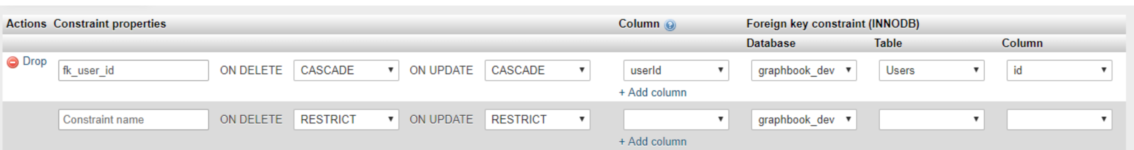
Rerun the migration, in order to see what changes occurred:

```
sequelize db:migrate --migrations-path src/server/migrations --config
src/server/config/index.js
```

The benefit of running migrations through Sequelize is that it goes through all of the possible migrations from the [migrations] folder. It excludes those that are already saved inside of the [SequelizeMeta] table, and then chronologically runs the migrations that are left. Sequelize can do this because the timestamp is included in every migration's filename.

After running the migration, there should be a [Users] table, and the [userId] column should be added to the [Posts] table.

Take a look at the relation view of the [Posts] table in phpMyAdmin. You can find it under the [Structure] view, by clicking on [Relation view]:



As you can see in the preceding screenshot, we have our foreign key constraint. The correct name was taken, and the cascade option, too.

If you receive an error when running migrations, you can easily undo them, as follows:

```
sequelize db:migrate:undo --migrations-path src/server/migrations --config
src/server/config/index.js
```

This command undoes the most recent migrations. Always be conscious of what you do here. Keep a backup if you are unsure whether everything works correctly.

You can also revert all migrations at once, or only revert to one specific migration, so that you can go back to a specific timestamp:

```
sequelize db:migrate:undo:all --to XXXXXXXXXXXXXX-create-posts.js --migrations-path
src/server/migrations --config src/server/config/index.js
```

Leave out the parameter [--to] to undo all migrations.

We have now established the database relationship, but Sequelize must know about the relationship, too. You will learn how this is done in the next section.

Model associations in Sequelize

Now that we have the relationship configured with the foreign key, it also needs to be configured inside of our Sequelize model.

Go back to the [Post] model file and replace the [associate] function with the following:

```
Post.associate = function(models) {
  Post.belongsTo(models.User);
};
```

The [associate] function gets evaluated inside of our aggregating `index.js` file, where all model files are imported.

We are using the [belongsTo] function, which tells Sequelize that every post belongs to exactly one user. Sequelize gives us a new function on the [Post] model, called [getUser], to retrieve the associated user. The naming is done by convention, as you can see. Sequelize does all of this automatically.

Do not forget to add the [userId] as a queryable field to the [Post] model itself, as follows:

```
userId:  DataTypes.INTEGER,
```

The [User] model needs to implement the reverse association, too. Add the following code to the [User] model file:

```
User.associate = function(models) {
  User.hasMany(models.Post);
};
```

The [hasMany] function means the exact opposite of the [belongsTo] function. Every user can have multiple posts associated in the Post table. It can be anything, from zero to multiple posts.

You can compare the new data layout with the preceding one. Up to this point, we had the posts and users inside of one big array of objects. Now, we have split every object into two tables. Both tables connect to each other through the foreign key. This is required every time we run the GraphQL query to get all posts, including their authors.

So, we must extend our current [resolvers.js] file. Add the [Post] property to the [resolvers] object, as follows:

```
Post: {
  user(post, args, context) {
```

```
    return post.getUser();
  },
},
```

The [RootQuery] and [RootMutation] were the two main properties that we had so far. The [RootQuery] is the starting point where all GraphQL queries begin.

With the old demo posts, we were able to directly return a valid and complete response, since everything that we needed was in there already. Now, a second query, or a [JOIN], is needed to collect all necessary data for a complete response.

The [Post] entity is introduced to our [resolvers], where we can define functions for every property of our GraphQL schema. Only the user is missing in our response; the rest is there. That is why we have added the [user] function to the resolvers.

The first parameter of the function is the [post] model instance that we are returning inside of the [RootQuery] resolver.

Then, we use the [getUser] function that Sequelize gave us. Executing the [getUser] function runs the correct MySQL [SELECT] query, in order to get the correct user from the [Users] table. It does not run a real MySQL [JOIN], but only queries the user in a separate MySQL command. Later on, you will learn another method for running a [JOIN] directly, which is more efficient.

However, if you query for all posts via the GraphQL API, the user will still be [null]. We have not added any users to the database yet, so let's insert them next.

Seeding foreign key data

The challenge of adding users is that we have already introduced a foreign key constraint to the database. You can follow these instructions to learn how to get it working:

1. We use the Sequelize CLI to generate an empty [seeders] file, as follows:

```
sequelize seed:generate --name fake-users --seeders-path src/server/seeders
```

2. Fill in the following code to insert the fake users:

```
'use strict';

module.exports = {
  up: (queryInterface, Sequelize) => {
    return queryInterface.bulkInsert('Users', [{
      avatar: '/uploads/avatar1.png',
      username: 'TestUser',
      createdAt: new Date(),
      updatedAt: new Date(),
    },
    {
      avatar: '/uploads/avatar2.png',
      username: 'TestUser2',
      createdAt: new Date(),
      updatedAt: new Date(),
    }],
    {});
```

```
  },
  down: (queryInterface, Sequelize) => {
    return queryInterface.bulkDelete('Users', null, {});
  }
};
```

The preceding code looks like the [seeders] file for the posts, but instead, we are now inserting users with the correct fields. Every user receives an auto-incremented ID by our MySQL server when inserting a user.

3. We must maintain the relationships as configured in our database. Adjust the [posts] seed file to reflect this, and add a [userId] to both posts in the [up] migration:

```
return queryInterface.bulkInsert('Posts', [{
  text: 'Lorem ipsum 1',
  userId: usersRows[0].id,
  createdAt: new Date(),
  updatedAt: new Date(),
},
{
  text: 'Lorem ipsum 2',
  userId: usersRows[1].id,
  createdAt: new Date(),
  updatedAt: new Date(),
}],
{});
```

We created the [users] seed file after the [post] seeders file. This means that the posts are inserted before the users exist, because of the timestamps of the files. Generally, this is not a problem, but since we have introduced a foreign key constraint, we are not able to insert posts with a [userId] when the underlying user does not exist in our database. MySQL forbids this.

There is also another problem. The current posts in our table do not receive a [userId], and we do not want to write a separate migration or seed to fix those posts.

There are two options here. You can either manually truncate the tables through phpMyAdmin and SQL statements, or you can use the Sequelize CLI. It is easier to use the CLI, but the result will be the same either way. The following command will undo all seeds:

```
sequelize db:seed:undo:all --seeders-path src/server/seeders --config
src/server/config/index.js
```

When undoing seeds, the tables are not truncated, and therefore, the [autoIncrement] index is not set back to one, but stays at the current index. Reverting seeds multiple times raises the user's or post's ID, and therefore, stops the seeds from working. The [userId] column in the post seed cannot be hardcoded when using the [down] migration.

You can fix this by selecting all users with a raw query in the [post] seed file. We can pass the retrieved user IDs statically. Replace the [up] property with the following:

```
  up: (queryInterface, Sequelize) => {
    // Get all existing users
    return queryInterface.sequelize.query(
      'SELECT id from Users;',
    ).then((users) => {
      const usersRows = users[0];
```

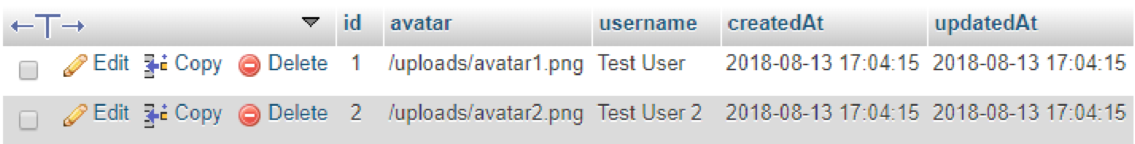
```
      return queryInterface.bulkInsert('Posts', [{
        text: 'Lorem ipsum 1',
        userId: usersRows[0].id,
        createdAt: new Date(),
        updatedAt: new Date(),
      },
      {
        text: 'Lorem ipsum 2',
        userId: usersRows[1].id,
        createdAt: new Date(),
        updatedAt: new Date(),
      }],
      {});
    });
  },
```

This way, we get all of the users first, and then select the ID manually. This solution is not great, but it fixes the problem with the static [userId] field in the seeds. You can undo and redo the seeds as often as you want. There is no need to truncate the table to get the correct [autoIncrement] index.

We have not gotten any further now, since the posts are still inserted before the users. From my point of view, the easiest way to fix this is to rename the seeder files. Simply adjust the timestamp of the fake user seed file to be before the post seed file's timestamp, or the other way around. Again, execute all seeds, as follows:

```
sequelize db:seed:all --seeders-path src/server/seeders --config
src/server/config/index.js
```

If you take a look inside your database, you should see a filled [Posts] table, including the [userId]. The [Users] table should look like the following screenshot:



	id	avatar	username	createdAt	updatedAt
Edit Copy Delete	1	/uploads/avatar1.png	Test User	2018-08-13 17:04:15	2018-08-13 17:04:15
Edit Copy Delete	2	/uploads/avatar2.png	Test User 2	2018-08-13 17:04:15	2018-08-13 17:04:15

You can now rerun the GraphQL query, and you should see a working association between the users and their posts, because the [user] field is filled.

We have achieved a lot. We can serve data from our database through the GraphQL API by matching its schema.

Mutating data with Sequelize

Requesting data from our database via the GraphQL API works. Now comes the tough part: adding a new post to the [Posts] table.

Before we start, we must extract the new database model from the [db] object at the top of the exported function in our [resolvers.js] file:

```
const { Post, User } = db.models;
```

Currently, we have no authentication to identify the user that is creating the post. We will fake this step until the authentication is implemented in a later lab.

We have to edit the GraphQL resolvers to add the new post. Replace the old [addPost] function with the new one, as shown in the following code snippet:

```
addPost(root, { post }, context) {
  logger.log({
    level: 'info',
    message: 'Post was created',
  });

  return User.findAll().then((users) => {
    const usersRow = users[0];

    return Post.create({
      ...post,
    }).then((newPost) => {
      return Promise.all([
        newPost.setUser(usersRow.id),
      ]).then(() => {
        return newPost;
      });
    });
  });
},
```

As always, the preceding mutation returns a promise. The promise is resolved when the deepest query has been executed successfully. The execution order is as follows:

1. We retrieve all users from the database through the [User.findAll] method.
2. We insert the post into our database with the [create] function of Sequelize. The only property that we pass is the post object from the original request, which only holds the text of the post. MySQL autogenerates the [id] of the post.

ProTip

Sequelize also offers a [build] function, which initializes the model instance for us. In this case, we would have to run the [save] method to insert the model manually. The [create] function does this for us all at once.

3. The post has been created, but the [userId] was not set.

You could also directly add the user ID in the [Post.create] function. The problem here is that we did not establish the model associations on the JavaScript side. If we return the created post model without explicitly using [setUser] on the model instance, we cannot use the [getUser] function until we create a new instance of the post model.

So, to fix this problem, we run the [create] function, resolve the promise, and then run [setUser] separately. As a parameter of [setUser], we statically take the ID of the first user from the [users] array.

We resolve the promise of the [setUser] function by using an array surrounded by [Promise.all]. This allows us to add further Sequelize methods later on. For example, you could add a category on each post, too.

4. The returned value is the newly created post model instance, after we have set the [userId] correctly.

Everything is set now. To test our API, we are going to use Postman again. We need to change the [addPost] request. The [userInput] that we added before is not needed anymore, because the backend statically chooses the first user out of our database. You can send the following request body:

```
{
  "operationName":null,
  "query": "mutation addPost($post : PostInput!) { addPost(post : $post) {
    id text user { username avatar }}}",
  "variables":{
    "post": {
      "text": "You just added a post."
    }
  }
}
```

Your GraphQL schema must reflect this change, so remove the [userInput] from there, too:

```
addPost (
  post: PostInput!
): Post
```

Running the [addPost] GraphQL mutation now adds a post to the [Posts] table, as you can see in the following screenshot:

←T→				id	text	createdAt	updatedAt	userId
☐	Edit	Copy	Delete	1	Lorem ipsum 1	2018-08-14 11:08:28	2018-08-14 11:08:28	1
☐	Edit	Copy	Delete	2	Lorem ipsum 2	2018-08-14 11:08:28	2018-08-14 11:08:28	2
☐	Edit	Copy	Delete	3	You just added a post.	2018-08-14 11:08:46	2018-08-14 11:08:46	1

We have rebuilt the example from the last lab, but we are using a database in our backend. To extend our application, we are going to add two new entities.

Many-to-many relationships

Facebook provides users with various ways to interact. Currently, we only have the opportunity to request and insert posts. As in the case of Facebook, we want to have chats with our friends and colleagues. We will introduce two new entities to cover this.

The first entity is called [Chat], and the second is called [Message].

Before starting with the implementation, we need to lay out a detailed plan of what those entities will enable us to do.

A user can have multiple chats, and a chat can belong to multiple users. This relationship gives us the opportunity to have group chats with multiple users, as well as private chats, between only two users. A message belongs to one user, but every message also belongs to one chat.

Model and migrations

When transferring this into real code, we first generate the [Chat] model. The problem here is that we have a many-to-many relationship between users and chats. In MySQL, this kind of relationship requires a table, to store the relations between all entities separately.

Those tables are called **join tables**. Instead of using a foreign key on the chat or a user to save the relationship, we have a table called [user_chats]. The user's ID and the chat's ID are associated with each other inside of this table. If a user participates in multiple chats, they will have multiple rows in this table, with different chat IDs.

Chat model

Let's start by creating the [Chat] model and migration. A chat itself does not store any data; we use it for grouping specific users' messages:

```
sequelize model:generate --models-path src/server/models --migrations-path
src/server/migrations --name Chat --attributes
firstName:string,lastName:string,email:string
```

Generate the migration for our association table, as follows:

```
sequelize migration:create --migrations-path src/server/migrations --name create-user-
chats
```

Adjust the [users_chats] migration generated by the Sequelize CLI. We specify the user and chat IDs as attributes for our relationship. References inside of a migration automatically create foreign key constraints for us. The migration file should look like the following code snippet:

```
'use strict';

module.exports = {
  up: (queryInterface, Sequelize) => {
    return queryInterface.createTable('users_chats', {
      id: {
        allowNull: false,
        autoIncrement: true,
        primaryKey: true,
        type: Sequelize.INTEGER
      },
      userId: {
        type: Sequelize.INTEGER,
        references: {
          model: 'Users',
          key: 'id'
        },
        onDelete: 'cascade',
        onUpdate: 'cascade',
      },
      chatId: {
        type: Sequelize.INTEGER,
        references: {
          model: 'Chats',
          key: 'id'
        },
        onDelete: 'cascade',
        onUpdate: 'cascade',
      },
      createdAt: {
        allowNull: false,
```

```
        type: Sequelize.DATE
      },
      updatedAt: {
        allowNull: false,
        type: Sequelize.DATE
      }
    });
  },
  down: (queryInterface, Sequelize) => {
    return queryInterface.dropTable('users_chats');
  }
};
```

A separate model file for the association table is not needed, because we can rely on this table in the models where the association is required. The [id] column could be left out, because the row should be identifiable.

Associate the user to the [Chat] model via the new relation table in the [User] model, as follows:

```
User.belongsToMany(models.Chat, { through: 'users_chats' });
```

Do the same for the [Chat] model, as follows:

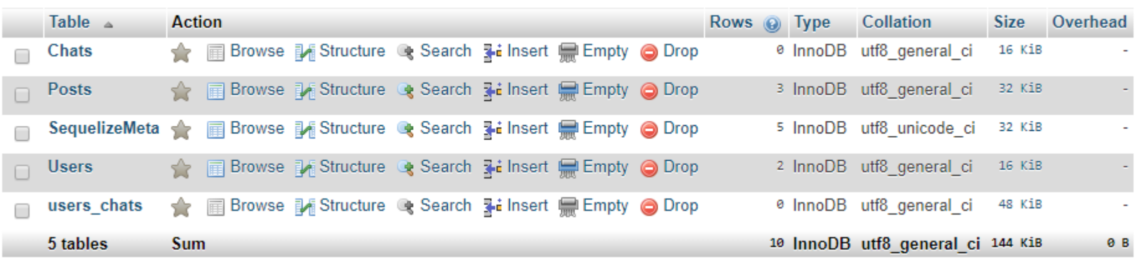
```
Chat.belongsToMany(models.User, { through: 'users_chats' });
```

The [through] property tells Sequelize that the two models are related via the [users_chats] table. Normally, when you are not using Sequelize and are trying to select all users and chats merged in raw SQL, you need to maintain this association manually, and join the three tables on your own. Sequelize's querying and association capabilities are so complex, this is all done for you.

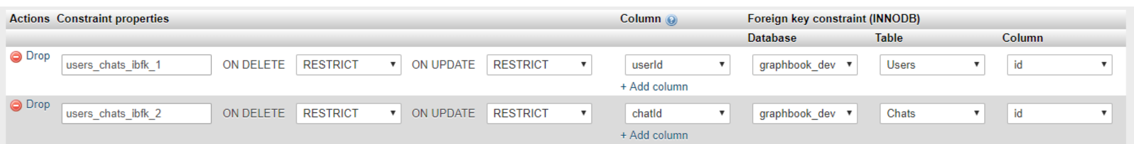
Rerun the migrations to let the changes take effect:

```
sequelize db:migrate --migrations-path src/server/migrations --config
src/server/config/index.js
```

The following screenshot shows how your database should look now:



You should see two foreign key constraints in the relation view of the [users_chats] table. The naming is done automatically:



This setup was the tough part. Next up is the message entity, which is a simple one-to-one relationship. One message belongs to one user and one chat.

Message model

A message is much like a post, except that it is only readable inside of a chat, and is not public to everyone.

Generate the model and migration file with the CLI, as follows:

```
sequelize model:generate --models-path src/server/models --migrations-path
src/server/migrations --name Message --attributes
text:string,userId:integer,chatId:integer
```

Add the missing references in the created migration file, as follows:

```
userId: {
  type: Sequelize.INTEGER,
  references: {
    model: 'Users',
    key: 'id'
  },
  onDelete: 'SET NULL',
  onUpdate: 'cascade',
},
chatId: {
  type: Sequelize.INTEGER,
  references: {
    model: 'Chats',
    key: 'id'
  },
  onDelete: 'cascade',
  onUpdate: 'cascade',
},
```

Now, we can run the migrations again, in order to create the [Messages] table using the [sequelize db:migrate] Terminal command.

```
{
  "operationName":null,
  "query": "mutation addPost($post : PostInput!) { addPost(post : $post) {
    id text user { username avatar }}}",
  "variables":{
    "post": {
      "text": "You just added a post."
    }
  }
}
```

The references also apply to our model file, where we need to use Sequelize's [belongsTo] function to get all of those convenient model methods for our resolvers. Replace the [associate] function of the [Message] model with the following code:

```
Message.associate = function(models) {
  Message.belongsTo(models.User);
  Message.belongsTo(models.Chat);
};
```

In the preceding code, we define that every message is related to exactly one user and chat.

On the other side, we must also associate the [Chat] model with the messages. Add the following code to the [associate] function of the [Chat] model:

```
Chat.hasMany(models.Message);
```

The next step is to adjust our GraphQL API to provide chats and messages.

Chats and messages in GraphQL

We have introduced some new entities with messages and chats. Let's include those in our Apollo schema. In the following code, you can see an excerpt of the changed entities, fields, and parameters of our GraphQL schema:

```
type User {
  id: Int
  avatar: String
  username: String
}

type Post {
  id: Int
  text: String
  user: User
}

type Message {
  id: Int
  text: String
  chat: Chat
  user: User
}

type Chat {
  id: Int
  messages: [Message]
  users: [User]
}

type RootQuery {
  posts: [Post]
  chats: [Chat]
}
```

Take a look at the following short changelog of our GraphQL schema:

- The [User] type received an [id] field, thanks to our database.

},

- The [Message] type is entirely new. It has a text field like a typical message, and user and chat fields, which are requested from the referenced tables in the database model.
- The [Chat] type is also new. A chat has a list of messages that are returned as an array. These can be queried through the chat ID saved in the message table. Furthermore, a chat can have an unspecified number of users. The relationships between users and chats are saved in our separate join table, as stated previously. The interesting thing here is that our schema does not know anything about this table; it is just for our internal use, to save the data appropriately in our MySQL server.
- I have also added a new [RootQuery], called [chats]. This query returns all of a user's chats.

These factors should be implemented in our resolvers, too. Our resolvers should look as follows:

```
Message: {
  user(message, args, context) {
    return message.getUser();
  },
  chat(message, args, context) {
    return message.getChat();
  },
},
Chat: {
  messages(chat, args, context) {
    return chat.getMessages({ order: [['id', 'ASC']] });
  },
  users(chat, args, context) {
    return chat.getUsers();
  },
},
RootQuery: {
  posts(root, args, context) {
    return Post.findAll({order: [['createdAt', 'DESC']]});
  },
  chats(root, args, context) {
    return User.findAll().then((users) => {
      if (!users.length) {
        return [];
      }

      const usersRow = users[0];

      return Chat.findAll({
        include: [{
          model: User,
          required: true,
          through: { where: { userId: usersRow.id } },
        },
        {
          model: Message,
        }],
      });
    });
  },
},
```

Let's go through the changes, one by one, as follows:

1. I added the new [RootQuery], called [chats], to return all fields, as in our schema:
    - Until we get a working authentication, we will statically use the first user when querying for all chats.
    - We are using the [findAll] method of Sequelize and joining the users of any returned chat. For this, we use the [include] property of Sequelize on the user model within the [findAll] method. It runs a MySQL [JOIN], and not a second [SELECT] query.
    - Setting the [include] statement to [required] runs an [INNER JOIN] and not a [LEFT OUTER JOIN], by default. Any chat that does not match the condition in the [through] property is excluded. In our example, the condition is that the user ID has to match.
    - Lastly, we join all available messages for each chat in the same way, without any condition.
2. We added the [Chat] property to the resolvers object. There, we ran the [getMessages] and [getUsers] functions, to retrieve all of the joined data. All messages are sorted by the ID in ascending order (to show the latest message at the bottom of a chat window, for example).
3. We added the [Message] property to our resolvers.

It is important that we are using the new models here. We should not forget to extract them from the [db.models] object inside of the resolver function. It must look as follows:

```
const { Post, User, Chat, Message } = db.models;
```

After saving all of the files, you can start the backend (or, it should restart automatically).

You can send this GraphQL request to test the changes:

```
{
  "operationName":null,
  "query": "{ chats { id users { id } messages { id text user { id username
  } } } }",
  "variables":{}
}
```

The response should give us an empty [chats] array, as follows:

```
{
  "data": {
    "chats": []
  }
}
```

The empty array was returned because we do not have any chats or messages in our database. You will see how to fill it with data in the next section.

Seeding many-to-many data

Testing our implementation requires data in our database. We have three new tables, so we will create three new seeders, in order to get some test data to work with.

Let's start with the chats, as follows:

```
sequelize seed:generate --name fake-chats --seeders-path src/server/seeders
```

Now, replace the new seeder file with the following code. Running the following code creates a chat in our database. We do not need more than two timestamps, because the chat ID is generated automatically:

```
'use strict';

module.exports = {
  up: (queryInterface, Sequelize) => {
    return queryInterface.bulkInsert('Chats', [{
      createdAt: new Date(),
      updatedAt: new Date(),
    }],
    {});
  },
  down: (queryInterface, Sequelize) => {
    return queryInterface.bulkDelete('Chats', null, {});
  }
};
```

Next, we insert the relation between two users and the new chat. We do this by creating two entries in the [users_chats] table where we reference them. Now, generate the boilerplate seed file, as follows:

```
sequelize seed:generate --name fake-chats-users-relations --seeders-path
src/server/seeders
```

Our seed should look much like the previous ones, as follows:

```
'use strict';

module.exports = {
  up: (queryInterface, Sequelize) => {
    const usersAndChats = Promise.all([
      queryInterface.sequelize.query(
        'SELECT id from Users;',
      ),
      queryInterface.sequelize.query(
        'SELECT id from Chats;',
      ),
    ]);

    return usersAndChats.then((rows) => {
      const users = rows[0][0];
      const chats = rows[1][0];

      return queryInterface.bulkInsert('users_chats', [{
        userId: users[0].id,
        chatId: chats[0].id,
        createdAt: new Date(),
        updatedAt: new Date(),
      },
      {
        userId: users[1].id,
        chatId: chats[0].id,
        createdAt: new Date(),
```

```
        updatedAt: new Date(),
      }],
      {});
    });
  },
  down: (queryInterface, Sequelize) => {
    return queryInterface.bulkDelete('users_chats', null, {});
  }
};
```

First, we resolve all users and chats by using [Promise.all]. This ensures that, when the promise is resolved, all of the chats and users are available at the same time. To test the chat functionality, we choose the first chat and the first two users returned from the database. We take their IDs and save them in our [users_chats] table. Those two users should be able to talk to each other through this one chat later on.

The last table without any data is the [Messages] table. Generate the seed file, as follows:

```
sequelize seed:generate --name fake-messages --seeders-path src/server/seeders
```

Again, replace the generated boilerplate code, as follows:

```
'use strict';

module.exports = {
  up: (queryInterface, Sequelize) => {
    const usersAndChats = Promise.all([
      queryInterface.sequelize.query(
        'SELECT id from Users;',
      ),
      queryInterface.sequelize.query(
        'SELECT id from Chats;',
      ),
    ]);

    return usersAndChats.then((rows) => {
      const users = rows[0][0];
      const chats = rows[1][0];

      return queryInterface.bulkInsert('Messages', [{
        userId: users[0].id,
        chatId: chats[0].id,
        text: 'This is a test message.',
        createdAt: new Date(),
        updatedAt: new Date(),
      },
      {
        userId: users[1].id,
        chatId: chats[0].id,
        text: 'This is a second test message.',
        createdAt: new Date(),
        updatedAt: new Date(),
      },
      {
```

```
        userId: users[1].id,
        chatId: chats[0].id,
        text: 'This is a third test message.',
        createdAt: new Date(),
        updatedAt: new Date(),
      }],
      {});
    });
  },
  down: (queryInterface, Sequelize) => {
    return queryInterface.bulkDelete('Messages', null, {});
  }
};
```

Now, all of the seed files should be ready. It makes sense to empty all of the tables before running the seeds, so that you can work with clean data. I personally like to delete all tables in the database from time to time and rerun all of the migrations and seeds, in order to test them from zero. Whether or not you are doing this, you should at least be able to run the new seed.

Try to run the GraphQL [chats] query again, as follows:

```
{
  "data": {
    "chats": [{
      "id": 1,
      "users": [
        {
          "id": 1
        },
        {
          "id": 2
        }
      ],
      "messages": [
        {
          "id": 1,
          "text": "This is a test message.",
          "user": {
            "id": 1,
            "username": "Test User"
          }
        },
        {
          "id": 2,
          "text": "This is a second test message.",
          "user": {
            "id": 2,
            "username": "Test User 2"
          }
        },
        {
          "id": 3,
          "text": "This is a third test message.",
```

```
          "user": {
            "id": 2,
            "username": "Test User 2"
          }
        }
      ]}
    ]
  }
}
```

Great! Now, we can request all of the chats that a user participates in, and get all referenced users and their messages.

Now, we also want to do that for only one chat. Follow these instructions to get it done:

1. Add a [RootQuery] chat that takes a [chatId] as a parameter:

```
chat(root, { chatId }, context) {
  return Chat.findById(chatId, {
    include: [{
      model: User,
      required: true,
    },
    {
      model: Message,
    }],
  });
},
```

With this implementation, we have the problem that all users can send a query to our Apollo server, and in return, get the complete chat history, even if they are not referenced in the chat. We will not be able to fix this until we have implemented authentication.

2. Add the new query to the GraphQL schema, under [RootQuery]:

```
chat(chatId: Int): Chat
```

3. Send the GraphQL request to test the implementation, as follows:

```
{
  "operationName":null,
  "query": "query($chatId: Int!){ chat(chatId: $chatId) {
    id users { id } messages { id text user { id username } } } }",
  "variables":{ "chatId": 1 }
}
```

We are sending this query, including the [chatId] as a parameter. To pass a parameter, you must define it in the query with its GraphQL data type. Then, you can set it in the specific GraphQL query that you are executing, which is the [chat] query, in our case. Lastly, you must insert the parameter's value in the [variables] field of the GraphQL request.

You may remember the response from the last time. The new response will look much like a result from the [chats] query, but instead of an array of chats, we will just have one [chat] object.

We are missing a major feature: sending new messages or creating a new chat. We will create the corresponding schema, and the resolvers for it, in the next section.

Creating a new chat

New users want to chat with their friends. Creating a new chat is essential, of course.

The best way to do this is to accept a list of user IDs that also allows the creation of group chats. Do this as follows:

1. Add the [addChat] function to the [RootMutation] in the [resolvers.js] file, as follows:

```
addChat(root, { chat }, context) {
  logger.log({
    level: 'info',
    message: 'Message was created',
  });
  return Chat.create().then((newChat) => {
    return Promise.all([
      newChat.setUsers(chat.users),
    ]).then(() => {
      return newChat;
    });
  });
},
```

Sequelize added the [setUsers] function to the chat model instance. It was added because of the associations using the [belongsToMany] method in the chat model. There, we can directly provide an array of user IDs that should be associated with the new chat, through the [users_chats] table.

2. Change the schema so that you can run the GraphQL mutation. We have to add the new input type and mutation, as follows:

```
input ChatInput {
  users: [Int]
}

type RootMutation {
  addPost (
    post: PostInput!
  ): Post
  addChat (
    chat: ChatInput!
  ): Chat
}
```

3. Test the new GraphQL [addChat] mutation as your request body:

```
{
  "operationName":null,
  "query": "mutation addChat($chat: ChatInput!) { addChat(chat:
    $chat) { id users { id } }}",
  "variables":{
    "chat": {
```

```
      "users": [1, 2]
    }
  }
}
```

You can verify that everything worked by checking the users returned inside of the [chat] object.

Creating a new message

We can use the [addPost] mutation as our basis, and extend it. The result accepts a [chatId] and uses the first user from our database. Later, the authentication will be the source of the user ID:

1. Add the [addMessage] function to the [RootMutation] in the [resolvers.js] file, as follows:

```
addMessage(root, { message }, context) {
  logger.log({
    level: 'info',
    message: 'Message was created',
  });

  return User.findAll().then((users) => {
    const usersRow = users[0];

    return Message.create({
      ...message,
    }).then((newMessage) => {
      return Promise.all([
        newMessage.setUser(usersRow.id),
        newMessage.setChat(message.chatId),
      ]).then(() => {
        return newMessage;
      });
    });
  });
},
```

2. Then, add the new mutation to your GraphQL schema. We also have a new input type for our messages:

```
input MessageInput {
  text: String!
  chatId: Int!
}

type RootMutation {
  addPost (
    post: PostInput!
  ): Post
  addChat (
    chat: ChatInput!
  ): Chat
  addMessage (
    message: MessageInput!
```

```
  ): Message
}
```

3. You can send the request in the same way as the [addPost] request:

```
{
   "operationName":null,
   "query": "mutation addMessage($message : MessageInput!) {
     addMessage(message : $message) { id text }}",
   "variables":{
     "message": {
       "text": "You just added a message.",
       "chatId": 1
     }
   }
}
```

Now, everything is set. The client can now request all posts, chats, and messages. Furthermore, users can create new posts, create new chat rooms, and send chat messages.

Summary

Our goal in this lab was to create a working backend with a database as storage, which we have achieved pretty well. We can add further entities and migrate and seed them with Sequelize. Migrating our database changes won't be a problem for us when it comes to going into production.

In this lab, we also covered what Sequelize automates for us when using its models, and how great it works in coordination with our Apollo Server.

In the next lab, we will focus on how to use the Apollo React Client library with our backend, as well as the database behind it.